Final Regulatory Analyses:

Including the:

- Final Cost-Benefit Analysis
- Least-Burdensome Alternative Analysis
- Administrative Procedure Act Determinations
- Regulatory Fairness Act Compliance

Chapter 173-446 WAC

Climate Commitment Act Program

By

Kasia Patora

For the

Air Quality Program

Washington State Department of Ecology

Olympia, Washington

September 2022, Publication 22-02-047

Publication Information

This document is available on the Department of Ecology's website at:
https://apps.ecology.wa.gov/publications/SummaryPages/2202047.html

Contact Information

Air Quality Program

P.O. Box 47600
Olympia, WA 98504-7600
Phone: 360-407-6800
Website: Washington State Department of Ecology[1]

ADA Accessibility

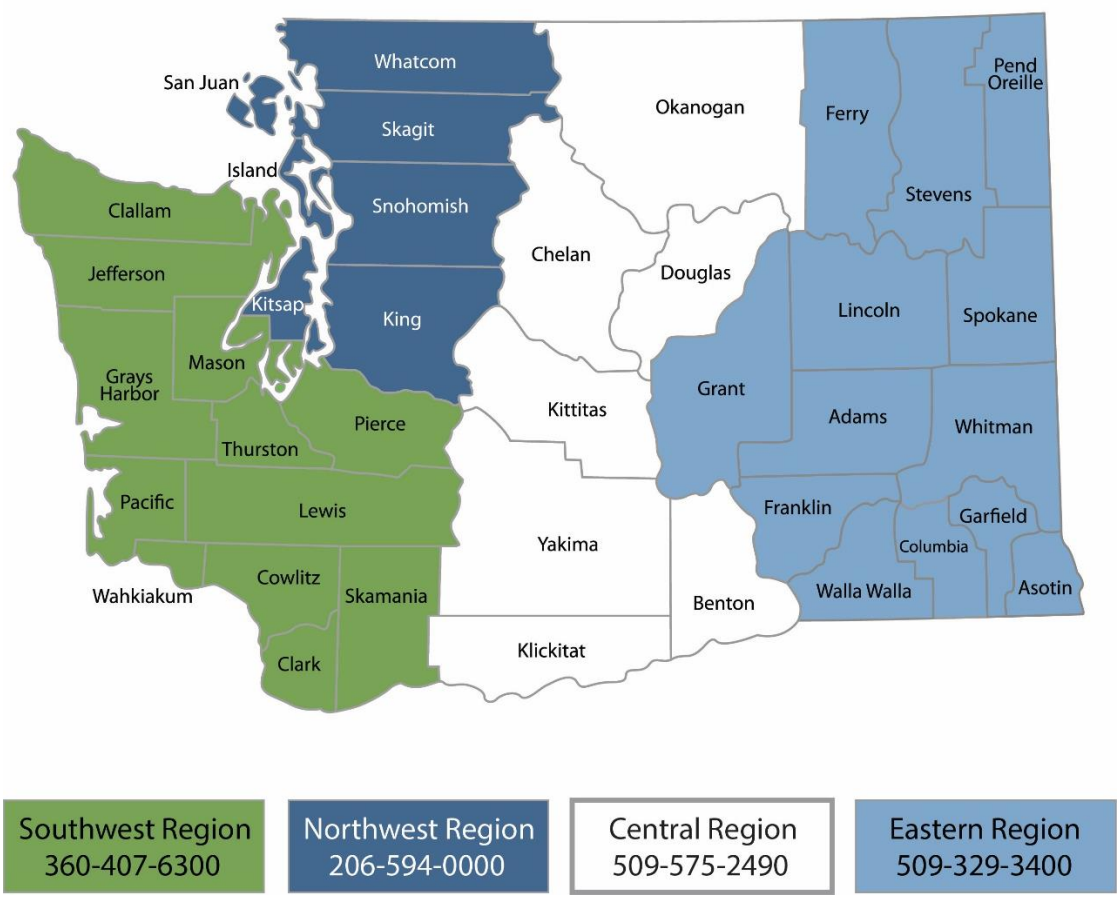
The Department of Ecology is committed to providing people with disabilities access to information and services by meeting or exceeding the requirements of the Americans with Disabilities Act (ADA), Section 504 and 508 of the Rehabilitation Act, and Washington State Policy #188.

To request an ADA accommodation, contact Ecology by phone at 360-407-6831 or email at ecyADAcoordinator@ecy.wa.gov. For Washington Relay Service or TTY call 711 or 877-833-6341. Visit Ecology's website for more information.

[1] www.ecology.wa.gov/contact

Department of Ecology's Regional Offices

Map of Counties Served



Region	Counties served	Mailing Address	Phone
Southwest	Clallam, Clark, Cowlitz, Grays Harbor, Jefferson, Mason, Lewis, Pacific, Pierce, Skamania, Thurston, Wahkiakum	P.O. Box 47775 Olympia, WA 98504	360-407-6300
Northwest	Island, King, Kitsap, San Juan, Skagit, Snohomish, Whatcom	P.O. Box 330316 Shoreline, WA 98133	206-594-0000
Central	Benton, Chelan, Douglas, Kittitas, Klickitat, Okanogan, Yakima	1250 W Alder St Union Gap, WA 98903	509-575-2490
Eastern	Adams, Asotin, Columbia, Ferry, Franklin, Garfield, Grant, Lincoln, Pend Oreille, Spokane, Stevens, Walla Walla, Whitman	4601 N Monroe Spokane, WA 99205	509-329-3400
Headquarters	Across Washington	P.O. Box 46700 Olympia, WA 98504	360-407-6000

Final Regulatory Analyses

Including the:

Final Cost-Benefit Analysis

Least-Burdensome Alternative Analysis

Administrative Procedure Act Determinations

Regulatory Fairness Act Compliance

Chapter 173-446 WAC
Climate Commitment Act Program

Air Quality Program
Washington State Department of Ecology

Olympia, WA

September 2022 | Publication 22-02-047

DEPARTMENT OF
ECOLOGY
State of Washington

Table of Contents

Tables

Figures

Abbreviations

APA	Administrative Procedure Act
APCR	Allowance Price Containment Reserve
BPA	Bonneville Power Administration
CBA	Cost Benefit Analysis
CCA	Climate Commitment Act
CETA	Clean Energy Transformation Act
CO_2e	Carbon dioxide equivalent
ECR	Emissions Containment Reserve
EITE	Emissions-intensive and trade-exposed
EPE	Electric power entity
FJD	First jurisdictional deliverer
FMD	Fuel Mix Disclosure
FTE	Full-time employee equivalent
GHG	Greenhouse gas
IWG	Interagency Working Group
LBA	Least Burdensome Alternative Analysis
MT	Metric tons
MWh	Megawatt hour
NAICS	North American Industry Classification System
RCW	Revised Code of Washington
RFA	Regulatory Fairness Act
SCC	Social Cost of Carbon
VRERA	Voluntary Renewable Electricity Reserve Account
VSL	Value of a statistical life
WAC	Washington Administrative Code

Executive Summary

This report presents the determinations made by the Washington State Department of Ecology as required under Chapters 34.05 RCW and 19.85 RCW, for the adopted Climate Commitment Act Program rule (Chapter 173-446 WAC; the "rule"). This includes the:

- Final Cost-Benefit Analysis (CBA)
- Least-Burdensome Alternative Analysis (LBA)
- Administrative Procedure Act Determinations
- Regulatory Fairness Act Compliance

All determinations are based on the best available information at the time of publication.

Reason for the rule

In 2021, the Washington State Legislature passed the Climate Commitment Act (CCA), which establishes a comprehensive program to reduce greenhouse gas pollution and help achieve the greenhouse gas limits set in state law. The program is codified in Chapter 70A.65 RCW, Greenhouse Gas Emissions – Cap and Invest Program, and will start January 1, 2023. In the CCA, the Legislature directs Ecology to adopt rules to implement a cap on greenhouse gas emissions, including mechanisms for the sale and tracking of tradable emissions allowances, along with compliance and accountability measures. The CCA also directs Ecology to design allowance auctions to allow for linkage to similar programs in other jurisdictions as much as possible.

Summary of the adopted rule

The adopted rule implements certain sections of the CCA and establishes detailed rules in the following areas:

- General Requirements (WAC 173-446-010 through -080).
- Program Account Requirements (WAC 173-446-100 through -150).
- Allowance Budgets and Distribution of Allowances (WAC 173-446-200 through -260).
- Allowance Auctions (WAC 173-446-300 through -385).
- Compliance Instrument Transactions (WAC 173-446-400 through -440).
- Offsets (WAC 173-446-500 through -595).

Regulatory baseline

The regulatory baseline for our analyses generally consists of existing rules and laws, and their requirements. This is what allows us to make a consistent comparison between the state of the world with and without the adopted rule.

For this rulemaking, the regulatory baseline includes:

- Greenhouse Gas Emissions – Cap and Invest Program law, Chapter 70A.65 RCW.
- Limiting Greenhouse Gas Emissions law, Chapter 70A.45 RCW.

- Criteria for Emissions-Intensive, Trade-Exposed Industries, Chapter 173-446A WAC.
- Reporting of Emissions of Greenhouse Gases rule, Chapter 173-441 WAC.
- Washington Clean Air Act law, Chapter 70A.15 RCW.
- Clean Energy Transformation Act law, Chapter 19.405 RCW, and rule, Chapter 173-444 WAC.
- Transportation Fuel – Clean Fuels Program law, Chapter 70A.535 RCW.
- Motor Vehicle Emission Standards law, Chapter 70A.30 RCW.

There are also proposed rules that are currently in the process of rulemaking, but have not yet been adopted. These rules are not part of the regulatory baseline for our primary analysis, but since they are likely future regulations, we also analyzed the rule compared to a regulatory baseline that includes them (see Appendix C).

- Directed by Chapter 70A.30 RCW: Clean Vehicle Standards rule, Chapter 173-423 WAC (proposed on September 7, 2022).
- Directed by Chapter 70A.535 RCW: Clean Fuels Program rule, Chapter 173-424 WAC (proposed on July 18, 2022).

Costs

We estimated annual and total present value costs of allowance purchases, emissions abatement, and offset credit purchases in Chapter 3. Here, we summarize total present value costs with and without offset credit use. Offset credit use reduces the average compliance cost within each year, while creating more opportunity to purchase credits to bank for future use.

Table 1: Total present value costs

Cost Category	Present Value through 2050, no offset use (billions of $)	Present Value through 2050, maximum offset use (billions of $)
Allowance purchases	$21.88	$21.88
Offset credit purchases	$0.00	$2.56
Emissions abatement	$11.11	$11.11
Total	$32.98	$35.54

In our model structure, the availability and use of offset credits does not change allowance market behavior. This is a result of the allowance market model excluding an interrelated offset credit market, due to limited resources and time to complete modeling of multiple allowance market scenarios, as well as the inherent complexity and high level of uncertainty about offset credit market attributes for Washington. Instead, in this model, use of offset credits allows for additional accumulation of banked allowances (to be used or sold at a later date), while reducing the average cost of compliance within each year. This results in a higher total present value cost estimate than in the scenario with no offsets, and is a highly conservative

assumption, as purchases of offset credits in lieu of allowances would only serve to decrease total costs.

If covered and opt-in entities purchased offset credits in lieu of purchasing allowances, it would reduce market demand, putting downward pressure on allowance prices, counteracting upward pressure that would result from reductions in allowance supply corresponding to offset use. Absent a combined allowance-offset credit market model, we cannot estimate the size of these effects, but allowance prices would still reflect the marginal emissions abatement costs of remaining market participants, and could not fall below the auction floor price in a given year. Greenhouse gas emissions reductions would remain the same in either scenario.

Entities might choose to retain a surplus of banked allowances through 2050 as a precautionary measure in the face of uncertainty about future regulation, or as a source of potential revenue if the market has been linked with ongoing programs in other jurisdictions. They might choose to sell any remaining banked allowances at the end of the program. Due to the allowance market model considering offset credit use as an factor external to allowance market decisions, combined with uncertainty in banking behavior at the end of the program, we could not make a confident assumption about the eventual disposition of surplus credits banked at the end of the program.

Benefits

We estimated annual and total present value benefits of emissions reductions, natural gas revenues from the sale of consigned no cost allowances, market revenues to the State, and sales of offset credits in Chapter 4. Here we summarize total quantifiable present value benefits, with and without offset credit use. Quantifiable benefits should be considered in conjunction with benefits discussed qualitatively or partially quantified, presented below the table.

Table 2: Total present value benefits

Cost Category	Present Value through 2050, no offset use (billions of $)	Present Value through 2050, maximum offset use (billions of $)
Revenues to Washington	$19.77	$19.77
Revenues to natural gas utilities	$2.11	$2.11
Avoided Social Cost of Carbon	$17.27	$17.27
Revenues to sellers of offset credits	$0.00	$2.56
Total	$39.14	$41.70

Qualitative and partially quantifiable benefits

Additional avoided impacts of climate change not included in the quantified SCC values:

- Health:

    - Respiratory illness
    - Lyme disease
    - Death, injuries, and illnesses from natural disaster and migration
    - Water, food, sanitation, shelter
- Agriculture:
    - Weeds, pests, pathogens
    - Food price spikes
    - Heat and precipitation extremes
- Oceans:
    - Acidification, temperature, and extreme weather impacts on fisheries, extinction, reef losses
    - Storm surge interaction with sea level rise
- Forests:
    - Pest infestations
    - Pathogens
    - Species invasion and migration
    - Flooding and soil erosion
- Wildfire:
    - Burned acreage
    - Public health
    - Property losses
    - Fire management costs
- Ecosystems:
    - Biodiversity
    - Habitat
    - Species extinction
    - Outdoor recreation and tourism
    - Ecosystem services
    - Rising value of ecosystems due to increased scarcity
    - Accelerated decline due to mass migration
- Productivity and economic growth:
    - Labor productivity and supply, public health
    - Infrastructure impacts from severe events
    - Diversion of resources to climate adaptation
- Water:
    - Availability and competing needs
    - Flooding
- Transportation:
    - Changes to land and ocean transportation
- Energy:

    - Energy supply disruptions
- Catastrophic impacts and tipping points:
    - Rapid sea level rise
    - Methane releases from permafrost
    - Damages at very high temperatures
    - Unknown catastrophic events
- Inter- and intra-regional conflict:
    - National security
    - Increased violent conflicts

Wildfires

- Based on a national average of comprehensive wildfire impacts, **wildfires cost Washingtonians at least $1.6 to $8 billion each year.**
- In 2020, Washington spent an estimated **$20 million on aviation readiness and support** for large fires.
- The WA Department of Natural Resources incurred **direct costs of over $12.5 million** responding to wildfire incidents in 2020, and estimated additional damages of:
    - **$20 million** to utilities.
    - **$15 million** to state agency infrastructure.
    - **$10 million** to other government infrastructure.
- During a severe wildfire season, which are forecast to increase due to climate change, burned **managed (working) forests can lose over 90 percent of the value of their timber,** even when salvage harvest is accounted for.
- Wildfires also cause **hazardous air quality** in broad regions, impacting rural as well as densely populated areas.

Heat impacts[2]

- The 2021 heat dome event in the Pacific Northwest resulted in **at least $1.45 billion in lost lives.**
- **Extreme heat events are forecast to increase due to climate change,** corresponding to wildfire events as well.

[2] Note that many heat impacts are tied to the degree of air conditioning or other cooling available to the public. If use of, or investment in, additional cooling helps to reduce heat-related costs, the cost reduction would be counteracted by increased cooling costs associated with equipment, installation, and electricity use. Due to environmental justice disparities, the populations receiving additional cooling may not be those most highly impacted by heat. In this case, additional cooling costs may be incurred without reducing health and mortality impacts.

- Even when extreme heat events do not result in death, they significantly increase burden on healthcare services. During the 2021 heat dome event, the **number of people needing emergency room services increased 70-fold.** Healthcare visits related to a high heat event **costs $12,544 per visit** on average.
- At least **30 percent impact to raspberry harvests**: The aggregate Whatcom County raspberry harvest was 30 to 40 percent lower than the average harvest, with individual growers experiencing losses between 15 and 75 percent, due to the 2021 heat dome event. In 2017, Washington produced nearly $200 million across all types of berry, of which 30 percent would be $60 million.
- At least **ten percent impact to cherry harvests**: The overall cherry harvest, largely in the Yakima Valley, was at least 10 percent lower than the average harvest, due to the 2021 heat dome event. In 2021, Washington produced nearly $0.5 billion in fresh and processed cherries, of which 10 percent would be $50 million.
- At least **40 percent impact to blueberry harvests and product quality**: Following the 2021 heat dome event, the Washington Blueberry Commission estimated $85 million in yield loss and quality impacts to the expected harvest that year. In 2017, Washington produced nearly $200 million across all types of berry, of which $85 million would be 43 percent.
- Wheat harvests:
    - A **34-fold increase in the share of "poor" or "very poor" condition spring wheat**.
    - A **6-fold increase in the share of "poor" or "very poor" condition winter wheat**.
- Shellfish harvests:
    - **40 percent losses of seeded oysters**.
    - A **56 percent increase in vibriosis cases**. Vibriosis is an illness in humans caused by shellfish contaminated with Vibrio bacteria, which are naturally occurring but present in high concentrations in warmer temperatures.
    - **5 – 30 percent oyster mortality** in the Salish Sea.
    - Higher losses among shellfish species in smaller, sheltered waters, and those that live nearer the surface, such as cockles.

Flood damages

A recent study by the Center for Western Weather and Water Extremes, at the University of California San Diego, modeled the impacts of various climate change scenarios on atmospheric rivers (long, flowing regions of the atmosphere that carry water vapor) impacting western states. Using flood insurance data, the study estimated county-level increases in annual costs of flood damage, through 2090, due to the contribution of climate change to frequency, duration, and magnitude of atmospheric rivers.

- Flood damage due to atmospheric rivers in western Washington (per county):

    - $10 million to $100 million per year increases in most Puget Sound-adjacent counties.
    - Over $100 million per year increases in Snohomish, King, and Lewis counties.
    - This is at least a doubling of annual flood damage costs in Western Washington, compared to costs in the 1990s.
- Flood damage due to atmospheric rivers in eastern Washington (per county):
    - $1 million per year increases in most eastern Washington counties, with some counties incurring up to $10 million more per year.
    - This is up to a doubling of annual costs for most eastern Washington counties.
    - For Pend Oreille, Spokane, Whitman, Columbia, and Asotin counties, this is between two and four times the size of flood damage costs in the 1990s.

Environmental justice improvements

Wildfires account for *at least* 25 to 50 percent of fine particulate matter in Washington, compounding health and quality of life impacts for overburdened populations that are more likely to live or work outdoors near high-traffic roadways and/or in wildfire smoke prone areas.

Heat-related mortality is more likely to affect people who:

- Have lower incomes.
- Have less shade and more impervious or paved surfaces.
- Are unsheltered or have inadequate housing.
- Have less education.
- Live alone.
- Are elderly.
- Lack transportation.
- Lack recreational spaces.
- Experience more job or income insecurity.

Other pollutants

Table 3: Value of damages from select criteria pollutants as reported in EPA rulemakings

Criteria Pollutant	Damages per MT in Current Dollars	Equivalent Mortality Risk (based on VSL)
$PM_{2.5}$	$1.74 – 1.92 million	16 – 18 percent or 1 in 6

Criteria Pollutant	Damages per MT in Current Dollars	Equivalent Mortality Risk (based on VSL)
Volatile Organic Compounds (VOCs)	$1,347 - 1,468	0.01 percent or 1 in 10,000
Nitrogen Oxides (NOx)	$5,624 – 6,111	0.005 percent or 1 in 2,000

While we cannot confidently estimate the degree to which emissions of these pollutants will be reduced under the adopted rule, we note that in the case of maximum offset credit use, rule requirements for direct environmental benefits to the state would further facilitate potential reductions in these other pollutant emissions specific to Washington.

CBA determination

We conclude, based on a reasonable understanding of the quantified and qualitative costs and benefits likely to arise from the adopted rule, as compared to the regulatory baseline, that the benefits of the rule are greater than the costs.

Alternatives considered

We considered the following alternatives for rule content during the rule development process, and did not include those elements in the rule if they did not achieve the goals and objectives of the authorizing statute or if they would impose higher burden on those required to comply with the rule.

- Setting different price controls.
- Establishing a different total allowance budget trajectory.
- Adopting additional offset protocols for additional offset project categories
- Adopting fewer offset protocols.
- Allowing separate bid guarantees for parallel auctions.
- Requiring all of the no cost allowances provided to EITE facilities to be from future vintage years.
- Putting a lower amount of the annual allowance budget into the APCR. (The minimum required under the regulatory baseline is 2 percent.)
- Not frontloading the APCR.
- Not including an annual APCR auction.
- Applying holding limits to all allowances in a compliance account, rather than exempting those allowances in a holding account needed for compliance at the next compliance deadline.
- Putting allowances not sold at a single auction directly into the ECR.

- Implementing the ECR trigger price.

LBA determination

After considering alternatives to the adopted rule's contents, within the context of the goals and objectives of the authorizing statute, we determined that the rule represents the least-burdensome alternative of possible rule contents meeting the goals and objectives.

Regulatory Fairness Act compliance

The analyses required under the Regulatory Fairness Act (RFA), Chapter 19.85 RCW, and their inclusion in a Small Business Economic Impact Statement, are based on whether the rule would impose compliance costs on small businesses. A rule is otherwise exempt from these analyses under RCW 19.85.025(4).

Based on available information, we did not identify any small businesses that would be covered entities and therefore required to comply with the rule. The average business that is likely to be a covered entity under the rule employs 19,894 people.

However, we do not have full information concerning all potential covered entities. For example, about half of the 50-60 electric power entities (EPEs) that are expected to start reporting under recent amendments to the GHG reporting rule[3] (Chapter 173-441 WAC), would also be covered entities. Based on the size of other covered entities, we do not expect these EPEs to be small businesses.

While it may be reasonable to assume that all EPEs are large businesses, we cannot be certain of all their attributes. This is particularly true for EPEs for which we have uncertainty about emissions levels. Due to uncertainty about the employment attributes of EPEs, we chose to complete a Small Business Economic Impact Statement and complete work required under the RFA, to fully understand potential disproportion in the impacts of the rule.

As the RFA requires analyses specifically related to employment impacts and price or output impacts (as they play into revenue and profits), we also determined this analysis would be the most appropriate space to discuss other macroeconomic modeling we performed to fully understand the potential impacts of the rule.

Since there is uncertainty in the employment levels of potential small business EPEs, we chose to examine the full range of 1 – 50 employees that defines a small business in the RFA.

Table 4: Average annual present value compliance costs per employee, through 2050

Employment or average cost category	Low	High
Small business employment	1	50
Average employment at largest ten percent of businesses	133,098	133,098
Small business cost per employee	$181,232	$9,763,768
Largest business cost per employee	$68	$73

We conclude that, **if the rule does impose compliance costs on small businesses, it may**

[3] WA Department of Ecology, 2022. Rulemaking for Chapter 173-441 WAC. Administrative Order #21-07.

disproportionately affect them. Therefore in the eventuality that the rule does impact small businesses, Ecology would need to include elements in the rule to mitigate this potential disproportion, as far as is legal and feasible, which it has done (see Sections 6.3 and 7.4).

Consumption price impacts

We modeled impacts to consumer prices based on the compliance costs incurred under the rule, as well as how those funds are spent as transfers to other industries and activities. We also considered the impacts of accounting for an "amenity value" in the model, based on the avoided Social Cost of Carbon. Where an amenity value assumption is included, it reflects a perceived higher value to the quality of life in Washington, in turn attracting higher-income labor force to the state. Unlike other variables in this model that are targeted toward specific industries, the amenity value is distributed across the entire state population. It therefore does not impact sectoral or statewide price levels as significantly as variables such as compliance costs or allowance market revenues.

Note that these estimates are influenced by the elasticity (responsiveness of demand to prices; ability of producers to pass costs on to consumers) associated with the industries modeled. The results presented for our primary analysis reflect industry elasticities as defined by industry codes – significantly, the wholesale industry for transportation fuel suppliers. For alternative specifications and results, including more inelastic assumptions surrounding transportation fuels resulting in higher potential fuel price impacts, see Appendix G.

Table 5: Impacts to consumption price levels (direct+indirect+induced), no amenity value, percent

Year	Statewide Price Level	Motor vehicle fuels, lubricants, and fluids	Electricity	Natural Gas	Fuel Oil
2030	0.19%	0.99%	1.45%	-1.56%	0.95%
2040	0.06%	0.33%	0.54%	0.18%	0.31%
2050	0.04%	0.18%	0.33%	1.18%	0.17%

Percent difference from REMI reference scenario price levels.
Note: Statewide price level impacts reflect aggregate price increases and decreases across all industries and commodities in the state, and are not the sum of the individual commodity price impacts presented above.

Table 6: Impacts to consumption price levels (direct+indirect+induced), SCC amenity value, percent

Year	Statewide Price Level	Motor vehicle fuels, lubricants, and fluids	Electricity	Natural Gas	Fuel Oil
2030	0.19%	0.99%	1.45%	-1.56%	0.95%
2040	0.05%	0.32%	0.54%	0.18%	0.31%
2050	0.03%	0.17%	0.32%	1.18%	0.16%

Percent difference from REMI reference scenario price levels.
Note: Statewide price level impacts reflect aggregate price increases and decreases across all industries and commodities in the state, and are not the sum of the individual commodity price impacts presented

above.

We note that potential consumption price impacts were significantly mitigated by the ability of covered parties to use frontloaded APCR allowances and otherwise intertemporally optimize their behavior to smooth allowance price trajectories and lower overall compliance costs. They were also mitigated by requirements to use consigned no cost allowance revenues to counteract impacts to consumers, and additional allowance releases of APCR allowances when allowance prices reached the rule's APCR trigger prices.

Output Impacts

Table 7: Impacts to output, no amenity value, billions of $

Year	Statewide	Utilities	Retail	Wholesale (includes transportation fuels)	Transportation and Warehousing	Construction (infrastructure)	Manufacturing
2030	-$0.99	-$0.19	-$0.26	-$0.56	-$0.07	$0.74	-$0.58
2040	-$1.73	-$0.15	-$0.17	-$0.46	-$0.07	$0.23	-$0.70
2050	-$0.84	-$0.08	-$0.12	-$0.24	-$0.04	$0.00	-$0.19

Difference from REMI reference scenario output levels.
Note: Statewide output level impacts reflect aggregate output increases and decreases across all industries in the state, and are not the sum of impacts to the sectors presented above.

Table 8: Impacts to output, SCC amenity value, billions of $

Year	Statewide	Utilities	Retail	Wholesale (includes transportation fuels)	Transportation and Warehousing	Construction (infrastructure)	Manufacturing
2030	-$0.75	-$0.18	-$0.24	-$0.55	-$0.07	$0.77	-$0.56
2040	-$1.11	-$0.14	-$0.12	-$0.43	-$0.06	$0.28	-$0.63
2050	-$0.09	-$0.07	-$0.03	-$0.20	-$0.02	$0.03	-$0.10

Difference from REMI reference scenario output levels.
Note: Statewide output level impacts reflect aggregate output increases and decreases across all industries in the state, and are not the sum of impacts to the sectors presented above.

Impacts to employment

Table 9: Impacts to employment, no amenity value, thousands of FTEs

Year	Statewide	Utilities	Retail	Wholesale (includes transportation fuels)	Transportation and Warehousing	Construction (infrastructure)	Manufacturing
2030	2.67	-0.14	-1.10	-1.40	-0.48	4.63	1.242
2040	-2.47	-0.09	-0.55	-0.88	-0.40	1.24	0.24
2050	-1.17	-0.04	-0.27	-0.35	-0.19	-0.15	0.681

Difference from REMI reference scenario employment levels.
Note: Statewide employment impacts reflect aggregate employment increases and decreases across all

industries in the state, and are not the sum of impacts to the sectors presented above.

Table 10: Impacts to employment, SCC amenity value, thousands of FTEs

Year	Statewide	Utilities	Retail	Wholesale (includes transportation fuels)	Transportation and Warehousing	Construction (infrastructure)	Manufacturing
2030	4.00	-0.13	-1.02	-1.37	-0.42	4.87	1.3
2040	0.46	-0.08	-0.34	-0.81	-0.26	1.54	0.404
2050	2.03	-0.04	-0.03	-0.27	-0.03	0.06	0.876

Difference from REMI reference scenario employment levels.
Note: Statewide employment impacts reflect aggregate employment increases and decreases across all industries in the state, and are not the sum of impacts to the sectors presented above.

Impacts to prices, output, and employment do not reflect significant structural changes to the state economy, such as local development of new or expanded green industries over time. The REMI model is based on the state's economy in its present state, and forecasts based on known and expected growth trajectories and sectoral relationships. The inclusion of large structural changes such as local development of a new industry or sector, a significant change to electrification infrastructure, or greater local access to technological advances, would allow for greater flexibility in the economy. This would mitigate price increases and negative impacts to output and employment.

This page intentionally left blank.

Chapter 1: Background and Introduction

1.1 Introduction

This report presents the determinations made by the Washington State Department of Ecology as required under Chapters 34.05 RCW and 19.85 RCW, for the adopted Climate Commitment Act Program rule (Chapter 173-446 WAC; the "rule"). This includes the:

- Final Cost-Benefit Analysis (CBA)
- Least-Burdensome Alternative Analysis (LBA)
- Administrative Procedure Act Determinations
- Regulatory Fairness Act Compliance

The Washington Administrative Procedure Act (APA; RCW 34.05.328(1)(d)) requires Ecology to evaluate significant legislative rules to "determine that the probable benefits of the rule are greater than its probable costs, taking into account both the qualitative and quantitative benefits and costs and the specific directives of the law being implemented." Chapters 1 – 5 of this document describe that determination and the analyses that support it.[4]

The APA also requires Ecology to "determine, after considering alternative versions of the rule…that the rule being adopted is the least burdensome alternative for those required to comply with it that will achieve the general goals and specific objectives" of the governing and authorizing statutes. Chapter 6 of this document describes that determination.

The APA also requires Ecology to make several other determinations (RCW 34.05.328(1)(a) – (c) and (f) – (h)) about the rule, including authorization, need, context, and coordination. Appendix A of this document provides the documentation for these determinations.

The Washington Regulatory Fairness Act (RFA; Chapter 19.85 RCW) requires Ecology to evaluate the relative impact of rules that impose costs on businesses in an industry. This analysis compares the relative compliance costs for small businesses to those of the largest businesses affected. Chapter 7 of this document describes that analysis, when applicable.

All determinations are based on the best available information at the time of publication.

Note that analysis under the APA focuses on direct costs and benefits, as it is concerned with the relative size of aggregate impacts of the rule. Direct costs and benefits then flow through economic activity, resulting in indirect (through economic exchange with input suppliers) and induced (through changes in economic choices based on relative prices and substitutes available) impacts. Analysis under the APA focuses on aggregate direct impacts to avoid double counting, as counting each of these costs and benefits occurs only once regardless of where

[4] Note that the APA requires analysis of the rule as proposed and adopted, and our analyses do not address other placeholder rule elements that were used during the rule development process. This includes placeholder values for the Total Program Baseline, which have been based on the most-recent data available, and have therefore evolved over the course of this rulemaking.

they occur in the economy. Since it provides additional information about the broader impacts of the rule, as well as more specific sectoral impacts, indirect and induced impacts are reflected through our macroeconomic modeling used to assess collective direct, indirect, and induced impacts to prices, output, and employment (see Chapter 7).

1.1.1 Background

In 2021, the Washington State Legislature passed the Climate Commitment Act (CCA), which establishes a comprehensive program to reduce greenhouse gas pollution and help achieve the greenhouse gas limits set in state law. The program is codified in Chapter 70A.65 RCW, Greenhouse Gas Emissions – Cap and Invest Program, and will start January 1, 2023. In the CCA, the Legislature directs Ecology to adopt rules to implement a cap on greenhouse gas emissions, including mechanisms for the sale and tracking of tradable emissions allowances, along with compliance and accountability measures. The CCA also directs Ecology to design allowance auctions to allow for linkage to similar programs in other jurisdictions as much as possible.

1.2 Summary of the adopted rule

The adopted rule implements certain sections of the CCA and establishes detailed rules in the following areas:

- General Requirements (WAC 173-446-010 through -080).
- Program Account Requirements (WAC 173-446-100 through -150).
- Allowance Budgets and Distribution of Allowances (WAC 173-446-200 through -260).
- Allowance Auctions (WAC 173-446-300 through -385).
- Compliance Instrument Transactions (WAC 173-446-400 through -440).
- Offsets (WAC 173-446-500 through -595).

1.3 Document organization

The remainder of this document is organized in the following chapters:

- **Regulatory baseline and the adopted rule (Chapter 2):** Description and comparison of the regulatory baseline (what would occur in the absence of the rule) and the requirements of the adopted rule.
- **Likely costs of the rule (Chapter 3):** Analysis of the types and sizes of costs we expect impacted entities to incur as a result of the rule.
- **Likely benefits of the rule (Chapter 4):** Analysis of the types and sizes of benefits we expect to result from the rule.
- **Cost-benefit comparison and conclusions (Chapter 5):** Discussion of the complete implications of the CBA.

- **Least-Burdensome Alternative Analysis (Chapter 6):** Analysis of considered alternatives to the contents of the rule.
- **Regulatory Fairness Act Compliance (Chapter 7):** When applicable. Comparison of compliance costs for small and large businesses; mitigation; impact on jobs.
- **APA Determinations (Appendix A):** RCW 34.05.328 determinations not discussed in Chapters 5 and 6.

Chapter 2: Regulatory Baseline and Adopted Rule

2.1 Introduction

We analyzed the impacts of the adopted rule within the context of all existing requirements (federal and state laws and rules). This context for comparison is called the regulatory baseline, and reflects the most likely regulatory circumstances that entities would face if the rule were not adopted. It is discussed in Section 2.2, below.

2.2 Regulatory baseline

The regulatory baseline for our analyses generally consists of existing rules and laws, and their requirements. This is what allows us to make a consistent comparison between the state of the world with and without the adopted rule.

For this rulemaking, the regulatory baseline includes:

- Greenhouse Gas Emissions – Cap and Invest Program law, Chapter 70A.65 RCW.
- Limiting Greenhouse Gas Emissions law, Chapter 70A.45 RCW.
- Criteria for Emissions-Intensive, Trade-Exposed Industries rule, Chapter 173-446A WAC.
- Reporting of Emissions of Greenhouse Gases rule, Chapter 173-441 WAC.
- Washington Clean Air Act law, Chapter 70A.15 RCW.
- Clean Energy Transformation Act law, Chapter 19.405 RCW, and rule, Chapter 173-444 WAC.
- Transportation Fuel – Clean Fuels Program law, Chapter 70A.535 RCW.
- Motor Vehicle Emission Standards law, Chapter 70A.30 RCW.

There are also proposed rules that are currently in the process of rulemaking, but have not yet been adopted. These rules are not part of the regulatory baseline for our primary analysis, but since they are likely future regulations, we also analyzed the rule compared to a regulatory baseline that includes them (see Appendix C).

- Authorized by Chapter 70A.30 RCW: Clean Vehicle Standards rule, Chapter 173-423 WAC (proposed on September 7, 2022). The authorizing statute explicitly adopts California clean vehicle standards; the rule would implement and maintain consistency with this directive by adopting the California Advanced Clean Cars II standard, and adding credits for early action.
- Directed by Chapter 70A.535 RCW: Clean Fuels Program rule, Chapter 173-424 WAC (proposed on July 18, 2022). The authorizing statute sets specific goals, and a schedule of interim goals, for gasoline and diesel fuels, to 20 percent below 2017 levels by 2038. The rule would establish the specific attributes and processes of the program achieving this goal.

Note that whether a regulation is included in the baseline or alternative baseline (Appendix C) assumptions, this analysis does not analyze the additional costs of compliance, or benefits resulting from, those regulations. Requirements of other regulations that are not the subject of this rulemaking are exempt from analysis under the APA (RCW 34.05.328(5)(b)(iii)). Our primary analysis focuses on the impacts of the rule as adopted. It identifies benefits and costs over and above the regulatory baseline. The regulatory baseline includes exempt elements as currently adopted in the rules that implement relevant statutes. The alternative baseline discussed in Appendix C provides additional information by including in the baseline elements of other rules in progress but not yet adopted. We provide this additional analysis because the goals of these not-yet adopted rules (and to some degree their specific structure and processes) are specified in statute and therefore constitute current law, even though the associated rulemaking has not yet concluded.

2.2.1 Separability of regulatory baseline and adopted rule

In most of Ecology's Regulatory Analyses, the rule requirements analyzed are readily separable from the requirements of their authorizing statute. In this rulemaking, Ecology included some of the adopted rule requirements that are dictated by the CCA as explicitly part of the regulatory baseline, while we excluded from the baseline the requirements that were included as a result of Ecology's discretion (see detailed discussion in Section 2.3). Due to the detailed nature of the authorizing statute, it is difficult to conceptually and analytically separate the regulatory baseline from discretionary elements of the adopted rule. For example, where the regulatory baseline CCA establishes the Cap and Invest Program's scope and key compliance mechanisms, and the rule includes processes or requirements needed to fully implement that scope and to facilitate compliance.

When this is the case, the projected impacts of the implementation details Ecology chose to adopt in the rule are not separable from the projected impacts of the overall program established under the regulatory baseline. To avoid underestimating costs in these cases, we estimated the costs and benefits accounting for individual elements of the regulatory baseline only wherever they were identifiably separable from the rule. When it was not possible, we evaluated the costs and benefits of the statutory requirements of the CCA (part of the regulatory baseline) as well as the rule.

2.2.2 Primary regulatory baseline and sensitivity analyses

The specific requirements of some regulatory baseline rules that are currently in the process of rulemaking are not yet finalized. Though they may be adopted in their final form by the time the Cap and Invest Program's first implementation period begins, we cannot be certain of their specific requirements and attributes at this time. While the Regulatory Analyses that will be conducted for rules adopted after Chapter 173-446 is adopted may include the Cap and Invest Program in their regulatory baseline (as an adopted rule, excluded from analysis under the APA, RCW 34.05.310(4)(c)), we believe that due to the scope and nature of this Cap and Invest Program rule, it is reasonable to consider baselines both with and without these future regulations.

We therefore analyzed the impacts of the rule both with and without additional future regulations, by using a primary regulatory baseline for our analyses, and including a sensitivity analysis accounting for highly likely future regulations to the extent possible (see Appendix C).

2.3 Adopted rule

The adopted rule implements certain sections of the CCA and establishes detailed rules in the following areas:

General Requirements (WAC 173-446-010 through -080)

- Purpose
- Definitions
- Applicability
- Covered emissions
- Covered entity registration
- Electric utilities registration
- General market participant registration
- Cap-and-invest consultants and advisors
- New or modified covered entities
- Exiting the program
- Allowances

Program Account Requirements (WAC 173-446-100 through -150)

- Program accounts required
- Disclosure of corporate associations – Indicia of corporate association
- Disclosure of corporate associations – types of disclosures required
- Disclosure of corporate association – information to be submitted
- Designation and certification of account representatives
- Designation of account viewing agents
- Accounts for registered entities

Allowance Budgets and Distribution of Allowances (WAC 173-446-200 through -260)

- Total program baseline
- Total program allowance budgets
- Distribution of allowances to Emissions-Intensive and Trade-Exposed Entities
- Distribution of allowances to electric utilities

- Distribution of allowances to natural gas utilities
- Removing and retiring allowances
- Allowance distribution dates

Allowance Auctions (WAC 173-446-300 through -385)

- Auctions of current and prior year allowances
- Public notice
- Registration for an auction
- Auctions - prohibited actions
- Suspension and revocation of registration
- Bid guarantee
- Purchase limits
- Auction floor price and ceiling price
- Administration of auction: lots
- Bids
- Determination of actual maximum bid value
- Maximum bid value in excess of bid guarantee
- Acceptance of bids
- Payment for purchases
- Summary of auction
- Auction of future year allowances
- Allowance Price Containment Reserve Account
- Emissions Containment Reserve Account
- Price ceiling units
- Price ceiling unit Sales

Compliance Instrument Transactions (WAC 173-446-400 through -440)

- Compliance instruments transactions – general information
- Transfers among registered entities – process
- Transaction requests – information required by Ecology
- Transfers to a compliance account – process
- Transfers of no cost allowances from an electric utility to an electrical generating facility or to a federal power marketing administrator

- Transfer of no cost allowances from a utility's holding account to its limited use holding account for consignment to auction
- Compliance instrument transactions – prohibited actions

Offsets (WAC 173-446-500 through -595)

- General requirements for Ecology offset credits and registry offset credits
- Requirements for compliance offset protocols
- Requirements for offset projects using Ecology compliance offset protocols
- Authorized Project Designee
- Listing of offset projects using Ecology compliance offset protocols
- Monitoring, reporting, and record retention requirements for offset projects
- Verification of GHG emissions reductions and GHG removal enhancements from offset projects
- Requirements for offset verification services
- Offset verifier and verification body accreditation
- Conflict of interest requirements for verification bodies and offset verifiers for verification of offset project data reports
- Issuance of registry offset credits
- Issuance of Ecology offset credits
- Process for issuance of Ecology offset credits
- Registration of Ecology offset credits
- Forestry offset reversals
- Transferability of Ecology offset credits
- Invalidation of Ecology offset credits
- Approval requirements for offset project registries
- Offset project registry requirements
- Direct environmental benefits in the state

2.3.1 General Requirements

2.3.1.1 Purpose

Regulatory baseline

In Chapter 70A.65 RCW, the Legislature finds that climate change is "an existential crisis with major negative impacts on environmental and human health" and that meeting greenhouse gas

(GHG) emissions limits established in law (Chapter 70A.45 RCW) will "require coordinated, comprehensive, and multisectoral implementation of policies, programs, and laws, as other enacted policies are insufficient to meet the limits." Chapter 70A.65 RCW directs Ecology to "implement a cap on greenhouse gas emissions from covered entities and a program to track, verify, and enforce compliance through the use of compliance instruments."

Adopted

The rule implements the requirements of the GHG emissions Cap and Invest Program created by RCW 70A.65.060 through 70A.65.210. This program establishes a declining cap on GHG emissions from covered entities consistent with the limits established in RCW 70A.45.020, and a program to track, verify, and enforce compliance with the cap through compliance instruments.

Expected impact

We expect the rule to result in costs of actions taken to comply with the Cap and Invest Program, for covered entities, opt-in entities, and general market participants.[5] We also expect it to result in benefits of reduced GHG emissions, for the public, environment, and economy as well as benefits to overburdened communities and vulnerable populations.

2.3.1.2 Definitions

Regulatory baseline

Chapter 70A.65 RCW includes multiple definitions associated with the Cap and Invest Program, environmental justice, and greenhouse gases and emitters. By reference, it includes definitions in:

- Environmental Justice, Chapter 70A.02 RCW.
- Limiting Greenhouse Gas Emissions, Chapter 70A.45 RCW.
- Washington Clean Air Act, Chapter 70A.15 RCW.
- Washington Clean Energy Transformation Act, Chapter 19.405 RCW.

Collectively, these definitions support implementation and consistency in the Cap and Invest Program the law directs Ecology to implement.

Adopted

The rule includes many definitions verbatim from the regulatory baseline, and adds definitions that further support Cap and Invest Program implementation, including, but not limited to, definitions related to:

[5] Depending on the attributes of markets in which entities operate, entities incurring direct costs may pass a portion of compliance costs on to their customers (intermediaries, retailers, consumers). These costs would not be in addition to direct costs of compliance and so are not added to the estimated compliance costs. We acknowledge, however, the value of understanding these indirect and induced (resulting from price changes within and across markets) impacts, and so have analyzed impacts to prices, output, and employment in Chapter 7 of this analysis.

- Emissions and crediting baselines. Note that the rule uses "baseline" to refer to emissions quantities and project attributes under current, historic, or business-as-usual behaviors and regulations. It does not have the same meaning as the regulatory baseline discussed in this document. We have made efforts to ensure clarity when the term does not refer to the regulatory baseline of the Cost-Benefit Analysis.
- Offset verification.
- Designation of account representatives.
- Transactions and prices.
- Closed and curtailed entities.
- Offset projects.
- References to definitions in Chapter 173-441 WAC – Reporting of Emissions of Greenhouse Gases:
    - Electricity importer.
    - Electric power entity.
    - Facility.
    - Greenhouse gas.
    - North American Industry Classification System (NAICS).
    - Point of delivery.
    - Reporter.
    - Any terms not otherwise defined in the rule or other referenced definitions in law or rule.
- References to definitions in Chapter 173-446A WAC – Criteria for Emissions-Intensive, Trade-Exposed Industries.
    - Any terms not otherwise defined in the rule or other referenced definitions in law or rule.
- References to definitions in Chapter 19.405 RCW – Washington Clean Energy Transformation Act:
    - Retail electric load.

Expected impact

Definitions do not, in and of themselves, create any costs or benefits. They are, however, relevant to the rule's requirements, and contribute to the costs and/or benefits of those requirements. Relevant sections below that involve terms defined in the rule reflect their overall costs and/or benefits.

2.3.1.3 Applicability

Regulatory baseline

RCW 70.65.080 establishes program coverage for the Cap and Invest Program as follows:

First compliance period

A person is a covered entity at the beginning of the first compliance period if the person reported emissions, under RCW 70A.15.2200 for any year from 2015 through 2019, or if additional data provided or required by the CCA indicates that emissions for any calendar year from 2015 through 2022 equaled or exceeded any of the following thresholds, or if the person is a first jurisdictional deliverer of electricity and imports electricity into the state during the compliance period:

Table 11: Covered entities in the first compliance period

Entity	GHG emissions
Facility owner or operator	Facility emissions are at least 25,000 MT CO_2e
First jurisdictional deliverer who is a generator of electricity in the state	GHG emissions associated with generation are at least 25,000 MT CO_2e
First jurisdictional deliverer who is importing electricity into the state	Cumulative annual total of GHG emissions associated with the imported electricity are at least 25,000 MT CO_2e
Supplier of fossil fuel other than natural gas	Combustion or oxidation of fuel (in Washington) would result in GHG emissions of at least 25,000 MT CO_2e
Natural gas suppliers	Combustion or oxidation (in Washington) of natural gas that is (excluding supply, delivery, or purchase at other covered parties or opt-in entities): • Supplied by a natural gas supplier and would result in GHG emissions of at least 25,000 MT CO_2e. • Delivered by a person who is not a natural gas company and has a tariff with a natural gas company to deliver to an end-use customer in Washington, that would result in GHG emissions of at least 25,000 MT CO_2e. • Purchased directly by an end-use customer in Washington from a person that is not a natural gas company and has the natural gas delivered through an interstate pipeline to a distribution system owned by the purchaser in amounts that would result GHG emissions of at least 25,000 MT CO_2e.

Second compliance period

An owner or operator of a waste to energy facility, used by a county or city solid waste management program, is a covered entity as of the beginning of the second compliance period if their reported emissions under RCW 70A.15.2200 or emissions data required under Chapter 70A.65 ECW for any year from 2023 through 2025 are at least 25,000 MT CO_2e.

Subsequent compliance periods

A railroad company is a covered entity beginning January 1, 2031, if their reported or provided emissions for any year from 2027 through 2029 are at least 25,000 MT CO_2e.

The regulatory baseline law (RCW 70A.65.060 through RCW 70A.65.210) also includes:

- Types of emissions that are not covered.
- Circumstances under which a person is no longer a covered entity.
- Coverage of new or modified emission sources.
- Coverage of existing emission sources that do not currently exceed the 25,000 MT CO_2e threshold but do so in the future.

Adopted

The rule establishes applicability identical to the regulatory baseline.

Expected impact

We expect the rule to result in costs of allowance purchases or GHG emissions reductions by GHG emitters, and benefits of GHG emissions reductions to the public, environment, and economy. The rule does not differ from the statute in its establishment of applicability. This means the regulatory baseline is technically responsible for associated costs and benefits of applicability.

However, since Ecology used its discretion in other sections of the rule that interact with the applicability of the Cap and Invest Program, we could not analytically separate the rule from the regulatory baseline. In other words, we could not analyze the impacts of other rule requirements without including the applicability established under the regulatory baseline. This means estimated costs and benefits in this analysis reflect the impacts of the Program as a whole, though Ecology's discretion in setting rule requirements is not responsible for all of them as they reflect statutory requirements.

2.3.1.4 Covered emissions

Regulatory baseline

Chapter 70A.65 RCW defines covered emissions as "emissions for which a covered entity has a compliance obligation under RCW 70A.65.080." The section referenced sets the applicability of the program, as discussed above in Section 2.3.1.3.

Adopted

The rule establishes additional specificity in emissions covered under the Cap and Invest Program, including:

- Data sources forming the basis for covered emissions, including reported emissions under Chapter 173-441.
- Criteria for exempting reported emissions from covered emissions, including certain emissions and activity types.

- Clarifying which covered entity is responsible for a given type of covered emissions in order to avoid double counting. These clarifying divisions include:
    - Facilities.
    - Natural gas suppliers.
    - Suppliers of fossil fuels that are not natural gas.
    - Suppliers of carbon dioxide.
    - First jurisdictional deliverers of imported electricity.

Expected impact

We expect the rule to result in costs of allowance purchases or GHG emissions reductions by GHG emitters, and benefits of GHG emissions reductions to the public, environment, and economy.

The rule adds specificity to the emissions covered under the Cap and Invest Program. This means the regulatory baseline is technically responsible for associated costs and benefits of emissions covered under the Cap and Invest Program. However, since Ecology used its discretion in specifying which emissions would be included, as well as including clarity about the emissions that are covered and not covered for different entities, we could not analytically separate the rule from the regulatory baseline.

In other words, we could not analyze the impacts of additional specificity added to regulatory baseline covered emissions, without including the covered emissions established under the regulatory baseline. This means estimated costs and benefits reflect the impacts of emissions coverage as a whole, though Ecology's discretion in setting rule requirements is not responsible for all of them.

2.3.1.5 Covered entity registration

Regulatory baseline

Chapter 70A.65 requires registration for:

- Covered entities.
- Opt-in entities that are responsible for GHG emissions and are not covered entities.
- General market participants that are not covered entities or opt-in entities.

Adopted

The rule requires any reporter under Chapter 173-441 WAC that reports at least 25,000 MT CO_2e of covered emissions in any year, starting in 2015, that meets applicability requirements register if it receives notice from Ecology that it is covered by the program. A reporter that is not a covered entity is able to register as an opt-in entity, by request to Ecology.

A party that is not a reporter but emits GHGs in Washington is able to voluntarily participate in the Cap and Invest Program as an opt-in entity by:

- Reporting voluntarily under Chapter 173-441 WAC.

- Requesting to be registered as an opt-in entity.

Note that opt-in entities incur compliance obligations as covered entities do.

Expected impact

We expect the rule to result in labor time costs associated with registration as well as benefits of full information about GHG allowance market participants. The rule adds registration processes and requirements for covered parties, opt-in entities, and general market participants, all of which are required to register under the regulatory baseline. This means the regulatory baseline is technically responsible for associated costs and benefits of registration itself, but Ecology discretion is responsible for the specific processes entities must use to register. As a result, we could not analytically separate the rule from the regulatory baseline. This means estimated costs and benefits reflect the impacts of registration as a whole, though Ecology's discretion in setting rule requirements is not responsible for all of them.

Transaction costs, such as registration, would be a part of overall private costs associated with Cap and Invest Program participation, and would underlie willingness to pay for GHG emission allowances. This means allowance market prices in the Cap and Invest Program will reflect transaction costs, and we do not analyze them separately (or in addition to) costs of allowance purchases.

2.3.1.6 Electric utilities registration

Regulatory baseline

Chapter 70A.65 requires registration for:

- Covered entities.
- Opt-in entities that are responsible for GHG emissions and are not covered entities.
- General market participants that are not covered entities or opt-in entities.

Adopted

The rule requires all electric utilities in Washington that are not reporters to register to receive no cost allowances. This provision is necessary because, while not all electric utilities have compliance obligations as first jurisdictional deliverers of electricity, they all receive no cost allowances. All electric utilities need to have accounts to handle those allowances, and must therefore register in order to have the required accounts. They need to provide to Ecology:

- Name, addresses, contact information, party type, date and place of incorporation, and ID number.
- Names and addresses of the utility's directors and officers with authority to make legally binding decisions on behalf of the utility, and partners with more than 10 percent of control over the partnership.
- Names and contact information for persons controlling more than 10 percent of the voting rights attached to all the outstanding voting securities of the utility.

- A business number, if one has been assigned to the utility by a Washington State agency.
- A government issued taxpayer or Employer Identification Number, or a U.S. Federal Tax Employer Identification Number.
- Disclosure of all other parties with whom the utility has a direct corporate association or indirect corporate association.
- Names and contact information for all employees of the utility with knowledge of the utility's market position.
- Information required for individuals serving as cap-and-invest consultants and advisors.

Expected impact

We expect the rule to result in registration costs as well as benefits of full information about GHG allowance market participants. The rule adds specific information that electric utilities are required to submit to register, to the general regulatory baseline requirement of registration. This means the regulatory baseline is technically responsible for associated costs and benefits of registration itself, but Ecology discretion is responsible for the specific process utilities must use to register. As a result, we could not analytically separate the rule from the regulatory baseline. This means estimated costs and benefits reflect the impacts of utility registration as a whole, though Ecology's discretion in setting rule requirements is not responsible for all of them.

Transaction costs, such as registration, would be a part of overall private costs associated with Cap and Invest Program participation, and would underlie willingness to pay for GHG emission allowances. This means allowance market prices in the Cap and Invest Program will reflect transaction costs, and we do not analyze them separately (or in addition to) costs of allowance purchases.

2.3.1.7 General market participant registration

Regulatory baseline

Chapter 70A.65 requires registration for:

- Covered entities.
- Opt-in entities that are responsible for GHG emissions and are not covered entities.
- General market participants that are not covered entities or opt-in entities.

Adopted

The rule requires parties that are not covered entities or opt-in entities but want to participate in the allowance or offset credit market to apply for approval as general market participants. A general market participant can:

- Not be a covered entity or opt-in entity.
- Intend to purchase, hold, sell, or voluntarily retire compliance instruments.

- Operate a registered offset project.

They need to:

- Have a primary residence in the United States.
- Disclose any parties for which they provide consulting services.
- Follow specific procedures if they also provide or are associated with a provider of cap and invest consulting services that gain access to the market position of another registered entity.
- Consent to being regulated by Ecology under the Cap-and-Invest program, including consent to the jurisdiction of Washington courts and administrative tribunals with respect to actions taken by Ecology to enforce applicable requirements of the program.

The following are not eligible to be general market participants:

- Individuals identified as having certain roles in corporate associations with registered entities.
- Account representatives for other registered entities.
- Account viewing agents for other registered entities.
- Parties identified as cap and invest consultants, unless disclosed.
- Employees of reporters under Chapter 173-441 WAC or the rule.
- Offset verifiers and accredited verification bodies.
- Offset project registries.
- Emissions reporting verifiers.

The rule requires a party to register as a general market participant by submitting to Ecology:

- Name, addresses, contact information, party type, date and place of incorporation, and ID number.
- Names and addresses of directors and officers with authority to make legally binding decisions on behalf of the general market participant, and partners with more than 10 percent of control over the partnership.
- Names and contact information for persons controlling more than 10 percent of the voting rights attached to all the outstanding voting securities of the party.
- A business number, if one has been assigned to the party by a Washington State agency.
- A government issued taxpayer or Employer Identification Number, or a U.S. Federal Tax Employer Identification Number.
- Disclosure of all other parties with whom the party has a direct corporate association or indirect corporate association.

- Names and contact information for all employees of the party with knowledge of the party's market position.
- Information required for cap-and-invest consultants and advisors.

Expected impact

We expect the rule to result in registration costs as well as benefits of full information about GHG allowance market participants. The rule adds specific information that general market participants are required to submit to register, to the general regulatory baseline requirement of registration. This means the regulatory baseline is technically responsible for associated costs and benefits of registration itself, but Ecology discretion is responsible for the specific process general market participants must use to register. As a result, we could not analytically separate the rule from the regulatory baseline. This means estimated costs and benefits reflect the impacts of general market participant registration as a whole, though Ecology's discretion in setting rule requirements is not responsible for all of them.

Transaction costs, such as registration, would be a part of overall private costs associated with Cap and Invest Program participation, and would underlie willingness to pay for GHG emission allowances. This means allowance market prices in the Cap and Invest Program will reflect transaction costs, and we do not analyze them separately (or in addition to) costs of allowance purchases.

2.3.1.8 Cap-and-invest consultants and advisors

Regulatory baseline

The regulatory baseline does not directly address cap-and-invest consultants or advisors. However, the regulatory baseline requires Ecology to adopt measures to guard against bidder collusion and minimize the potential for market manipulation. The transparency required under this provision will help meet those requirements.

Adopted

The rule defines cap-and-invest consultants or advisors and their activities, and requires a party employing cap-and-invest consultants and advisors to disclose to Ecology:

- Name.
- Contact information.
- Physical work address of the Cap-and-Invest Consultant or Advisor.
- Employer.

Expected impact

We expect the rule to result in disclosure costs as well as benefits of full information about GHG allowance market participants and the concomitant reductions in market manipulation and bidder collusion. The rule requires parties using Cap-and-Invest Consultants and Advisors to disclose certain information to Ecology. Transaction costs, such as use of Consultants or Advisors, would be a part of overall private costs associated with Cap and Invest Program

participation, and would underlie willingness to pay for GHG emission allowances. This means allowance market prices in the Cap and Invest Program will reflect transaction costs, and we do not analyze them separately (or in addition to) costs of allowance purchases.

2.3.1.9 New or modified covered entities

Regulatory baseline

Chapter 70A.65 RCW requires emission sources that are covered entities under the law but do not begin operation or are modified after January 1, 2023 or 2027 (as relevant to source type) to be covered under the Cap and Invest Program beginning in the year their emissions exceed applicable thresholds.

Adopted

The rule sets the same requirements as the regulatory baseline, adding specificity and clarity by:

- Specifying January 1, 2023 as the relevant date for new facilities, suppliers, and first jurisdictional deliverers.
- Specifying January 1, 2027 as the relevant date for waste to energy facilities.
- Setting November 1 compliance deadlines for the year following the year their emissions were at least 25,000 MT CO_2e.

Expected impact

We do not expect specification of dates within the years set under the regulatory baseline to generate costs or benefits beyond clarity in coverage dates.

2.3.1.10 Exiting the program

Regulatory baseline

Chapter 70A.65 RCW sets the criteria for exiting the Cap and Invest Program. A covered entity is no longer covered as of the beginning of a compliance period if in the previous compliance period:

- It reported emissions below 25,000 MT CO_2e for each year during an entire compliance period, unless the department notifies the entity they were within 10 percent of the threshold and will continue to be designated as covered to ensure equity among all covered entities.
- It has ceased all processes requiring GHG reporting.

Adopted

The rule sets criteria for exiting the program that are identical to the regulatory baseline.

Expected impact

The rule does not differ from the regulatory baseline's criteria for exiting the Cap and Invest Program. These criteria further define the applicability of the Program, and we could not analytically separate the rule from the regulatory baseline.

2.3.1.11 Allowances

Regulatory baseline

Beyond defining an allowance as "an authorization to emit up to one metric ton of carbon dioxide equivalent," Chapter 70A.65 RCW does not include specific attributes of allowances.

Adopted

The rule requires Ecology to:

- Create GHG allowances to cover annual allowance budgets.
- Assign each allowance a unique serial number.

Regarding allowance retirement, the rule designates the vintage of an allowance as the year of the annual allowance budget from which it comes, and requires older vintage allowances to be retired before newer ones. It also specifies that allowances do not expire and may be banked.

Expected impact

We expect the rule to result in costs of allowance purchases or GHG emissions reductions by GHG emitters, and benefits of GHG emissions reductions to the public, environment, and economy. The rule adds specific attributes to the allowances defined under the regulatory baseline. This means the regulatory baseline is technically responsible for associated costs and benefits of the existence of allowances. However, since Ecology used its discretion in specifying allowance attributes, we could not analytically separate the rule from the regulatory baseline. In other words, we could not analyze the difference between an allowance in general and allowances with the same definition but additional serial numbers and vintages. Moreover, allowances themselves would generate neither costs nor benefits, but contribute to the costs and benefits of their allocation, purchase, trading, or retirement, as discussed in subsequent sections. We therefore do not expect this element of the rule to result in costs or benefits in and of itself.

2.3.2 Program Account Requirements

2.3.2.1 Program accounts required

Regulatory baseline

Chapter 70A.65 RCW requires Ecology to use an electronic tracking system that allows two accounts to each covered or opt-in entity:

- Compliance account: for transferring allowances to Ecology for retirement.
- Holding account: for trading allowances. The number of allowances a registered entity may have in its holding account must be below the holding limit in the rule. Current holding account information must be publicly available.

The statute also specifies that:

- General market participants are each allowed an account, to hold, trade, sell, or transfer allowances.

- Ecology must maintain an account for retiring allowances transferred by registered entities and from the voluntary renewable reserve account.
- Ecology must maintain a public roster of all covered entities, opt-in entities, and general market participants on its website.
- Ecology must include a voluntary renewable reserve account[6] in the Cap and Invest Program.

Adopted

The rule adds specifics and timing to the regulatory baseline requirements, including:

- Up to 40 days after registration notice for covered entities to register, make corporate association disclosures and designate account representatives.
- After submission of the above information, Ecology sets up the required accounts for each registered entity.

It also allows a registered entity that is a member of a direct corporate association to apply for a consolidated entity account or register separately (with allocation of the purchase and holding limits across accounts).

Expected impact

We do not expect this element of the rule to result in costs or benefits beyond added clarity regarding timing of disclosures and accounts.

2.3.2.2 Disclosure of corporate associations – Indicia of corporate association

Regulatory baseline

Chapter 70A.65 RCW requires entities that register to describe any direct or indirect affiliation with other registered entities.

Adopted

The rule identifies specific types of corporate associations and defines their attributes. Direct corporate association is based on:

- Ownership interest in or control over a second party.
- Indicators of ownership (greater than 50 percent).
- Connection through more than one direct corporate association.
- Connection through a third party with shared direct corporate association.

Indirect corporate associations are corporate associations that are not direct corporate associations, but whose indicators of ownership are greater than 20 percent but less than 50 percent.

[6] Note that the rule calls this the Voluntary Renewable Electricity Reserve Account.

The rule also specifies situations in which:

- Electric utilities have direct corporate associations with others.
- An individual with access to market positions of multiple registered entities performs a shared role that creates a corporate association.
- An individual acting as a cap-and-invest consultant or advisor performs a shared role that creates a corporate association.

Expected impact

We expect the rule to result in disclosure costs as well as benefits of full information about GHG allowance market participants. The rule adds specific information that registered entities would be required to disclose as part of disclosing direct corporate associations as required under the regulatory baseline. This means the regulatory baseline is technically responsible for associated costs and benefits of direct corporate association disclosure itself, but Ecology discretion is responsible for the specific information that must be disclosed. As a result, we could not analytically separate the rule from the regulatory baseline. This means estimated costs and benefits reflect the impacts of direct corporate association disclosure as a whole, though Ecology's discretion in setting rule requirements is not responsible for all of them.

Transaction costs, such as disclosures, would be a part of overall private costs associated with Cap and Invest Program participation, and would underlie willingness to pay for GHG emission allowances. This means allowance market prices in the Cap and Invest Program will reflect transaction costs, and we do not analyze them separately (or in addition to) costs of allowance purchases.

2.3.2.3 Disclosure of corporate associations – Types of disclosures required

Regulatory baseline

Chapter 70A.65 RCW requires entities that register to describe any direct or indirect affiliation with other registered entities.

Adopted

The rule requires registered entities to disclose all direct and indirect corporate associations, and information about associated parties. It allows this to be accomplished using one or more existing governmental forms:

- Exhibit 21 of the Form 10-K submitted to the Securities and Exchange Commission by the registrant or an affiliate of the registrant.
- Application for market-based rate authority, or update to such application, submitted by the registrant or an affiliate of the registrant to the Federal Energy Regulatory Commission pursuant to 18 CFR Part 35 and Order 697.
- Application for registration with the National Futures Association, or update to such application, submitted by the registrant or an affiliate of the registrant as required by the Commodity Futures Trading Commission pursuant to the Commodity Exchange Act.

- Form 40 or Form 40S filed by the registrant or an affiliate of the registrant in accordance with the Commodity Futures Trading Commission's reporting rules.
- Part 1A of a Form ADV filed with the Securities and Exchange Commission by a registered investment advisor responsible for managing the registrant.

The rule also includes entities that would be exempt from disclosure.

Expected impact

We expect the rule to result in disclosure costs as well as benefits of full information about GHG allowance market participants. The rule adds governmental forms that could be used to satisfy disclosure requirements, as part of disclosing direct corporate associations as required under the regulatory baseline. This means the regulatory baseline is technically responsible for associated costs and benefits of disclosure itself, but Ecology discretion is responsible for the specific information that must be disclosed. As a result, we could not analytically separate the rule from the regulatory baseline. This means estimated costs and benefits reflect the impacts of disclosure as a whole, though Ecology's discretion in setting rule requirements is not responsible for all of them.

Transaction costs, such as disclosures, would be a part of overall private costs associated with Cap and Invest Program participation, and would underlie willingness to pay for GHG emission allowances. This means allowance market prices in the Cap and Invest Program will reflect transaction costs, and we do not analyze them separately (or in addition to) costs of allowance purchases.

2.3.2.4 Disclosure of corporate association – Information to be submitted

Regulatory baseline

Chapter 70A.65 RCW requires entities that register to describe any direct or indirect affiliation with other registered entities.

Adopted

The rule requires registered entities to provide (about each reportable corporate association):

- Name, contact information, and physical address.
- Tracking system identification number.
- Names and addresses of the party's directors and officers with authority to make legally binding decisions on behalf of the party, and partners with over 10 percent of control over the partnership.
- Names and contact information for individuals or parties controlling over 10 percent of the voting rights attached to all the outstanding voting securities of the party.
- Business number, if one has been assigned by a Washington State agency.
- A government issued Taxpayer Identification Number or Employer Identification Number, or for parties located in the United States, a U.S. Federal Tax Employer Identification Number.

- Place and date of incorporation.
- Names and contact information for all employees of the party with knowledge of the party's market position.
- For direct corporate associations with registered entities only, the percentage share of the holding limit and purchase limit assigned to each party opting out of account consolidation.

Expected impact

We expect the rule to result in disclosure costs as well as benefits of full information about GHG allowance market participants. The rule adds specific information that registered entities are required to submit as part of disclosing corporate associations as required under the regulatory baseline. This means the regulatory baseline is technically responsible for associated costs and benefits of disclosure itself, but Ecology discretion is responsible for the specific information that must be disclosed. As a result, we could not analytically separate the rule from the regulatory baseline. This means estimated costs and benefits reflect the impacts of disclosure as a whole, though Ecology's discretion in setting rule requirements is not responsible for all of them.

Transaction costs, such as disclosures, would be a part of overall private costs associated with Cap and Invest Program participation, and would underlie willingness to pay for GHG emission allowances. This means allowance market prices in the Cap and Invest Program will reflect transaction costs, and we do not analyze them separately (or in addition to) costs of allowance purchases.

2.3.2.5 Designation and certification of account representatives

Regulatory baseline

Chapter 70A.65 RCW does not include requirements for designation and certification of account representatives. However, RCW 70A.65 does require Ecology to oversee the market and adopt measures to prevent market manipulation. Limiting those who can act on behalf of a registered entity as account representatives helps accomplish this goal.

Adopted

The rule requires registered entities to designate between two and five account representatives to perform any operations within the Cap-and-Invest Program on its behalf. One of them must be a primary account representative. Registered entities are required to submit:

- Name and contact information of the registered entity.
- The following information concerning each designated account representative:
    - Name and contact information at the individual's home address.
    - Date of birth.
    - Copies of at least two identity documents.
- The name and contact information of the individual's employer.

- Confirmation from a financial institution located in the United States that the individual has a deposit account with the institution.
- Any conviction for a criminal offense declared in any jurisdiction during the previous five years constituting a felony under U.S. federal law or Washington law, or the equivalent thereof.
- A declaration signed by a director or by any other officer, or a resolution of the board of directors of the registered entity attesting that the account representatives have been duly designated to act on behalf of the registered entity for the purposes of this program.
- A declaration signed by each of the account representatives.

Expected impact

We expect the rule to result in designation costs as well as benefits of full information about designated representatives, and security and quality assurance of Cap and Invest Program activities. The rule requires registered entities to submit specific information to designate account representatives. Transaction costs, such as account representative designation, would be a part of overall private costs associated with Cap and Invest Program participation, and would underlie willingness to pay for GHG emission allowances.[7] This means allowance market prices in the Cap and Invest Program will reflect transaction costs, and we do not analyze them separately (or in addition to) costs of allowance purchases.

2.3.2.6 Designation of account viewing agents

Regulatory baseline

Chapter 70A.65 RCW does not include requirements for designation of account viewing agents. However, RCW 70A.65 does require Ecology to oversee the market and adopt measures to prevent market manipulation. Limiting those who can view accounts to only designated account representatives and account viewing agents helps accomplish this goal.

Adopted

The rule allows primary or alternate account representatives to authorize up to five account viewing agents. These agents are able to view all information contained in the tracking system involving the registered entity's accounts, information, and transfer records. Account representatives are required to submit a notice of delegation including:

- The name, address, email address, and telephone number of each primary account representative or alternate account representative.
- The name, address, email address, and telephone number of each account viewing agent.

[7] Similarly, entities buying or selling offsets would incorporate their transaction costs into willingness to pay or willingness to accept payment for offsets that underlie offset prices.

- An attestation signed by the officer of the registered entity who is responsible for the conduct of the account viewing agent.
- Notarized attestation stating that the notary has established the identity of the individual.

Expected impact

We expect the rule to result in designation costs as well as benefits of full information about account viewing agents, and security and quality assurance of Cap and Invest Program activities. The rule requires registered entities to submit specific information to designate account viewing agents. Transaction costs, such as account viewing agent designation, would be a part of overall private costs associated with Cap and Invest Program participation, and would underlie willingness to pay for GHG emission allowances. This means allowance market prices in the Cap and Invest Program will reflect transaction costs, and we do not analyze them separately (or in addition to) costs of allowance purchases.

2.3.2.7 Accounts for registered entities

Regulatory baseline

Chapter 70A.65 RCW requires Ecology to use an electronic tracking system that allows two accounts for each covered or opt-in entity:

1. A compliance account for transferring compliance instruments to Ecology for retirement.
2. A holding account for trading allowances. The number of allowances a registered entity may have in its holding account must be below the holding limit in the rule. Current holding account information must be publicly available.

The statute also specifies that:

- General market participants are each allowed an account, to hold, trade, sell, or transfer compliance instruments.
- Ecology must maintain an account for retiring compliance instruments transferred by registered entities and from the voluntary renewable reserve account.
- Ecology must maintain a public roster of all covered entities, opt-in entities, and general market participants on its website.

Adopted

The rule requires Ecology to set up two accounts for covered and opt-in entities after receiving complete documentation.

1. A compliance account for transferring allowances to Ecology for retirement.
2. A holding account for trading allowances. The number of allowances a registered entity may have in its holding account must be below the holding limit in the rule.

For general market participants, Ecology is required to set up only a holding account.

In addition, the rule establishes holding accounts for utilities in which they place allowances to be consigned to auction.

The rule sets holding limits, defining the maximum total number of allowances of the current or prior vintage, and of each vintage subsequent to the current year, that a registered entity may hold in its holding account and, where applicable, its compliance account. It limits general market participants to no more than ten percent of the total number of allowances of any vintage. It also establishes a process for changes of ownership.

Finally, the rule requires Ecology to post information about the contents of each holding account, including but not limited to the number of allowances in the account, on Ecology's Cap-and-Invest public website. The website also includes a public roster of all covered entities, opt-in entities, and general market participants.

Expected impact

We expect the rule to result in the benefit of preventing market manipulation, in line with regulatory baseline requirements. This element of the rule adds specificity to the regulatory baseline primarily by setting specific holding limits. We expect holding limits to result in a benefit of limiting the ability of registered entities to hold a long position and manipulate the allowance market. By holding large numbers of allowances in a limited market, individual entities could affect market price stability.

2.3.3 Allowance Budgets and Distribution of Allowances

2.3.3.1 Total program baseline

Regulatory baseline

Chapter 70A.65 RCW requires Ecology to determine emissions baselines as follows:

- By October 1, 2022: Adopt annual allowance budgets for the first compliance period of the program, calendar years 2023 through 2026. Ecology must determine an emissions baseline establishing the proportionate share that the total greenhouse gas emissions of covered entities for the first compliance period bears to the total anthropogenic greenhouse gas emissions in the state during 2015 through 2019, for the Cap and Invest Program commencing on January 1, 2023.
- By October 1, 2026: Add to the emissions baseline by incorporating the proportionate share that the total GHG emissions of new covered sectors in the second compliance period bear to the total anthropogenic greenhouse gas emissions in the state during 2023 through 2025. Ecology must adopt annual allowance budgets for the second compliance period of the program, calendar years 2027 through 2030.
- By October 1, 2028: Adopt annual allowance budgets for calendar years 2031 through 2040.

Annual allowance budgets must be set to achieve the proportionate share of reductions by covered entities necessary to achieve the 2030, 2040, and 2050 statewide emissions limits established in RCW 70A.45.020.

Allowances do not expire and may be banked.

Adopted

The rule specifies the methods used to establish a total program emissions baseline. This includes subtotal emissions baselines calculated individually for each reporter or sector, and a total program emissions baseline that is the sum of these subtotal emissions baselines. The rule includes methods to calculate these subtotal emissions baselines for:

- Facilities that are not emissions-intensive and trade-exposed (EITE) facilities.
- EITE facilities.
- Suppliers of natural gas.
- Suppliers of fossil fuel other than natural gas.
- Carbon dioxide suppliers.
- Importers of electricity (electric power entities).

For the second compliance period, subtotal emissions baselines for additional sectors of covered entities (based on the regulatory baseline: waste to energy facilities and railroads[8]) will be added to the total program emissions baseline. For subsequent compliance periods, subtotal emissions baselines for new covered sectors will be added to the previous program emissions baseline. For new or modified covered entities that are not in the new covered sectors, Ecology is not required to adjust the total program emissions baseline.

Table 12: Total program baselines

Emissions Years	Total Program Baseline (annual MT CO_2e)
2023-2026	68,052,220
2027-2030	Set by rule by October 1, 2026
2031 and subsequent years	Set by rule by October 1, 2028

Expected impact

We expect the rule to result in costs of compliance instrument purchases or GHG emissions reductions by GHG emitters, and benefits of GHG emissions reductions to the public, environment, and economy. The rule sets a total program emissions baseline for the first compliance period (calendar years 2023 – 2026), as required under the regulatory baseline. This means the regulatory baseline is technically responsible for associated costs and benefits of the total program emissions baseline itself, but Ecology discretion is responsible for adding details based on statutory requirements. As a result, we could not analytically separate the rule from the regulatory baseline. This means estimated costs and benefits reflect the impacts of the total

[8] Note that railroads are mobile emissions sources, which are exempt from facility emissions. Therefore Ecology does not expect any railroad facilities to be covered by the adopted rule.

program emissions baseline as a whole, though Ecology's discretion in setting the quantity of annual MT CO_2e is not responsible for all of them.[9]

2.3.3.2 Total program allowance budgets

Regulatory baseline

Chapter 70A.65 RCW requires Ecology to determine annual allowance budgets as follows:

- By October 1, 2022: Adopt annual allowance budgets for the first compliance period of the program, calendar years 2023 through 2026. Ecology must determine an emissions baseline establishing the proportionate share that the total greenhouse gas emissions of covered entities for the first compliance period bears to the total anthropogenic greenhouse gas emissions in the state during 2015 through 2019, for the Cap and Invest Program commencing on January 1, 2023.
- By October 1, 2026: Add to the emissions baseline by incorporating the proportionate share that the total GHG emissions of new sectors of covered entities in the second compliance period bear to the total anthropogenic greenhouse gas emissions in the state during 2023 through 2025. Ecology must adopt annual allowance budgets for the second compliance period of the program, calendar years 2027 through 2030.
- By October 1, 2028: Adopt annual allowance budgets for calendar years 2031 through 2040.

Annual allowance budgets must be set to achieve the proportionate total share of reductions by all covered entities necessary to achieve the 2030, 2040, and 2050 statewide emissions limits established in RCW 70A.45.020

Allowances do not expire and may be banked.

Adopted

The rule establishes required methods for setting the total allowances in the program for each year.

Table 13: Methods for setting total allowances in the program

Year	Method
2023	93 percent of total program baseline for 2023 – 2026
2024 – 2026	Decreases annually by an additional 7.0 percent of total program baseline for 2023 – 2026
2027	The 2026 total program allowance budget plus adjustment for newly covered sectors, reduced by an additional 7.0 percent of total program baseline for 2027 – 2030

[9] Note that the APA requires analysis of the rule as proposed and adopted, and our analyses do not address other placeholder rule elements that were used during the rule development process. This includes placeholder values for the Total Program Baseline, which have been based on the most-recent data available, and have therefore evolved over the course of this rulemaking.

Year	Method
2028 – 2030	Decreases annually by an additional 7.0 percent of total program baseline for 2027 – 2030
2031	The 2030 total program allowance budget plus adjustment for newly covered sectors, reduced by an additional 1.9 percent of total program baseline for 2031 and later
2032 – 2042	Decreases annually by an additional 1.9 percent of total program baseline for 2031 and later
2043 – 2050	Decreases annually by an additional 2.5 percent of total program baseline for 2031 and later

Table 14: Total program allowances for the first compliance period

Emissions Year	Total Covered Emissions (MT CO_2e)
2023	63,288,565
2024	58,524,909
2025	53,761,254
2026	48,997,598

Expected impact

We expect the rule to result in costs of compliance instrument purchases or GHG emissions reductions by GHG emitters, and benefits of GHG emissions reductions to the public, environment, and economy. The rule sets required methods for determining total covered emissions, for each emissions year through 2050, as required under the regulatory baseline. It numerically specifies total covered emissions for the first compliance period (emissions years 2023 – 2026). This means the regulatory baseline is technically responsible for associated costs and benefits of total covered emissions itself, but Ecology is responsible for applying the method specified under the regulatory baseline to the total program emissions baseline, so to the extent Ecology had discretion in detailing the contents of the total program emissions baseline, we could not separate this in our analysis. This means estimated costs and benefits reflect the impacts of total covered emissions as a whole, though Ecology's discretion in setting the quantity of annual MT CO_2e is not responsible for all of them.

2.3.3.3 Distribution of allowances to Emissions-Intensive and Trade-Exposed entities

Regulatory baseline

Chapter 173-446A WAC establishes criteria for emissions intensity and trade exposure, as required by Chapter 70A.65 RCW.

Chapter 70A.65 RCW also requires emissions-intensive and trade-exposed (EITE) facilities in specific industries to receive no cost allowances. They are listed below, with corresponding North American Industry Classification System (NAICS) codes.

Table 15: Industries receiving no cost allowances as EITE

Industry description	NAICS Codes
Metals manufacturing, including iron and steel making, ferroalloy and primary metals manufacturing, secondary aluminum smelting and alloying, aluminum sheet, plate, and foil manufacturing, and smelting, refining, and alloying of other nonferrous metals	Beginning with 331
Paper manufacturing, including pulp mills, paper mills, and paperboard milling	Beginning with 322
Aerospace product and parts manufacturing	Beginning with 3364
Wood products manufacturing	Beginning with 321
Nonmetallic mineral manufacturing, including glass container manufacturing	Beginning with 327
Chemical manufacturing	Beginning with 325
Computer and electronic product manufacturing, including semiconductor and related device manufacturing	Beginning with 334
Food manufacturing	Beginning with 311
Cement manufacturing	327310
Petroleum refining	324110
Asphalt paving mixtures and block manufacturing from refined petroleum	324121
Asphalt shingle and coating manufacturing from refined petroleum	324122
All other petroleum and coal products manufacturing from refined petroleum	324199

For the first compliance period, EITE facilities must receive no cost allowances equal to their carbon intensity multiplied by their actual production. If facilities use a mass-based approach, they must receive no cost allowances equal to their mass-based emissions baseline.

For subsequent compliance periods, annual allocations of no cost allowances must be adjusted according to the benchmark reductions schedules below, multiplied by the facilities' actual production.

- First compliance period: 100 percent of baseline emissions.
- Second compliance period: 97 percent of baseline emissions.
- Third compliance period: 94 percent of baseline emissions.

EITE facilities are required to submit their carbon intensity baselines for the first compliance period to Ecology. During the first compliance period, EITE facilities must record their facility-specific carbon intensity baseline based on actual production. For the second compliance period, the benchmark for each EITE facility is 3 percent below the first period's carbon intensity baseline. For the third compliance period, the benchmark is 3 percent below the second period benchmark.

For subsequent compliance periods, Ecology must provide a report to the appropriate committees of the state Senate and House of Representatives that describes alternative methods for determining the amount and a schedule of allowances to be provided to facilities owned or operated by each covered entity designated as an EITE facility through 2050. If the

legislature does not adopt a compliance obligation for EITE facilities by December 1, 2027, those facilities must continue to receive no cost allowances as provided in the third four-year compliance period that begins January 1, 2031.

Adopted

The rule establishes methods required for determining allocation baselines for EITE facilities, and lists data sources Ecology may use with adjustment as necessary. These methods are consistent with the regulatory baseline, and facilitate consistency and compliance through direction to data and regulatory sources supporting allocation baseline determination.

The rule also requires Ecology to assign an allocation baseline by November 15, 2022 to any EITE facility that submitted their information by September 15, 2022.

EITE facilities will be given no cost allowances according to the reduction schedule:

- First compliance period: 100 percent of the facility's allocation baseline for each year.
- Second compliance period: 97 percent of the facility's allocation baseline for each year.
- Third compliance period: 94 percent of the facility's allocation baseline for each year.

Expected impact

We expect the rule to mitigate impacts of the Cap and Invest Program on EITE facilities, resulting in reduced leakage of GHG emissions. GHG emissions leakage occurs when GHG emissions reductions in the state are offset by associated emission increases in other jurisdictions, for example if a company shifts production to another facility out of state, or if costs impact output prices such that a market shifts its demand to producers out of state. The rule sets required methods for allocating no cost allowances to EITE facilities, for the first three compliance periods, in line with the regulatory baseline.

This means the regulatory baseline is technically responsible for associated costs and benefits of no cost allowances allocated to EITE facilities, and their allocation during the first three compliance periods, but Ecology discretion is responsible for the specific methods for determining total allocation baselines for EITE facilities. As a result, we could not analytically separate the rule from the regulatory baseline. This means estimated costs and benefits reflect the impacts of no cost allowances as a whole, though Ecology's discretion in setting methods for determining total EITE facility allocation baselines, is not responsible for all of them.

2.3.3.4 Distribution of allowances to electric utilities

Regulatory baseline

Chapter 70A.65 RCW allows electric utilities subject to Chapter 19.405 RCW, the Washington Clean Energy Transformation Act, to receive no cost allowances to mitigate the cost burden of the Cap and Invest Program on electricity consumers.

It requires Ecology to adopt rules, in consultation with the Department of Commerce and the Utilities and Transportation Commission, establishing the methods and procedures for allocating allowances for investor-owned electric utilities and for consumer-owned utilities. The rules must take into account the cost burden of the program on electricity customers.

It also requires Ecology to adopt an allocation schedule in rule for the first compliance period, consistent with a forecast approved by the Utilities and Transportation Commission for investor-owned utilities, or by the governing boards of consumer-owned utilities, of each utility's supply and demand, and the resulting cost burden resulting from inclusion of the covered entities in the first compliance period. Ecology is also required to adopt an allocation schedule for the second compliance period and for 2031 through 2045. Utilities may not receive no cost allowances after 2045.

During the first compliance period, no cost allowances may be consigned to auction for the benefit of ratepayers, deposited for compliance, or a combination of both. Requirements for future compliance periods must be established by Ecology by future rulemakings.

Benefits of all allowances consigned to auction must be used by consumer-owned and investor-owned electric utilities for the benefit of ratepayers, with the first priority the mitigation of any rate impacts to low-income customers.

Adopted

Under the rule, allowances allocated to electrical utilities for a compliance period are based on the cost burden effect of the Cap and Invest Program. Ecology is required to use the following method to determine how cost burden and its effect will be used to allocate allowances to each electric utility for each emissions year.

Ecology will determine the generation resource fuel types forecasted to be used to provide retail electric load for a utility for the compliance period, and the rule sets emission factors to determine the emissions associated with the projected generation mix.

The cost burden effect from the emissions for each utility is calculated according to an equation in the rule. One allowance is allocated for each metric ton of emissions of the cost burden effect for each electric utility, for each emissions year as projected through this process.

Finally, Ecology allocates allowances to a Voluntary Renewable Electricity Reserve Account (VRERA). The number of allowances allocated to the VRERA for the first compliance period is 1/3 of one percent of the total program allowance budget for each year.

Expected impact

We expect the rule to result in the benefit of mitigating impacts of the Cap and Invest Program on electric utility ratepayers. Costs incurred either directly or indirectly (due to compliance costs putting upward pressure on electricity prices throughout the market) under the regulatory baseline and the rule could be passed on to ratepayers, and allocation of no cost allowances is intended to reduce these costs and prevent significant increases in electricity bills.

The rule sets required methods for allocating no cost allowances to electric utilities, in line with the regulatory baseline, but specifies emission factors and cost burden effect calculation. This means the regulatory baseline is technically responsible for associated costs and benefits of no cost allowances allocated to electric utilities, but Ecology discretion is responsible for the specific methods for determining allocation amounts. As a result, we could not analytically separate the rule from the regulatory baseline. This means estimated costs and benefits reflect

the impacts of no cost allowances as a whole, though Ecology's discretion is not responsible for all of them.

While it is not specified in the rule what the percentage of the total program budget would be allocated to the VRERA for the second compliance period and subsequent compliance periods, we assume one-third of one percent will continue to be allocated.

2.3.3.5 Distribution of allowances to natural gas utilities

Regulatory baseline

Chapter 70A.65 RCW also requires allocation of no cost allowances to natural gas utilities for the benefit of ratepayers.

It requires Ecology to adopt rules in consultation with the Utilities and Transportation Commission, establishing the methods and procedures for allocating allowances for natural gas utilities. Allocations must allow utilities to cover their emissions and decline proportionally with the cap.

It also requires Ecology to adopt an allocation schedule in rule for the first compliance period, in consultation with the Utilities and Transportation Commission, for the provision of these allowances.

Beginning in 2023, 65 percent of no cost allowances must be consigned to auction. Rules must increase this percentage by five percent each year until a total of 100 percent is reached. Revenues from allowances sold at auction must be returned by providing nonvolumetric credits on ratepayer utility bills, prioritizing low-income customers, or used to minimize cost impacts on low-income, residential, and small business customers. Remaining allowances may be consigned to auction for the benefit of ratepayers, deposited for compliance, or both.

To qualify for no cost allowances, covered entities that are natural gas utilities must provide copies of their greenhouse gas emissions reports filed with the US Environmental Protection Agency (EPA) under 40 C.F.R. Part 98 subpart NN - suppliers of natural gas and natural gas liquids for calendar years 2015 through 2021 to Ecology by March 31, 2022.

To continue receiving no cost allowances, a natural gas utility must provide to the department their greenhouse gas emissions report or equivalent information for each reporting year in the manner and by the dates provided by RCW 70A.15.2200(5) as part of greenhouse gas reporting.

Adopted

Under the rule, allowances allocated to natural gas utilities for a compliance period are based on specified data sources and methods. Ecology assigns an allocation baseline to each natural gas utility using the methods for calculating subtotal emissions baselines discussed above in Section 2.3.3.1. Allowance allocation is then based on the utility's allocation baseline.

A natural gas utility that is a covered entity under the Cap and Invest Program was required to submit a GHG report under Chapter 173-441 WAC for each emissions year 2015 through 2021 by March 31, 2022 in order to qualify for no cost allowances in the first compliance period. A natural gas utility that becomes a covered entity after 2023 needs to submit a complete GHG

report for each emissions year 2015 through the current reporting year by the reporting deadline for the year they become a covered reporter in order to qualify for no cost allowances.

Prior to the beginning of a new compliance period, Ecology may make an upward or downward adjustment in the allocation baseline for a natural gas utility effective starting in the next compliance period.

The rule establishes methods for establishing total no cost allowances allocated to a natural gas utility:

- 2023: 93 percent of allocation baseline.
- 2024 – 2030: Decreases by an additional 7 percent of their allocation baseline.
- 2031 - 2042: Their 2030 total allowance budget reduced annually by an additional 1.9 percent of their allocation baseline.
- 2043 – 2049: Decreases annually by an additional 2.5 percent of their allocation baseline.

The rule requires no cost allowances allocated to natural gas utilities to be consigned to auction for the benefit of ratepayers, deposited for compliance, or a combination of both. Trading, transfer, or sale is not allowed.

Expected impact

We expect the rule to result in the benefit of mitigating impacts of the Cap and Invest Program on natural gas utilities and their ratepayers. Costs incurred either directly or indirectly (due to compliance costs putting upward pressure on natural gas prices throughout the market) under the regulatory baseline and the rule could be passed on to ratepayers, and allocation of no cost allowances is intended to reduce these costs and prevent significant increases in natural gas bills.

The rule sets required methods for allocating no cost allowances to natural gas utilities, in line with the regulatory baseline, but specifies the rate of decline consistent with the overall program reduction rate. This means the regulatory baseline is technically responsible for associated costs and benefits of no cost allowances allocated to natural gas utilities, but Ecology discretion is responsible for the specific methods for determining allocation amounts. As a result, we could not analytically separate the rule from the regulatory baseline. This means estimated costs and benefits reflect the impacts of no cost allowances as a whole, though Ecology's discretion is not responsible for all of them.

2.3.3.6 Removing and retiring allowances

Regulatory baseline

Chapter 70A.65 RCW authorizes Ecology to adjust allowance budgets as needed to ensure meeting the requirements of RCW 70A.45.020 (see RCW 70A.65.070(3)), but does not specify methods for removing and retiring allowances.

Adopted

The rule establishes processes for removal and retirement of allowances to account for the use of offset credits.

To ensure consistency with proportional GHG emission limits, the rule enables Ecology to remove and retire allowances if the analysis of the state's progress toward the greenhouse gas limits indicates insufficient progress toward those limits based on the proportion of covered emissions in the program relative to total statewide greenhouse gas emissions.

Ecology is required to remove and retire allowances from the VRERA in recognition of the generation of renewable electricity that is directly delivered to Washington and used for the purposes of voluntary renewable electricity programs.

Expected impact

We do not expect the procedures used to retire allowances to result in costs or benefits. These impacts are administrative impacts to Ecology.

Removal and retirement of allowances constricts allowance supply, putting upward pressure on prices. We cannot, however, confidently forecast when this would happen.

2.3.3.7 Allowance distribution dates

Regulatory baseline

Chapter 70A.65 RCW does not specify distribution dates for no cost allowances.

Adopted

Under the rule, Ecology will distribute vintage 2023 no cost allowances:

- To mass-based EITE facilities by September 1, 2023.
- To natural gas utilities:
    - 35 percent by July 1, 2023.
    - Remaining by September 1, 2023.
- To investor-owned electric utilities within 60 days of UTC approval of forecasts, or by July 1, 2023 if the UTC takes no action.
- To consumer-owned electric utilities within 60 days of their governing board approval of forecasts, or by July 1, 2023 if they take no action.

The rule sets additional deadlines:

- Preliminary distribution of vintage 2023 no cost allowances to intensity-based EITE facilities based on 2021 production data by September 1, 2023.
- Final reconciliation of no cost allowances for EITE facilities based on 2023 production data by October 24, 2024.
- No cost allowances to natural gas and electric utilities, of the vintage of the year in which they are distributed, by October 24 of each year after 2023.

- Preliminary distribution of no cost allowances to EITE facilities based on production data from the prior year, of the vintage of the year following the year in which they are distributed, by October 24 of 2023, and every October 24 thereafter.
- Final reconciliation of no cost allowances for EITE facilities for the prior year based on production data for the prior year, by October24 of 2024, and every October 24 thereafter.

Expected impact

We do not expect the distribution dates of allowances, processes for distribution, or processes for reconciliation between preliminary and final distribution of no cost allowances to result in differentiable costs or benefits. The rule provides clarity in procedures and timing.

2.3.4 Allowance Auctions

2.3.4.1 Auctions of current and prior year allowances

Regulatory baseline

Chapter 70A.65 RCW requires Ecology to distribute allowances through auction, and specifies that an allowance is not a property right. It requires Ecology to:

- Hold up to four auctions each year, plus reserve auctions.
- Auction allowances from the current allowance budget and those remaining from previous years.
- Notify and communicate results of auctions to the Environmental Justice Council.
- Auction future vintage allowances in at least two parallel auctions each year.
- Hire a contractor to run the auctions, and an administrator to manage bid guarantees.
- Adopt requirements for auction registration and participation, including:
    - Submitting an application 30 days before an auction, and receiving approval notice in order to participate.
    - Having separate representatives for each registered entity participating in an auction.
- Adopt provisions that guard against bidder collusion and minimize potential for market manipulation, including cancellation or rejection of auction applications for:
    - Providing false or misleading facts.
    - Withholding material information that could influence a decision by the department.
    - Violating any part of the auction rules.
    - Violating registration requirements.
    - Violating any of the rules regarding the conduct of the auction.

- Design auctions to allow linkage with GHG trading programs in other jurisdictions to the maximum extent practicable.

The law also allows Ecology to:

- Require a bid guarantee.
- Impose additional purchase and holding limits to protect the integrity of auctions.

Adopted

The rule builds on the regulatory baseline requirements to fully design allowance auctions. Under the rule, Ecology submits allowances to auctions held four times each year, each with a single round of bidding. Auctions include:

- Allowances reserved by Ecology for the purpose of auctions.
- Allowances consigned to auction by electric utilities and natural gas utilities:
    - Electric utilities may choose to consign up to 100 percent of their allowances to auction.
    - Natural gas utilities may choose to consign up to 100 percent of their allowances to auction, and must consign a portion of their no cost allowances to auction.

Table 16: Minimum share of natural gas utility no cost allowances consigned to auction

Year	Minimum Share Consigned
2023	65%
2024	70%
2025	75%
2026	80%
2027	85%
2028	90%
2029	95%
2030	100%

The rule requires all auction proceeds from auctions consigned by natural gas utilities to be used for the benefit of customers.

Expected impact

We expect the rule to result in the benefit of mitigating impacts of the Cap and Invest Program on electric utilities and natural gas utilities and their ratepayers. Costs incurred either directly or indirectly (due to compliance costs putting upward pressure on prices throughout the market) under the regulatory baseline and the rule could be passed on to ratepayers, and allocation of no cost allowances is intended to reduce these costs and prevent significant increases in electric and natural gas bills.

The rule sets required minimum percentages of no cost allowances that natural gas utilities must consign to auction in each year, consistent with the regulatory baseline, and allows electric utilities flexibility in the number of no cost allowances consigned to auction. This means the regulatory baseline is technically responsible for associated costs and benefits of no cost

allowances consigned to auction for the benefit of ratepayers, but Ecology discretion is responsible for the specific methods for determining allocation amounts. As a result, we could not analytically separate the rule from the regulatory baseline. This means estimated costs and benefits reflect the impacts of no cost allowances consigned to auction as a whole, though Ecology's discretion is not responsible for all of them.

2.3.4.2 Public notice

Regulatory baseline

Chapter 70A.65 RCW requires Ecology to notify the Environmental Justice Council at least 60 days before auctions, and to provide a summary results report and post-auction public proceeds report within 60 days after auctions. It also requires Ecology to communicate the results of the previous calendar year's auctions to the environmental justice council on an annual basis beginning in 2024.

The authorizing statute also explicitly empowers the state's Environmental Justice Council to provide Ecology with recommendations related to environmental justice.

Adopted

The rule builds on the regulatory baseline by adding specifics of notices. It requires Ecology to provide notice of auctions to the Environmental Justice Council and to the public. Notices include the following information about auction:

- Date, time, and location.
- Rule requirements.
- Number of available allowanced.

The rule sets a 60 day limit after each auction for Ecology to provide the Environmental Justice Council with a summary of results and proceeds, as well as requiring an annual report.

Expected impact

We do not expect this element of the rule to result in costs or benefits. These are purely administrative costs to Ecology, and the rule builds on the administrative actions required under the regulatory baseline.

2.3.4.3 Registration for an Auction

Regulatory baseline

Chapter 70A.65 RCW requires Ecology to adopt requirements for auction registration and participation, including:

- Submitting an application 30 days before an auction, and receiving approval notice in order to participate.
- Having separate representatives for each registered entity participating in an auction.

Adopted

Under the rule, a registered entity is required to apply to Ecology before bidding in each auction. To apply to bid in an auction they need to:

- Update their information at least 40 days before the auction.
- Submit information to Ecology at least 30 days before the auction:
    - Name, contact information and holding account number of the registered entity.
    - Names and identification numbers of all designated account representatives of the registered entity.
    - Name and contact information of any consultant that provides advice related to the auction participant's bidding strategy and, if applicable, the name of the consultant's employer.
    - Form of bid guarantee to be given.
- Submit their bid guarantee at least 12 days before the auction.

Cap-and-Invest Consultants or Advisors advising on bidding strategy need to provide Ecology with:

- Names of the registered entities they are advising.
- Description of the advisory services they are providing.
- Assurance under penalty of perjury that the advisor is not transferring to or otherwise sharing information with other auction participants.

Expected impact

We expect the rule to result in registration costs as well as benefits of full information about GHG allowance market participants. The rule specifies the required information registered entities must submit to register to participate in an auction.

Transaction costs, such as registration, would be a part of overall private costs associated with auction participation, and would underlie willingness to pay for GHG emission allowances. This means allowance market prices in the Cap and Invest Program will reflect transaction costs, and we do not analyze them separately (or in addition to) costs of allowance purchases.

2.3.4.4 Auctions – Prohibited actions

Regulatory baseline

Chapter 70A.65 RCW requires Ecology to adopt provisions that guard against bidder collusion and minimize potential for market manipulation.

Adopted

To prevent bidder collusion and minimize the potential for market manipulation, the rule does not allow a registered entity that is registered to participate in an auction to release or disclose any bidding information including, but not limited to:

- Intent to participate or refrain from participating in an auction.

- Auction approval status.
- Intent to bid.
- Bidding strategy.
- Bid price or bid quantity.

It also prohibits coordinating bidding strategies of more than one auction participant.

Expected impact

We expect the rule to result in benefits of preventing bidder collusion and minimizing the potential for market manipulation. We do not expect this element of the rule to result in costs, as no costs are associated with not releasing or disclosing bidding information.

2.3.4.5 Suspension and revocation of registration

Regulatory baseline

Chapter 70A.65 RCW requires Ecology to adopt provisions that guard against bidder collusion and minimize potential for market manipulation, including cancellation or rejection of auction applications for:

- Providing false or misleading facts.
- Withholding material information that could influence a decision by the department.
- Violating any part of the auction rules.
- Violating registration requirements.
- Violating any of the rules regarding the conduct of the auction.

It also states that a registered entity may not release or disclose any bidding information including:

- Intent to participate or refrain from participation.
- Auction approval status.
- Intent to bid.
- Bidding strategy.
- Bid price or bid quantity.
- Information on the bid guarantee provided to the financial services administrator.

Adopted

The rule includes the regulatory baseline criteria for cancellation or rejection of auction applications, and prohibition against disclosing bidding information. Exemptions are allowed for entities within direct corporate associations.

Expected impact

We do not expect this element of the rule to result in costs or benefits aside from the benefits of preventing bidder collusion and minimizing the potential for market manipulation.

2.3.4.6 Bid guarantee

Regulatory baseline

Chapter 70A.65 RCW requires Ecology to:

- Hire a qualified, independent contractor to run the auctions.
- Hire a qualified financial services administrator to:
    - Hold the bid guarantees.
    - Evaluate bid guarantees.
    - Inform the department of the value of bid guarantees once the bids are accepted.

It also allows Ecology to require a bid guarantee, payable to the financial services administrator, in an amount greater than or equal to the sum of the maximum value of the bids to be submitted by the registered entity.

Finally, it prohibits registered entities from buying more than their bid guarantee.

Adopted

The rule builds on the regulatory baseline by specifying attributes of bid guarantees, including:

- Denomination: US dollars.
- Validity: 26 or more days after auction.
- Form: wire transfer, irrevocable letter of credit, or bond.
- Value: at least the registered entity's proposed maximum bid value, based on the highest product of each bid price and the number of allowances proposed for purchase at that price or a higher price.

Expected impact

We do not expect this element of the rule to result in costs or benefits as compared to the regulatory baseline. The bid guarantee is required under the regulatory baseline, while the rule allows flexibility that does not require additional effort on the part of auction participants.

2.3.4.7 Purchase limits

Regulatory baseline

Chapter 70A.65 RCW defines a purchase limit as "the limit on the number of allowances one registered entity or a group of affiliated registered entities may purchase from the share of allowances sold at an auction." The statute specifies that

- A covered entity or opt-in entity that is not a member of a direct corporate association shall not purchase more than 10 percent of the allowances available.

- A general market participant that is not a member of a direct corporate association shall not purchase more than 4 percent of the allowances available.

Adopted

Under the rule, registered entities are required to comply with the purchase limits specified in statute.

For purposes of auction purchase limits, all members of a direct corporate association are considered to be a single party.

Expected impact

We expect this element of the rule to result in the benefit of preventing auction participants from manipulating the market or cornering the market in such a way that affects the ability of other entities to comply efficiently with the law and rule. We do not expect this element of the rule to result in costs, as purchase limits and treatment of direct corporate associations are specified under the regulatory baseline.

2.3.4.8 Auction floor price and ceiling price

Regulatory baseline

Chapter 70A.65 RCW requires Ecology to:

- Adopt an auction floor price and schedule for annual increases.
- Adopt an auction ceiling price.
- Place at least two percent of allowances in an allowance Price Containment Reserve (APCR), during 2023 – 2026.
- Adopt rules for separate auctioning allowances from the APCR when settlement prices approach the ceiling price.
- Distribute allowances from the APCR by auction when new covered or opt-in entities enter the program and the Emissions Containment Reserve (ECR) are exhausted.
- Limit auctioning of allowances from the APCR to covered and opt-in entities.
- Set the reserve auction floor price or price tiers.
- Establish the number of allowances to be placed in the APCR after the first compliance period.

Adopted

The rule sets an auction floor price for 2023 of $19.70 in 2022-dollars plus 5 percent plus inflation as determined in December, 2022.The floor price increases by 5 percent plus the inflation rate each year. Each December, Ecology announces the floor price for the next year, based on the current year's inflation index through December.

The rule also sets a ceiling price for 2023 of $72.29 in 2022-dollars plus 5 percent plus inflation as determined in December, 2022. The ceiling price increases by 5 percent plus the inflation

rate each year. Each December, Ecology announces the ceiling price for the next year, based on the current year's inflation index through December.

Expected impact

We expect the rule to maintain allowance market success by setting an auction price floor and ceiling, as required by the regulatory baseline. The allowance price floor prevents allowances from being auctioned below that price, maintaining incentives for GHG emissions reductions by those entities that can do so most cost-effectively when allowances would otherwise sell for very low prices due to high supply relative to demand for allowances. Ecology based the price floor on the California allowance floor price trajectory. This consistency facilitates potential future linkage with other jurisdictions.

The allowance price ceiling sets an upper benchmark against which to set Tier prices for APCR auctions and to help determine when to hold APCR auctions. The price ceiling is also the price of last resort for covered entities needing price ceiling units to meet their compliance obligations. The price ceiling thus comes into play in the event that allowances would sell for very high prices due to low supply relative to demand for allowances. This is intended to control the costs of the Cap and Invest Program, and resulting potential impacts to covered entities and the economy. Ecology based the price ceiling on the California allowance price ceiling. This consistency facilitates potential future linkage with other jurisdictions.

2.3.4.9 Administration of auction: Lots

Regulatory baseline

The regulatory baseline does not address auctions of allowances by lot, beyond direction to facilitate Cap and Invest Program linkage with other programs. Other programs typically auction allowances in lots.

Adopted

Under the rule, Ecology divides allowances that are to be auctioned into lots. Each lot is 1,000 allowances, except the final lot of a given vintage if fewer than 1,000 allowances remain. Each lot only contains one vintage of allowances.

Expected impact

We do not expect this element of the rule to result in costs or benefits beyond the benefits of providing efficient units for the auction to use, and clarity in what happens in the event of a final lot of a given vintage containing fewer than 1,000 allowances.

2.3.4.10 Bids

Regulatory baseline

The regulatory baseline does not specify attributes of bids.

Adopted

The rule sets requirements for bids. Bids submitted need to:

- Include the bid price.

- Include the number of lots the bidder wishes to purchase.
- Be sealed and submitted in a form approved by Ecology.

Bids will be rejected if they would result in exceeding holding or purchase limits, or exceed the bidder's bid guarantee, starting with a registered entity's lowest bid and continuing in increasing order by bid price.

Expected impact

We do not expect this element of the rule to result in costs or benefits, as bids are necessary under the regulatory baseline, and the attributes specified under the rule are minimal. The process for rejection of bids is consistent with other administrative requirements under the regulatory baseline and rule requirements, including holding limits and purchase limits.

2.3.4.11 Determination of actual maximum bid value

Regulatory baseline

Chapter 70A.65 RCW allows Ecology to "require a bid guarantee, payable to the financial services administrator, in an amount greater than or equal to the sum of the maximum value of the bids to be submitted by the registered entity."

Adopted

The rule requires Ecology to determine whether each registered entity's actual maximum bid value is greater than their bid guarantee. Actual maximum bid value is based on the highest product of each bid price and the number of allowances proposed for purchase at that price or a higher price.

Expected impact

We do not expect this element of the rule to result in costs or benefits, as it is a clarification of the bid guarantee required under the regulatory baseline, and accounts for rejected bids.

2.3.4.12 Maximum bid value in excess of bid guarantee

Regulatory baseline

Chapter 70A.65 RCW allows Ecology to "require a bid guarantee, payable to the financial services administrator, in an amount greater than or equal to the sum of the maximum value of the bids to be submitted by the registered entity."

Adopted

Under the rule, if the actual maximum bid value of a registered entity's bids exceeds the value of the registered entity's bid guarantee, Ecology will remove lots from the bids until the actual maximum bid value would no longer exceed the bid guarantee.

The rule specifies the process Ecology must use for removed lots in the auction.

Expected impact

We do not expect this element of the rule to result in costs, beyond administrative process costs to Ecology. It results in potential benefits of registered entities not having entire bids

rejected for being in excess of the bid guarantee, by providing a process for removing lots from the bid until that is no longer the case.

2.3.4.13 Acceptance of bids

Regulatory baseline

Chapter 70A.65 RCW prohibits accepting bids below the auction floor price.

Adopted

The rule builds on the regulatory baseline by specifying the process for Ecology to accept bids, starting with the highest bid price. It also sets out the process for dealing with multiple bids submitted at the lowest accepted bid price or at the Tier 1 or Tier 2 price for APCR auctions.

Ecology distributes each allowance for which a bid has been accepted. The auction settlement price is the lowest accepted bid price, and this is the price to be paid by all bidders for each allowance.

Expected impact

We do not expect this element of the rule to result in costs, as it reflects administrative processes for Ecology. It would facilitate benefits associated with APCR.

2.3.4.14 Payment for purchases

Regulatory baseline

The regulatory baseline does not address specifics of payment for purchases of allowances at auction.

Adopted

The rule sets processes for payment.

Expected impact

While it specifies processes for payment, we do not expect this element of the rule to result in costs or benefits beyond administrative and procedural costs for Ecology.

2.3.4.15 Summary of auction

Regulatory baseline

Chapter 70A.65 RCW requires Ecology to submit a summary results report and post-auction public proceeds report to the Environmental Justice Council within 60 days after each auction. It does not address auction summaries for the public beyond information about covered entities, opt-in entities, general market participants, and holding accounts on the Ecology website.

Adopted

The rule requires Ecology to provide a post-auction public proceeds report to the Environmental Justice Council within 60 days after each auction and to, within 45 days after an auction, make the following available to the public in a written summary for each auction:

- Auction settlement price.
- Registered entities with permission to participate in the auction.
- Number of allowances sold.
- Number of each vintage year of allowances sold.
- Description of how the allowances were distributed among the registered entities who submitted bids, without identifying which registered entities purchased the allowances.

Expected impact

While it specifies information that Ecology must make available to the Environmental Justice Council and the public, we do not expect this element of the rule to result in costs or benefits beyond administrative and procedural costs for Ecology. As compared to the regulatory baseline, the rule makes the summary report available to the public as well.

2.3.4.16 Auction of future year allowances

Regulatory baseline

Chapter 70A.65 RCW requires Ecology to hold parallel auctions of future vintage allowances at least twice each year.

Adopted

Under the rule, Ecology holds parallel future vintage allowance auctions according to the regulatory baseline. It specifies that these auctions follow the same procedure as auctions for current and past vintage allowances.

At each auction of future allowances, Ecology consigns to auction 5 percent of the allowances for the year that is three years later than the auction year.

Expected impact

As compared to the regulatory baseline, the rule specifies that each auction of future allowances includes 5 percent of the allowances of a vintage three years later than the auction year. This provides a benefit by allowing for additional planning by registered entities for future GHG emissions or emissions reductions. Ecology based the 5 percent value on the levels established by jurisdictions with existing cap and trade programs with which Washington's program may link. We do not expect this element of the rule to result in costs beyond the costs of purchasing future vintage year allowances if entities desire them.

2.3.4.17 Allowance Price Containment Reserve Account

Regulatory baseline

Chapter 70A.65 RCW requires Ecology to:

- Place at least two percent of allowances in an Allowance Price Containment Reserve (APCR), during 2023 – 2026.
- Adopt rules for separate auctioning allowances from the APCR when settlement prices approach the ceiling price.

- Distribute allowances from the APCR by auction when new covered or opt-in entities enter the program and the Emissions Containment Reserve (ECR) is exhausted.
- Limit auctioning of allowances from the APCR to covered and opt-in entities.
- Set the reserve auction floor price or price tiers.
- Establish the number of allowances to be placed in the APCR after the first compliance period.

Adopted

Under the rule, Ecology frontloads the APCR by, in 2023, placing 5 percent of the allowances from the annual allowance budgets for 2023 through 2030 in the APCR, and removing the vintage dates from those allowances such that they could be used for compliance in any year. Ecology holds separate auctions for APCR allowances when the settlement price in the preceding auction (of current and past vintage allowances) reaches the Tier 1 price for the APCR.

Ecology also auctions allowances from the APCR when new covered and opt-in entities enter the program and allowances from the ECR account are exhausted, and once each year before the compliance deadline.

Only covered and opt-in entities are be allowed to participate in APCR auctions. Purchase limits do not apply.

There are two tiers of allowance prices at which bidders may bid:

- Tier 1: $46.05 plus five percent and the rate of inflation, for 2023.
- Tier 2: $59.17 plus five percent and the rate of inflation, for 2023.

The Tier prices increase by five percent plus the inflation rate each year. Each December, Ecology announces the APCR tier prices for the next year, based on the inflation index through December of the current year.

The rule also sets the process for:

- Order of allowance sales.
- Rejection of bids.
- Determination of maximum bid value.
- Removal of lots in the event of maximum bid value exceeding bid guarantee.

Expected impact

We expect the rule to provide the benefit of maintaining allowance market success by front loading allowances into the APCR, and setting APCR tier prices. As market prices for allowances approach the allowance price ceiling, and reach the Tier 1 APCR price, it triggers an increase in the supply of allowances released for auction, at either the Tier 1 or Tier 2 price. This allows for maintenance of flexible prices if the market would otherwise move toward the allowance price ceiling, allowing for an efficient balance of additional allowances auctioned with cost impacts of

the Cap and Invest Program. Ecology based the APCR Tier 1 and Tier 2 prices on the California allowance market APCR price structure. This consistency facilitates potential future linkage with other jurisdictions.

2.3.4.18 Emissions Containment Reserve Account

Regulatory baseline

Chapter 70A.65 RCW required Ecology to establish an Emissions Containment Reserve (ECR).

Ecology must transfer to the ECR at least two percent of the allowance budgets in 2023 – 2026. Additional allowances that go to the ECR include:

- When allowances are unsold in auctions.
- When facilities curtail or close.
- When facilities fall below the emissions threshold. The amount of allowances withdrawn from the program budget must be proportionate to the amount of emissions such a facility was previously using.

Finally, the law specifies when allowances must be distributed from the ECR:

- By auction when new covered and opt-in entities enter the program.
- By distribution of no cost allowances for a new or expanded EITE facility with emissions in excess of 25,000 MT CO_2e during the first applicable compliance period. These must be retired by the facility.

Adopted

Under the rule, the ECR account contains:

- Two percent of the annual allowance budgets for 2023 – 2026.
- Allowances submitted by Ecology for auction that remain unsold after being offered for sale for 24 months in current and past year vintage allowance auctions and future vintage allowance auctions.
- Allowances from EITE facilities that have been curtailed or closed.
- Allowances from facilities that fall below the emissions threshold. The number of these allowances must be proportionate to the amount of emissions the facility was previously using.

Ecology is required to distribute allowances:

- By auction when new covered and opt-in entities enter the program.
- By direct allocation at no cost to new or expanded EITE facilities with emissions greater than 25,000 MT CO_2e per year during the first applicable compliance period.

And Ecology holds auctions of allowances from the ECR:

- When new covered and opt-in entities enter the program.

- Following processes and procedures for other auctions, except limiting participation to covered and opt-in entities.

Expected impact

We expect the rule to maintain allowance market success by setting aside allowances to the ECR, as required by the regulatory baseline. We do not expect this element of the rule to result in costs, as the specification of two percent of allowances being placed in the ECR (compared to at least two percent under the regulatory baseline; the rest of this element of the rule matches or clarifies the regulatory baseline) is the minimum required under the statute, and retains the maximum allowances available for auction.

2.3.4.19 Price ceiling units

Regulatory baseline

Chapter 70A.65 RCW requires Ecology to:

- Adopt an auction floor price and schedule for annual increases.
- Adopt an auction ceiling price.
- Place at least two percent of allowances in an allowance Price Containment Reserve (APCR), during 2023 – 2026.
- Adopt rules for separate auctioning allowances from the APCR when settlement prices approach the ceiling price.
- Distribute allowances from the APCR by auction when new covered or opt-in entities enter the program and the Emissions Containment Reserve (ECR) are exhausted.
- Limit auctioning of allowances from the APCR to covered and opt-in entities.
- Set the reserve auction floor price or price tiers.
- Establish the amount of allowances to be placed in the APCR after the first compliance period.

Adopted

Under the rule, if no allowances remain in the APCR, Ecology issues price ceiling units for sale at the price ceiling to covered entities that do not have sufficient eligible compliance instruments in their holding and compliance accounts to meet their compliance obligations for a compliance period.

Expected impact

We expect the rule to provide the benefit of maintaining allowance market success by setting an auction price ceiling, and Tier 1 and Tier 2 APCR prices, as required by the regulatory baseline, and issuing price ceiling units when the APCR is exhausted. The sale of price ceiling units facilitates compliance by covered entities when prices would otherwise be very high due to low supply relative to demand for allowances. This is intended to control the costs of the Cap and Invest Program, and resulting potential impacts to covered entities and the economy.

Since price ceiling units are not part of the total emissions program baseline, their sale increases the risk of effectively increasing the cap on emissions, reducing progress toward emissions reduction goals. Ecology is required to use proceeds from price ceiling unit sales to offset emissions increases, though because the sale of price ceiling units implies relative scarcity of other emissions reductions in Washington, the offset of price ceiling units could have lower direct environmental benefits to Washington in terms of reducing other environmental or environmental justice impacts.

Ecology chose the Tier 1 and Tier 2 APCR prices and allowance price ceiling based on California's allowance price control structures, balancing the need to control program costs to covered entities, with the need to effectively reduce emissions. This consistency facilitates potential future linkage with other jurisdictions.

2.3.4.20 Price ceiling unit sales

Regulatory baseline

The regulatory baseline does not address the specifics of the process for price ceiling unit sales.

Adopted

Under the rule, Ecology holds price ceiling unit sales between the last APCR sale before the compliance deadline at the end of a compliance period and the compliance deadline itself. The units are sold at the ceiling price, only if a covered entity requests a price ceiling unit sale.

A request includes an accounting showing that it has insufficient compliance instruments to meet its compliance obligations for the next compliance period.

When Ecology sells price ceiling units, Ecology instructs the financial services administrator to begin to accept cash payment for purchases from price ceiling sales no earlier than ten business days after the previous reserve sale and to cease accepting payments no later than seven business days thereafter.

Ecology credits price ceiling unit purchasers accordingly, to each purchaser's compliance account for retirement at the next compliance deadline.

Expected impact

We do not expect the procedures for selling price ceiling units to result in costs or benefits, as these are minimal administrative costs to covered entities, and administrative costs to Ecology. We expect the costs of requests for price ceiling units to be minimal, as they should be readily demonstrable using emissions and allowance accounting under the regulatory baseline and rule.

2.3.5 Compliance Instrument Transactions

2.3.5.1 General information

Regulatory baseline

The regulatory baseline does not include specific requirements for compliance instrument transfers.

Adopted

Under the rule:

- A compliance instrument authorizes a covered entity to emit one MT CO_2e in one calendar year. It does not expire, and can be held or banked. Once used for compliance it is retired.
- By November 1 of the year after the end of each four-year compliance period, each covered entity and opt-in entity needs to use the number of compliance instruments equal to the number of MT CO_2e they emitted during the compliance period for compliance.
- Allowances are obtained by direct distribution of no-cost allowances from Ecology, by purchase at auction, or by purchase, trade or transfer from other parties owning allowances.
- Offset credits are obtainable.
- Compliance instruments are traded only among registered covered entities, opt-in entities, and general market participants.
- Covered or opt-in entities are only able to hold compliance instruments for their own use and may not hold compliance instruments on behalf of another party.
- Only compliance instruments recorded in a holding account can be traded.
- Electric utilities can transfer no cost allowances to an electrical generating facility following a process delineated in the rule (discussed below in Section 2.3.5.4).

Expected impact

We do not expect these general requirements to result in costs or benefits beyond administrative costs to Ecology, as they are consistent with other elements of the regulatory baseline and rule, including use of offset credits, program applicability, and allowance market structures.

2.3.5.2 Transfers among registered entities – process

Regulatory baseline

The regulatory baseline does not address specific attributes of the allowance transfer process.

Adopted

Under the rule, every registered entity wishing to trade compliance instruments with another registered party needs to follow these procedures:

- To initiate the transfer, a transferor's account representative submits a transaction request to Ecology and to all the transferor's other account representatives, and the second transferor's account representative must submit a confirmation.
- To accept the transfer, the transferee's account representative submits a confirmation of acceptance to Ecology and to the transferor.

Ecology transfers the compliance instruments unless:

- The transfer would result in non-compliance.
- Ecology has reasonable grounds to believe that a violation has been committed.
- The request contains errors, omissions, or is otherwise incomplete.

The rule also includes a process for transfer refusal.

Expected impact

Transaction costs, such as transfer requests, would be a part of overall private costs associated with Cap and Invest Program participation, and would underlie willingness to pay for GHG emission allowances. This means allowance market prices in the Cap and Invest Program will reflect transaction costs, and we do not analyze them separately (or in addition to) costs of allowance purchases. In the case of transfer requests, however, we expect the rule to result in minimal transfer request and confirmation costs, as this will be facilitated by the electronic accounting structure contracted by Ecology.

2.3.5.3 Transaction requests – information required by Ecology

Regulatory baseline

The regulatory baseline does not address specific attributes of the transaction request process.

Adopted

Under the rule, each transaction request must contain:

- Transferor holding account number.
- Transferee holding account number.
- Quantity, type and vintage of the compliance instruments to be traded.
- Settlement price of each type and vintage of compliance instruments.
- Method used to determine the settlement price.
- Type of trading agreement.
- Date of signing of the agreement.
- Trading date.
- Attestation statement.

Expected impact

Transaction costs, such as transfer requests, would be a part of overall private costs associated with Cap and Invest Program participation, and would underlie willingness to pay for GHG emission allowances. This means allowance market prices in the Cap and Invest Program will reflect transaction costs, and we do not analyze them separately (or in addition to) costs of allowance purchases. In the case of transfer requests, however, we expect the rule to result in

minimal transfer request and confirmation costs, as this will be facilitated by the electronic accounting structure contracted by Ecology.

2.3.5.4 Transfers to a compliance account – process

Regulatory baseline

The regulatory baseline does not address specific attributes of the allowance transfer process.

Adopted

Under the rule, every registered entity wishing to transfer compliance instruments from its holding account to its compliance account needs to send Ecology a request including:

- Holding account number and compliance account number.
- Quantity, type, and vintage of the compliance instruments to be transferred.

To initiate a transfer to a compliance account, an account representative from the registered entity submits the transfer request to Ecology and to all the registered entity's other account representatives. One of the other account representatives needs to confirm the request.

Ecology transfers the compliance instruments from the registered entity's holding account to its compliance account.

Expected impact

Transaction costs, such as transfer requests, would be a part of overall private costs associated with Cap and Invest Program participation, and would underlie willingness to pay for GHG emission allowances. This means allowance market prices in the Cap and Invest Program will reflect transaction costs, and we do not analyze them separately (or in addition to) costs of allowance purchases. In the case of transfer requests, however, we expect the rule to result in minimal transfer request and confirmation costs, as this will be facilitated by the electronic accounting structure contracted by Ecology.

2.3.5.5 Transfers of no cost allowances from an electric utility to an electrical generating facility or federal power marketing administration

Regulatory baseline

The regulatory baseline does not address specific attributes of the allowance transfer process.

Adopted

Under the rule, an electric utility wishing to transfer no cost allowances to the compliance account of an electrical generating facility or federal power marketing administration submits a request to Ecology asking for the transfer and providing the following information:

- Electric utility holding account number.
- Electrical generating facility or federal power marketing administration compliance account number.
- Quantity and vintage of no cost allowances to be transferred.

- Relationship between the electric utility and the electric generating facility or federal power marketing association.

Ecology is allowed to transfer the allowances only if:

- The electric generating facility is operated by the electric utility; or
- The electric utility has an agreement to purchase imported electricity or a power purchase agreement, including a custom product contract from the electric generating facility or federal power marketing administration.

AND

- The transfer will not violate the electricity generating facility's or federal power marketing administration's holding limit.

Expected impact

Transaction costs, such as transfer requests, would be a part of overall private costs associated with Cap and Invest Program participation, and would underlie willingness to pay for GHG emission allowances. This means allowance market prices in the Cap and Invest Program will reflect transaction costs, and we do not analyze them separately (or in addition to) costs of allowance purchases. In the case of transfer requests, however, we expect the rule to result in minimal transfer request and confirmation costs, as this will be facilitated by the electronic accounting structure contracted by Ecology.

2.3.5.6 Transfers of no cost allowances from a utility's holding account to its limited use holding account for consignment to auction

Regulatory baseline

The regulatory baseline does not address specific attributes of the allowance transfer process.

Adopted

Under the rule, utilities wishing to consign no cost allowances to auction must transfer those no cost allowances from their holding account to their limited use holding account by submitting a request to Ecology asking for the transfer and providing the following information:

- The utility's holding account number.
- The utility's limited use holding account number.
- The quantity and vintage of no cost allowances to be transferred.

Expected impact

Transaction costs, such as transfer requests, would be a part of overall private costs associated with Cap and Invest Program participation, and would underlie willingness to pay for GHG emission allowances. This means allowance market prices in the Cap and Invest Program will reflect transaction costs, and we do not analyze them separately (or in addition to) costs of allowance purchases. In the case of transfer requests, however, we expect the rule to result in

minimal transfer request and confirmation costs, as this will be facilitated by the electronic accounting structure contracted by Ecology.

2.3.5.7 Compliance instrument transactions – Prohibited actions

Regulatory baseline

Chapter 70A.65 RCW requires Ecology to adopt provisions to guard against bidder collusion and minimize the potential for market manipulation. The Act prohibits registered entities from releasing or disclosing any bidding information, including:

- Intent to participate or refrain from participation.
- Auction approval status.
- Intent to bid.
- Bidding strategy.
- Bid price or bid quantity.
- Information on the bid guarantee provided to the financial services administrator.

Ecology may cancel or restrict a previously approved auction participation application or reject a new application if the department determines that a registered entity has:

- Provided false or misleading facts.
- Withheld material information that could influence a decision by the department.
- Violated any part of the auction rules.
- Violated registration requirements.
- Violated any of the rules regarding the conduct of the auction.

Adopted

Consistent with the regulatory baseline, the rule establishes the following prohibited actions:

- Other than the account representatives directly involved in a transaction, no party holding privileged information on a compliance instrument may trade that compliance instrument, disclose the information or recommend that another party trade the compliance instrument, except if the party has reason to believe that the information is known to the public or to the other party in the transaction. However, the party may disclose the information or recommend that another party trade the compliance instrument if the party is required to disclose the information in the course of business, and if nothing leads the person to believe that the information will be used or disclosed in contravention of this section.
- No party prevented from trading compliance instruments due to prohibited disclosure may use the privileged information in any other way, unless the party has reason to believe that the information is known to the public.

- A party with knowledge of material order information may not carry out or recommend that another party carry out a transaction involving a compliance instrument, or disclose the information to any other party except if:
    - The party has reason to believe the other party is already aware of the information;
    - The party must disclose the information in the course of business, and nothing leads the party to believe that it will be used or disclosed in contravention of this section;
    - The party carries out a transaction involving the compliance instrument concerned by the information in order to perform a written obligation that the party contracted before becoming aware of the information; and
    - For the purposes of this section, material order information is any information concerning an order to buy or an order to sell a compliance instrument that could have a major impact on the price of a compliance instrument.

The rule also prohibits false and misleading information:

- No party may disclose false or misleading information or information that must be filed under the rule before it is filed, in order to carry out a transaction, in particular when it could influence the price of a compliance instrument.
- False or misleading information is any information likely to mislead on an important fact, as well as the simple omission of an important fact.
- An important fact is any fact that may reasonably be believed to have a significant impact on the price or value of a compliance instrument.

Expected impact

We do not expect this element of the rule to result in costs or benefits beyond the benefit of guarding against bidder collusion and market manipulation.

2.3.6 Offsets

2.3.6.1 General requirements for offset credits and registry offset credits

Regulatory baseline

Chapter 70A.65 RCW requires Ecology to adopt protocols for establishing offset projects and securing offset credits that may be used to meet a portion of a covered or opt-in entity's compliance obligation. The protocols must align with RCW 70A.45.090 (Forests and forest products sector—Climate response) and RCW 70A.45.100 (Carbon sequestration).

Under this law, offset projects must:

- Provide direct environmental benefits to Washington or be located in a jurisdiction with which Washington has entered into a linkage agreement.
- Result in greenhouse gas reductions or removals that:

- Are real, permanent, quantifiable, verifiable, and enforceable.
- Are in addition to greenhouse gas emission reductions or removals otherwise required by law and other greenhouse gas emission reductions or removals that would otherwise occur.
- Have been certified by a recognized registry after July 25, 2021, or within two years prior to July 25, 2021.

The law limits the amount of a covered or opt-in entity's compliance obligation can be met using offsets:

- Five percent during the first compliance period.
- Four percent during the second compliance period.

These limits are adjustable by Ecology, depending on offset availability and whether a specific covered or opt-in entity has or is likely to:

- Contribute substantively to cumulative air pollution burden in an overburdened community.
- Violate any permits required by any federal, state, or local air pollution control agency where the violation may result in an increase in emissions.

An offset project on federally recognized tribal land does not count against the offset credit limits. No more than three percent of a covered or opt-in entity's compliance obligation may be met by transferring offset credits from projects on federally recognized tribal land during the first compliance period. No more than two percent of a covered or opt-in entity's compliance obligation may be met by transferring offset credits from projects on federally recognized tribal land during the second compliance period.

The law requires Ecology to:

- Take into consideration standards, rules, or protocols for offset projects and offset credits established by other states, provinces, and countries with programs comparable to the program established in this law.
- Encourage opportunities for the development of offset projects in this state by adopting offset protocols that may include, but need not be limited to, protocols that make use of aggregation or other mechanisms to reduce transaction costs related to the development of offset projects and that support the development of carbon dioxide removal projects.
- Adopt a process for monitoring and invalidating offset credits as necessary to ensure the credit reflects emission reductions or removals that continue to meet the standards required by this law.
- Make use of aggregation or other mechanisms, including cost-effective inventory and monitoring provisions, to increase the development of offset and carbon removal projects by landowners across the broadest possible variety of types and sizes of lands, including lands owned by small forestland owners.

Finally, the law specifies that offset credits used may not be in addition to or allow for an increase in the emissions limits established under RCW 70A.45.020, as reflected in annual allowance budgets for the Cap and Invest Program.

Adopted

Under the rule, an offset project operator or authorized project designee must ensure the requirements for Ecology offset credits and registry offset credits are met:

- A registry offset credit must:
    - Represent a GHG emission reduction or GHG removal enhancement that is real, quantifiable, permanent, verifiable, enforceable, and additional to GHG reductions or removals otherwise required by law and other GHG reductions or removals that would otherwise occur.
    - Result from the use of a Compliance Offset Protocol that meets the requirements of WAC 173-446-505.
    - Result from an offset project that is listed in accordance with WAC 173-446-520.
    - Result from an offset project that complies with the monitoring, reporting and record retention requirements of WAC 173-446-525.
    - Result from an offset project that is verified pursuant to the requirements of WAC 173-446-530.
    - Be issued by an Offset Project Registry approved pursuant to the requirements of WAC 173-446-590.
- An Ecology offset credit must meet the requirements of this section and:
    - Be issued pursuant to WAC 173-446-555.
    - Be registered pursuant to WAC 173-446-565.
    - Provide direct environmental benefits to the state pursuant to WAC 173-446-595.
    - When used for compliance be subject to the quantitative usage limits set forth in WAC 173-446-600(6).

The rule also specifies that:

- For the first compliance period:
    - No more than 5 percent of a compliance obligation may be satisfied by offset credits.
    - In addition to, but separate from the above limit, a covered entity or opt-in entity may satisfy up to 3 percent of its compliance obligation using offset credits generated from offset projects on federally recognized tribal land.
- For the second compliance period:

- No more than 4 percent of a compliance obligation may be satisfied by offset credits.
- In addition to, but separate from the above limit, a covered entity or opt-in entity may satisfy up to 2 percent of its compliance obligation using offset credits generated from offset projects on federally recognized tribal land.

- For the third and subsequent compliance periods:
  - No more than 4 percent of a compliance obligation may be satisfied by offset credits.
  - A covered entity or opt-in entity may satisfy an additional 2 percent of its compliance obligation using offset credits generated from offset projects on federally recognized tribal land, but may also use offset credits generated from offset projects on federally recognized tribal land to fulfill any portion of the 4 percent limit.

Expected impact

We expect the rule to result in costs of offset purchases by GHG emitters (reflecting underlying costs associated with offset project development, registration, and verification). We also expect it to result in benefits of GHG emissions reductions and removals to the public, environment, and economy, as well as ancillary benefits of some types of offset projects, including reduced impacts of other pollutants and habitat preservation. The rule does not differ from the statute in terms of offset credit use, but specifies protocols and procedures for their use.

Finally, the rule adds more flexibility to the regulatory baseline, in its allowable use of offset credits generated from offset projects on federally recognized tribal land.

2.3.6.2 Requirements for compliance offset protocols

Regulatory baseline

Chapter 70A.65 RCW requires Ecology to adopt protocols for establishing offset projects and securing offset credits that may be used to meet a portion of a covered or opt-in entity's compliance obligation. The protocols must align with RCW 70A.45.090 (Forests and forest products sector—Climate response) and RCW 70A.45.100 (Carbon sequestration).

Under this law, offset projects must:

- Provide direct environmental benefits to Washington or be located in a jurisdiction with which Washington has entered into a linkage agreement.[10]
- Result in greenhouse gas reductions or removals that:
  - Are real, permanent, quantifiable, verifiable, and enforceable.

[10] The requirement for offsets to provide direct environmental benefits to Washington or be located in a linked jurisdiction supersedes other listed offset limits.

- Are in addition to greenhouse gas emission reductions or removals otherwise required by law and other greenhouse gas emission reductions or removals that would otherwise occur.
- Have been certified by a recognized registry after July 25, 2021, or within two years prior to July 25, 2021.

The law limits the amount of a covered or opt-in entity's compliance obligation can be met using offsets:[11]

- Five percent during the first compliance period, with at least half of the offset credits sourced from offset projects that provide direct environmental benefits in Washington.
- Four percent during the second compliance period, with at least 75 percent sourced from projects that provide direct environmental benefits in Washington.

These limits are adjustable by Ecology, depending on offset availability and whether a specific covered or opt-in entity has or is likely to:

- Contribute substantively to cumulative air pollution burden in an overburdened community.
- Violate any permits required by any federal, state, or local air pollution control agency where the violation may result in an increase in emissions.

An offset project on federally recognized tribal land does not count against the offset credit limits. No more than three percent of a covered or opt-in entity's compliance obligation may be met by transferring offset credits from projects on federally recognized tribal land during the first compliance period. No more than two percent of a covered or opt-in entity's compliance obligation may be met by transferring offset credits from projects on federally recognized tribal land during the second compliance period.

The law requires Ecology to:

- Take into consideration standards, rules, or protocols for offset projects and offset credits established by other states, provinces, and countries with programs comparable to the program established in this law.
- Encourage opportunities for the development of offset projects in this state by adopting offset protocols that may include, but need not be limited to, protocols that make use of aggregation or other mechanisms to reduce transaction costs related to the development of offset projects and that support the development of carbon dioxide removal projects.
- Adopt a process for monitoring and invalidating offset credits as necessary to ensure the credit reflects emission reductions or removals that continue to meet the standards required by this law.

[11] All offset projects must provide direct environmental benefits to Washington unless they are from a linked jurisdiction.

- Make use of aggregation or other mechanisms, including cost-effective inventory and monitoring provisions, to increase the development of offset and carbon removal projects by landowners across the broadest possible variety of types and sizes of lands, including lands owned by small forestland owners.

Finally, the law specifies that offset credits used may not be in addition to or allow for an increase in the emissions limits established under RCW 70A.45.020, as reflected in annual allowance budgets for the Cap and Invest Program.

Adopted

The rule sets detailed requirements for a compliance offset protocol, including:

- Accurately determining the extent to which GHG emission reductions and GHG removal enhancements are achieved by the offset project type.
- Establishing data collection and monitoring procedures relevant to the type of GHG emissions sources, GHG sinks, and GHG reservoirs for that offset project type.
- Establishing a project baseline that reflects an estimate of business-as-usual performance or practices for comparison against the GHG emission reductions and/or GHG removal enhancements to be achieved by the offset project type.
- Accounting for activity-shifting leakage and market-shifting leakage for the offset project type, unless the offset protocol stipulates eligibility conditions limiting the use of the offset protocol that eliminate the risk of activity-shifting and/or market-shifting leakage.
- Accounting for any uncertainty in quantification factors for the offset project type.
- Ensuring GHG emission reductions and GHG removal enhancements are permanent.
- Including a mechanism to ensure permanence of GHG removal enhancements for sequestration offset project types.
- Establishing the length of the crediting period for the offset project type.
- Establishing the eligibility and additionality of the offset project type, and quantify GHG emission reductions and GHG removal enhancements using standardized baseline assumptions, emission factors, and monitoring methods.
- Specify the geographic area(s) where the protocol is applicable.

It also limits crediting periods for non-sequestration offset projects to 7 – 10 years, and for sequestration projects to 10 – 30 years.

The rule also specifies that:

- For the first compliance period:
    - No more than 5 percent of a compliance obligation may be satisfied by offset credits.

    - In addition to, but separate from the above limit, a covered entity or opt-in entity may satisfy up to 3 percent of its compliance obligation using offset credits generated from offset projects on federally recognized tribal land.
- For the second compliance period:
    - No more than 4 percent of a compliance obligation may be satisfied by offset credits.
    - In addition to, but separate from the above limit, a covered entity or opt-in entity may satisfy up to 2 percent of its compliance obligation using offset credits generated from offset projects on federally recognized tribal land.
- For the third and subsequent compliance periods:
    - No more than 4 percent of a compliance obligation may be satisfied by offset credits.
    - A covered entity or opt-in entity may satisfy an additional 2 percent of its compliance obligation using offset credits generated from offset projects on federally recognized tribal land, but may also use offset credits generated from offset projects on federally recognized tribal land to fulfill any portion of the 4 percent limit.

Expected impact

We expect the rule to result in costs of offset purchases by GHG emitters (reflecting underlying costs associated with offset project development, registration, and verification). We also expect it to result in benefits of GHG emissions reductions and removals to the public, environment, and economy, as well as ancillary benefits of some types of offset projects, including reduced impacts of other pollutants or habitat preservation. The rule does not differ from the regulatory baseline in terms of offset credit use, but specifies protocols and procedures for their use, and is therefore not possible to analytically separate from the regulatory baseline.

Finally, the rule adds more flexibility to the regulatory baseline, in its allowable use of offset credits generated from offset projects on federally recognized tribal land.

2.3.6.3 Requirements for offset projects using Ecology compliance offset protocols

Regulatory baseline

Chapter 70A.65 RCW requires Ecology to adopt protocols for establishing offset projects and securing offset credits that may be used to meet a portion of a covered or opt-in entity's compliance obligation. The protocols must align with RCW 70A.45.090 (Forests and forest products sector—Climate response) and RCW 70A.45.100 (Carbon sequestration).

Under this law, offset projects must:

- Provide direct environmental benefits to Washington or be located in a jurisdiction with which Washington has entered into a linkage agreement. [12]
- Result in greenhouse gas reductions or removals that:
    - Are real, permanent, quantifiable, verifiable, and enforceable.
    - Are in addition to greenhouse gas emission reductions or removals otherwise required by law and other greenhouse gas emission reductions or removals that would otherwise occur.
    - Have been certified by a recognized registry after July 25, 2021, or within two years prior to July 25, 2021.

The law limits the amount of a covered or opt-in entity's compliance obligation can be met using offsets: [13]

- Five percent during the first compliance period, with at least half of the offset credits sourced from offset projects that provide direct environmental benefits in Washington.
- For percent during the second compliance period, with at least 75 percent sourced from projects that provide direct environmental benefits in Washington.

These limits are adjustable by Ecology, depending on offset availability and whether a specific covered or opt-in entity has or is likely to:

- Contribute substantively to cumulative air pollution burden in an overburdened community.
- Violate any permits required by any federal, state, or local air pollution control agency where the violation may result in an increase in emissions.

An offset project on federally recognized tribal land does not count against the offset credit limits. No more than three percent of a covered or opt-in entity's compliance obligation may be met by transferring offset credits from projects on federally recognized tribal land during the first compliance period. No more than two percent of a covered or opt-in entity's compliance obligation may be met by transferring offset credits from projects on federally recognized tribal land during the second compliance period.

The law requires Ecology to:

- Take into consideration standards, rules, or protocols for offset projects and offset credits established by other states, provinces, and countries with programs comparable to the program established in this law.
- Encourage opportunities for the development of offset projects in this state by adopting offset protocols that may include, but need not be limited to, protocols that make use of

[12] The requirement for offsets to provide direct environmental benefits to Washington or be located in a linked jurisdiction supersedes other listed offset limits.
[13] All offset projects must provide direct environmental benefits to Washington unless they are from a linked jurisdiction.

aggregation or other mechanisms to reduce transaction costs related to the development of offset projects and that support the development of carbon dioxide removal projects.

- Adopt a process for monitoring and invalidating offset credits as necessary to ensure the credit reflects emission reductions or removals that continue to meet the standards required by this law.
- Make use of aggregation or other mechanisms, including cost-effective inventory and monitoring provisions, to increase the development of offset and carbon removal projects by landowners across the broadest possible variety of types and sizes of lands, including lands owned by small forestland owners.

Finally, the law specifies that offset credits used may not be in addition to or allow for an increase in the emissions limits established under RCW 70A.45.020, as reflected in annual allowance budgets for the Cap and Invest Program.

Adopted

The rule sets requirements for offset project operators and authorized project designees to:

- Ensure offset projects meet compliance offset protocol requirements and additionality requirements. These also include transitioning to applicable versions of specific compliance offset protocols for livestock, urban forest, and US forest projects.
- Fulfill all local, regional, state, and national requirement on environmental impact assessments that apply based on project location.

Expected impact

We expect the rule to result in costs of offset purchases by GHG emitters (reflecting underlying costs associated with offset project development, registration, and verification). We also expect it to result in benefits of GHG emissions reductions and removals to the public, environment, and economy, as well as ancillary benefits of some types of offset project, including reduced impacts of other pollutants and habitat preservation. The rule does not differ from the regulatory baseline in terms of offset credit use, but specifies protocols and procedures for their use, and is therefore not possible to analytically separate from the regulatory baseline.

2.3.6.4 Authorized project designee

Regulatory baseline

The regulatory baseline does not specify requirements for authorized project designees.

Adopted

Under the rule, an offset project operator may designate a party as an authorized project designee at the time of offset project listing or any time after offset project listing as long as it meets certain requirements. This designation may be modified once within each year after the offset project has been listed by Ecology or an offset project registry.

Expected impact

We expect the rule to result in designation costs as well as benefits of full information about authorized project designees, and security and quality assurance of offset activities. The rule allows offset project operators to designate an authorized project designee. Transaction costs, such as representative designation, would be a part of overall private costs associated with offset project operations, and would underlie the price of offset credits. This means offset credit prices will reflect transaction costs, and we do not analyze them separately (or in addition to) costs of offset credit purchases.

2.3.6.5 Listing of offset projects using Ecology compliance offset protocols

Regulatory baseline

The regulatory baseline does not specify requirements for listing offset projects using Ecology compliance offset protocols.

Adopted

Under the rule, before an offset project can be listed by Ecology or an offset project registry, the offset project operator and its authorized project designee are required to:

- Register with Ecology.
- Not be subject to any holding account restrictions.

Offset project operators and any authorized project designees are required to submit specific attestations. They are also required to provide required documentation and disclosures, and provide listing information per the most reason of a compliance offset protocol for the project type. For offset projects located on land over which Washington does not have jurisdiction, they are required to demonstrate consent of the landowner(s) to being regulated by Ecology under the Cap and Invest Program, including consent to the jurisdiction of Washington courts and administrative tribunals with respect to actions taken by Ecology to enforce applicable requirements of the program.

The rule also sets out timing and notice requirements for listing during initial and renewed crediting periods.

Expected impact

We expect the rule to result in registration costs as well as benefits of full information about offset projects. The rule requires offset project operators to submit information and documentation to Ecology. Transaction costs, such as registration and documentation costs, would be a part of overall private costs associated with offset project operations, and would underlie the price of offset credits. This means offset credit prices will reflect transaction costs, and we do not analyze them separately (or in addition to) costs of offset credit purchases.

2.3.6.6 Monitoring, reporting, and record retention requirements for offset projects

Regulatory baseline

Chapter 70A.65 RCW requires Ecology to:

- Adopt a process for monitoring and invalidating offset credits as necessary to ensure the credit reflects emission reductions or removals that continue to meet the standards required by this law.
- Make use of aggregation or other mechanisms, including cost-effective inventory and monitoring provisions, to increase the development of offset and carbon removal projects by landowners across the broadest possible variety of types and sizes of lands, including lands owned by small forestland owners.

Adopted

The rule requires offset project operators or authorized project designees to use the procedures in the adopted offset protocols for monitoring measurements and project performance for offset projects. This includes maintenance and calibration.

The rule also requires offset project operators or authorized project designees to submit an offset project data report to Ecology or an offset project registry for each reporting period. It specifies the timing and contents of offset project data reports, as well as procedures for requesting alternative methods or reporting periods.

Expected impact

We expect the rule to result in monitoring, reporting, and recordkeeping costs as well as benefits of guaranteeing accurate accounting and understanding of offset project effectiveness. Monitoring, reporting, and recordkeeping costs would be a part of overall private costs associated with offset project operations, and would underlie the price of offset credits. This means offset credit prices will reflect these costs, and we do not analyze them separately (or in addition to) costs of offset credit purchases.

2.3.6.7 Verification of GHG emissions reductions and GHG removal enhancements from offset projects

Regulatory baseline

Chapter 70A.65 RCW requires Ecology to adopt protocols for establishing offset projects and securing offset credits that may be used to meet a portion of a covered or opt-in entity's compliance obligation. The protocols must align with RCW 70A.45.090 (Forests and forest products sector—Climate response) and RCW 70A.45.100 (Carbon sequestration).

Under this law, offset projects must:

- Provide direct environmental benefits to Washington or be located in a jurisdiction with which Washington has entered into a linkage agreement.
- Result in greenhouse gas reductions or removals that:
    - Are real, permanent, quantifiable, verifiable, and enforceable.
    - Are in addition to greenhouse gas emission reductions or removals otherwise required by law and other greenhouse gas emission reductions or removals that would otherwise occur.

- Have been certified by a recognized registry after July 25, 2021, or within two years prior to July 25, 2021.

The law requires Ecology to:

- Adopt a process for monitoring and invalidating offset credits as necessary to ensure the credit reflects emission reductions or removals that continue to meet the standards required by this law.

Adopted

The rule requires offset project operators or authorized project designees to obtain the services of an Ecology-accredited verification body for the purposes of verifying offset project data reports. This includes:

- Timing for sequestration and non-sequestration projects.
- Timing for submittal of offset verification statements.

Expected impact

We expect the rule to result in verification costs as well as benefits of guaranteeing accurate understanding of offset project effectiveness. Verification costs would be a part of overall private costs associated with offset project operations, and would underlie the price of offset credits. This means offset credit prices will reflect these costs, and we do not analyze them separately (or in addition to) costs of offset credit purchases.

2.3.6.8 Requirements for offset verification services

Regulatory baseline

The regulatory baseline does not specify requirements for offset verification services, beyond requiring offsets to result in GHG reductions that are verifiable and meet the standards of the law.

Adopted

The rule requires:

- Rotation of verification bodies.
- Offset verification services that:
    - Submit a notice of offset verification services.
    - Begin offset verification services 10 calendar days after the notice for offset verification services is received.
    - Do not conduct the site visit until at least 15 calendar days after the notice for offset verification services is received, or until at least 40 days if the verification is being audited.
    - Include:
        - Offset verification plan.

- Timing of offset verification services.
- Planning meetings with the offset project operator or authorized project designee.
- Site visits for offset projects.
- Review offset project operations to identify applicable GHG emissions sources, project emissions, GHG sinks, and GHG reservoirs required to be included and quantified in the offset project data report as required by the applicable compliance offset protocol.
- Review of all information and documentation used to calculate and report project baseline and project GHG emissions, GHG reductions, and GHG removal enhancements, and other information required by the applicable compliance offset protocol.
- Sampling plan for offset project data reports.
- Data checks for offset project data reports.
- Verification the offset project data report is free of offset material misstatement.
- Issues log.
- Assessment of offset material misstatement
- Offset verification statement.

Expected impact

We expect the rule's specification of requirements for offset verification services to result in costs that are passed on as part of the costs of verification services, which in turn would underlie the price of offset credits. This means offset credit prices will reflect these costs, and we do not analyze them separately (or in addition to) costs of offset credit purchases.

2.3.6.9 Offset verifier and verification body accreditation

Regulatory baseline

The regulatory baseline does not specify requirements for offset verifier or verification body accreditation.

Adopted

The rule requires an offset verifier or verification body to meet accreditation requirements to provide offset verification services. This accreditation is separate from GHG emissions reporting verification body requirements in Chapter 173-441 WAC.

Expected impact

We expect the rule's specification of requirements for offset verifier or verification body accreditation to result in costs that are passed on as part of the costs of verification services, which in turn would underlie the price of offset credits. This means offset credit prices will

reflect these costs, and we do not analyze them separately (or in addition to) costs of offset credit purchases.

2.3.6.10 Conflict of interest requirements for verification bodies and offset verifiers for verification of offset project data reports

Regulatory baseline

Chapter 70A.65 RCW requires Ecology to adopt "provisions to guard against bidder collusion and minimize the potential for market manipulation."

Adopted

The rule applies conflict of interest provisions to verification bodies, lead verifiers, and offset verifiers accredited by Ecology to perform offset verification services for offset project operators, and authorized project designees, as well as any other member of the offset verification team and any technical consultant(s) used by the offset project operator or authorized project designee.

Expected impact

We do not expect this element of the rule to result in costs or benefits beyond the benefits of guarding against bidder collusion and market manipulation.

2.3.6.11 Issuance of registry offset credits

Regulatory baseline

The regulatory baseline does not specify requirements for the issuance of registry offset credits.

Adopted

Under the rule, one registry offset credit, which represents one MT CO_2e for a direct GHG emission reduction or direct GHG removal enhancement, is issued only if:

- An offset project registry has listed the offset project.
- The GHG emission reductions or GHG removal enhancements were issued a positive offset or qualified positive offset verification statement.
- An offset project registry has received a positive offset or qualified positive offset verification statement issued and attested to by an Ecology-accredited verification body for the offset project data report for which registry offset credits would be issued.

An offset project registry determines whether the GHG emission reductions and GHG removal enhancements meet the necessary requirements, the information submitted is complete, and the positive offset or qualified positive offset verification statement meets the requirements of this section within 45 calendar days of receiving it.

The rule also establishes determination for timing and duration of initial crediting periods and renewed crediting periods.

Expected impact

We expect the rule's specification of requirements for issuance of registry offset credits to result in costs that are passed on as part of the costs of offset project operations. Transaction costs, such as costs of registry activities, would be a part of overall private costs associated with offset project operations, and would underlie the price of offset credits. This means offset credit prices will reflect transaction costs, and we do not analyze them separately (or in addition to) costs of offset credit purchases.

2.3.6.12 Issuance of Ecology offset credits

Regulatory baseline

The regulatory baseline does not specify requirements for the issuance of Ecology offset credits.

Adopted

Under the rule, one Ecology offset credit, which represents one MT CO_2e for a direct GHG emission reduction or direct GHG removal enhancement, is issued only for a GHG emission reduction or GHG removal enhancement that occurs during a reporting period, and only if:

- Ecology or an offset project registry has listed the offset project.
- The GHG emission reductions and GHG removal enhancements were issued a positive offset or qualified positive offset verification statement.
- Ecology or an offset project registry has received a positive offset or qualified positive offset verification statement issued and attested to by an Ecology accredited verification body for the offset project data report for which registry offset credits were issued if the offset project was submitted for listing with an offset project registry, or for which Ecology offset credits would be issued.
- The issued Ecology offset credits would not immediately be subject to invalidation.

The rule would also set out requirements for offset projects submitted through an offset project registry seeking issuance of Ecology offset credits.

Initial crediting periods begin with the date that the first verified GHG emission reductions and GHG removal enhancements occur, according to the first positive offset or qualified positive offset verification statement that is received by Ecology, unless otherwise specified in a compliance offset protocol.

Renewed crediting periods begin the day after the conclusion of the prior crediting period.

Expected impact

We expect the rule's specification of requirements for issuance of Ecology offset credits to result in costs that are passed on as part of the costs of offset project operations. Transaction costs, such as costs of issuing offset credits, would be a part of overall private costs associated with offset project operations, and would underlie the price of offset credits. This means offset credit prices will reflect transaction costs, and we do not analyze them separately (or in addition to) costs of offset credit purchases.

2.3.6.13 Process for issuance of Ecology offset credits

Regulatory baseline

The regulatory baseline does not specify requirements for the process for issuance of Ecology offset credits.

Adopted

The rule establishes a process for Ecology to issue offset credits, including notices, information requests, changes, and determinations.

Ecology transfers Ecology offset credits into the holding account of the offset project operator, authorized project designee, or any other third party requested by the offset project operator to receive Ecology offset credits, within 15 business days of the offset project registry providing proof to Ecology that the registry offset credits have been permanently removed or cancelled from the registry system.

Expected impact

We do not expect this element of the rule to result in costs or benefits beyond administrative costs to Ecology.

2.3.6.14 Registration of Ecology offset credits

Regulatory baseline

The regulatory baseline does not specify requirements for registration of Ecology offset credits.

Adopted

Under the rule, an Ecology offset credit is registered by:

- Creating a unique Ecology serial number.
- Transferring the Ecology offset credits to the holding account of the listed offset project operator, authorized project designee, or another third party as requested by the offset project operator to receive Ecology offset credits, unless otherwise required by a forestry offset reversal.

Expected impact

We do not expect this element of the rule to result in costs or benefits beyond administrative costs to Ecology.

2.3.6.15 Forestry offset reversals

Regulatory baseline

The regulatory baseline does not specify requirements for forestry offset reversals.

Adopted

Under the rule, a portion of Ecology offset credits issued to a forest offset project is placed by Ecology into the Forest Buffer Account at the time of offset credit registration. The portion is determined by the applicable version of the compliance offset protocol.

The rule details process and replacement requirements for unintentional and intentional forest reversals, in which the forestry offset project does not result in the expected GHG emissions reductions, as well as early project termination.

Expected impact

We do not expect this element of the rule to result in costs or benefits beyond the benefits of assuring that offset credits reflect real GHG reductions as required under the regulatory baseline.

2.3.6.16 Transferability of Ecology offset credits

Regulatory baseline

The regulatory baseline does not specify requirements for transferability of Ecology offset credits.

Adopted

Under the rule, an Ecology offset credit may be sold, traded, or transferred, unless:

- It has been retired, used for compliance, or used to meet any GHG mitigation requirements in any voluntary or regulatory program.
- It resides in the Forest Buffer Account.
- It has been invalidated.

And may only be used:

- To meet a compliance obligation under this article, except if used by a covered entity in a program approved for linkage.
- By a general market participant for purposes of voluntary retirement.

Expected impact

We do not expect this element of the rule to result in costs or benefits as compared to the regulatory baseline. Neither the regulatory baseline nor the rule create a new trading structure or market for offset credits, and the rule clarifies how the transferability of offset credits differs from allowances.

2.3.6.17 Invalidation of Ecology offset credits

Regulatory baseline

The regulatory baseline does not specify requirements for the invalidation of Ecology offset credits.

Adopted

The rule establishes criteria for invalidation of Ecology offset credits.

Expected impact

We do not expect this element of the rule to result in costs or benefits beyond the benefits of assuring that offset credits reflect real GHG reductions as required under the regulatory baseline.

2.3.6.18 Approval requirements for offset project registries

Regulatory baseline

The regulatory baseline does not specify requirements for approval of offset project registries.

Adopted

The rule establishes approval requirements for all offset project registries that operate to provide registry services. These include:

- Offset project registry approval application.
- Procedures to screen and address internal conflicts of interest.
- The applicant's primary business being operating an offset project registry for voluntary or regulatory purposes.
- Professional liability insurance.
- Attestations.
- Training and examination of at least two management staff.
- Training and examination of staff in all compliance offset protocols.
- At lest two years experience.

Expected impact

We expect the rule's specification of information that must be submitted by offset project registries to result in costs that are passed on as part of the costs of offset project operations. Transaction costs, such as costs of registry activities, would be a part of overall private costs associated with offset project operations, and would underlie the price of offset credits. This means offset credit prices will reflect transaction costs, and we do not analyze them separately (or in addition to) costs of offset credit purchases.

2.3.6.19 Offset project registry requirements

Regulatory baseline

The regulatory baseline does not specify requirements for an offset project registry.

Adopted

The rule establishes requirements for offset project registries, using approved compliance offset protocols, to determine whether an offset project may be listed with the offset project registry for issuance of registry offset credits.

The registry needs to make information about the offset projects publicly available.

An offset project registry is required to audit at least 10 percent of the annual full offset verifications developed for offset projects using a compliance offset protocol, and review each detailed verification report for completeness. It is also required to make data readily available, and remove or cancel credits issued.

Registries are required to provide an annual report of the previous year's offset projects, and all information submitted, and correspondence related to, listed offset projects under compliance offset protocols by the offset project registry must be maintained for a minimum of 15 years.

Expected impact

We expect the rule's specification of offset project registry requirements to result in costs that are passed on as part of the costs of offset project operations. Transaction costs, such as costs of registry activities, would be a part of overall private costs associated with offset project operations, and would underlie the price of offset credits. This means offset credit prices will reflect transaction costs, and we do not analyze them separately (or in addition to) costs of offset credit purchases.

2.3.6.20 Direct environmental benefits in the State

Regulatory baseline

Chapter 70A.65 RCW requires offset projects to provide direct environmental benefits to Washington or be located in a jurisdiction with which Washington has entered into a linkage agreement.

Adopted

Under the rule, offset projects that are located within, or that avoid GHG emissions within the State of Washington are considered to provide direct environmental benefits in the State.

Projects located outside of Washington are able to submit information to Ecology to enable a determination of whether the project provides direct environmental benefits in the State, based on showing that the offset project or offset project type provides for the:

- Reduction or avoidance of emissions of any air pollutant that is not credited pursuant to the applicable compliance offset protocol in the State of Washington.
- Reduction or avoidance of any pollutant that is not credited pursuant to the applicable compliance offset protocol that could have an adverse impact on waters of the State of Washington.

The rule details the types of information that may be used to support such a determination.

In addition, the rule provides that Ecology will accept offset credits only from offset projects that do not have significant adverse environmental impacts after mitigation.

Expected impact

We expect the rule's specification of what constitutes "direct environmental benefits to the state" to create benefits of additional potential for ancillary benefits to Washington's environment and public, including emissions of pollutants other than GHGs to the air or waters.

2.4 Additional regulatory baseline information

2.4.1 Use of auction revenues

Chapter 70A.65 RCW also specifies allocations of auction revenues to various accounts. While not directly applicable to any particular section of the rule, these allocations inform the types of spending, and therefore the types of benefits that could result from projects or investments made as part of the Cap and Invest Program.

- Fiscal year 2023:
    - $127,341,000 must first be deposited into the carbon emissions reduction account.
    - The remaining auction proceeds go to the climate investment account and the air quality and health disparities improvement account.
- Fiscal year 2024:
    - $356,697,000 must first be deposited into the carbon emissions reduction account
    - The remaining auction proceeds go to the climate investment account and the air quality and health disparities improvement account.
- Fiscal year 2025:
    - $366,558,000 must first be deposited into the carbon emissions reduction account.
    - The remaining auction proceeds go to the climate investment account and the air quality and health disparities improvement account.
- Fiscal years 2026 through 2037:
    - $359,117,000 per year must first be deposited into the carbon emissions reduction account.
    - The remaining auction proceeds go to the climate investment account and the air quality and health disparities improvement account.
- Fiscal years 2038 and later:
    - 50 percent of the auction proceeds go to the carbon emissions reduction account.
    - The remaining auction proceeds go to the climate investment account and the air quality and health disparities improvement account.
- Deposits into the carbon emissions reduction account must not exceed $5.2 billion over the first 16 years.

- Any remaining auction proceeds must be deposited into the climate investment account and the air quality and health disparities improvement account.

2.5 Analytic structure and assumptions

This section describes the structure for our analysis of likely costs and benefits of the rule – the basis of cost estimation results discussed in Chapter 3, and benefits estimation results discussed in Chapter 4. It is also the structure used for analyses of alternative assumptions in sensitivity analyses discussed in the appendices.

For the CBA, we consider direct costs and benefits, but as this rule potentially has broad impacts across the state economy, we also considered indirect (upstream or downstream) and induced (resulting from relative price changes) impacts that could result from changes in economic activity, including impacts to output and jobs. These results help decisionmakers, the public, and other stakeholders to understand the full implications of the rule (see Chapter 7 for modeling discussion and results).

2.5.1 Likely covered entities

We began this analysis by developing an understanding of likely covered entities. Most covered entities have been reporting emissions under the GHG reporting rule (Chapter 173-441 WAC). Ecology identified 107 total facilities, natural gas suppliers, and other fuel suppliers that would be covered entities under the rule.[14]

There are also likely covered entities that do not have existing reported GHG emissions. These are electricity importers and other fuel suppliers not currently required to report GHG emissions to Ecology. In a recent GHG reporting rulemaking, we assumed, as supported by information from the Bonneville Power Administration,[15] that 25-30 EPEs could be likely covered entities as electricity importers. These numbers were based on half of 50 – 60 new EPE reporters under a recent GHG reporting rulemaking being likely CCA covered entities as electricity importers. Accounting for these additional covered parties, the tables below summarize information about all likely covered entities.[16]

Table 17: Number of likely covered entities with reported GHG emissions

First Year of Coverage	Number of Likely Covered Entities
2023	106
2027	1
Total	107

[14] WA Department of Ecology, 2022. CCA Total Program Baseline calculation. "2022 08 25 – CCA Total Program Baseline.xlsx". August 25, 2022.
[15] Bonneville Power Administration phone discussion with Neil Caudill and Bill Drumheller, WA Department of Ecology Air Quality Program. Summer 2021.
[16] WA Department of Ecology, 2022. GHG Reporting Program Publication dataset. https://data.wa.gov/Natural-Resources-Environment/GHG-Reporting-Program-Publication/idhm-59de/data

Table 18: Likely covered entities by sector

Sector	Number of Entities	EITE
Chemicals	3	Yes
Electricity Importers	25 – 30	No
Food Production	11	Yes
Fuel Supplier – Natural Gas Distribution	6	No
Fuel Supplier – Other Fuels	23	No
Government (Universities)	2	No
Manufacturing	7	Yes
Metals	6	Yes
Minerals	4	Yes
Natural Gas Systems	14	No
Petroleum Systems	7	Yes
Power Plants	15	No
Pulp and Paper	8	Yes
Waste to Energy	1	No
Total	132 – 137	n/a

2.5.2 Baseline emissions and trajectories

We estimated the likely baseline emissions for the Cap and Invest Program for each likely covered entity or group of entities.

- Emissions for likely covered entities with existing GHG reporting data were based on 2015 – 2019 emissions.[17]
- Emissions for electricity importers were based on reported emissions from known power plants out-of-state that supply Washington electric load combined with an assessment of unspecified market power assumed to originate from out-of-state.

We based baseline emissions on existing GHG reporting data (see detailed discussion in Section 2.5.2.1),[18] as well as estimated electricity emissions (see detailed discussion in Section 2.5.2.2).

2.5.2.1 Likely covered entities with known emissions

Based on reported GHG emissions subject to the rule, we estimated the following baseline emissions, summarized by sector.

Table 19: Baseline emissions by sector, known emissions[19]

Sector	Baseline Emissions (MT CO_2e)
Chemicals	253,791

[17] Ibid.

[18] WA Department of Ecology, 2022. GHG Reporting Program Publication dataset. https://data.wa.gov/Natural-Resources-Environment/GHG-Reporting-Program-Publication/idhm-59de/data

[19] This analysis uses the most recent reported emissions available for likely covered entities. As expected, emissions values changed slightly with new reporting data over the course of this rulemaking.

Sector	Baseline Emissions (MT CO_2e)
Food Production	562,669
Other Fuel Suppliers	30,007,424
Natural Gas Suppliers	8,846,424
Government	151,448
Manufacturing	404,224
Metals	1,519,626
Minerals	592,020
Natural Gas Systems	692,231
Petroleum Systems	6,533,999
Power Plants (including waste to energy)	4,972,500
Pulp and Paper	1,034,812

Note: Emissions will likely have slightly different distribution across sectors and individual entities due to differences in emissions data reported over time relative to the date of this analysis, as well as differences or new information available via the multiple information sources used by Ecology under WAC 173-446-200(2).

2.5.2.2 Electricity importers

Establishing the baseline for the electricity sector is difficult because electricity importer data is not available for baseline years 2015 through 2019 through the greenhouse gas reporting program. And it won't be available until the electricity sector starts reporting in 2023. Below we explain how we developed the baseline given this context.

The only data set available to Ecology and the general public, that is not confidential and proprietary, is the WA Department of Commerce's data collected through their Fuel Mix Disclosure (FMD) reporting process. The purpose of this data is to show the resources used to supply power to Washington customers, based on the power contracts and sources of power procurement for Washington utilities.

The data is itemized by "claims" on power plants, to show the quantity of electrical energy (in MWh) used to serve electrical load in Washington from each power plant. Or, if not from a known power plant (a "specified source"), then the other major sources of electricity – notably the general power market and the Bonneville Power Administration (BPA) federal power marketer. In all cases, if there is no known power plant associated with the delivered power, or other known source, the power falls into a broad category known as "unspecified power." Importantly, the FMD data is not greenhouse gas emissions data, are not intended to be treated as such, and were not used that way in this analysis.

Ideally the baseline for electricity should reflect the compliance approach in the Cap and Invest Program, i.e., the first jurisdictional deliverer (FJD) of electricity. The emissions total should be greater than one derived from a consumption-based inventory approach, i.e., one based only on the emissions associated with the use of electricity in Washington (which is the approach under the state inventory). A "FJD inventory" approach is appropriate, which represents the sum of in-state generation and the separate sum of imported electricity. This will be larger than

a consumption-based approach, if for no other reason than emissions associated with exported electricity are by definition not part of the consumption-based approach.

Ecology did not use the FMD emissions data to identify the baseline for this analysis. As described in the rule, Ecology used the identified power plants and associated energy data ("claims") from the FMD process, but did not use any associated emissions data. Instead, Ecology constructed an "FJD inventory" by combining in-state electrical generation emissions data (from existing reporting) with emissions generated. We did this by multiplying the electrical energy imported from the associated power plant by the actual emissions factor for that power plant based on the methods used under the Clean Energy Transformation Act (CETA) greenhouse gas attribution rules (Chapter 173-444 WAC). In both cases, and for both in-state generation and for out-of-state generation that is imported into Washington, the associated greenhouse gas emissions are based on actual reported greenhouse gas emissions (except for a few small sources which are based on other methods, per the CETA rules).

While estimating emissions from specified sources is reasonably straightforward, since power contracts with major generating sources are well understood, it is more challenging to estimate so-called unspecified power (and associated emissions) where the source of the power is unknown or unknowable. Here the FMD data is useful, as is the process used to generate the data. Ecology obtained the raw data used for the FMD process from the Department of Commerce, and one of the elements of that data is the amount of power from each power plant that is not claimed by a utility. This power is considered unspecified power or, more generally, "market power." Ecology took the total of this market power generated by power plants with emissions in Washington, subtracted it from the total of market power used by Washington utilities, and assumed the difference was made up by importing out of state market power into Washington. Ecology then applied the unspecified emissions factor from the CETA rule process to this estimate of imported unspecified market power, and the result is an estimate of imported unspecified electricity emissions. An additional component is included, which is the portion of Bonneville Power Administration (BPA) power purchases that are derived from market power purchases. This small amount (a few percent of BPA power) is included in the unspecified emissions total, using the same unspecified emissions factor.

From all of this, the final unspecified electricity import baseline estimate was generated as part of this rulemaking process. To summarize, the electricity import baseline is the sum of the total greenhouse gas emissions reported from contracted delivery from specified out-of-state sources, an estimate of unspecified ("market") power imported into Washington with associated emissions, and market power reported by BPA as being delivered to its Washington customers. This estimate is higher than earlier estimates used in the legislative process, and in earlier analyses of the Cap and Invest Program. Taken together, the in-state electricity generation component, combined with the electricity import component, comprise a "FJD inventory" representing the total electricity sector emissions baseline component of the program.

Table 20: Electricity sector emissions

Sub-sector	GHG Emissions (MT CO_2e)
In-State electricity generation	4,972,500
Electricity Imports	12,579,903

2.5.2.3 Total baseline emissions

We based total baseline emissions in the rule on total baseline emissions across all likely covered entities, as summarized in the table below.

Table 21: Baseline emissions by sector

Sector	Baseline Emissions (MT CO_2e)
Sectors covered in 2023	n/a
Chemicals	253,791
Electricity Imports	12,579,903
Food Production	562,669
Other Fuel Supplier	30,007,424
Government	151,448
Manufacturing	404,224
Metals	1,519,626
Minerals	592,020
Natural Gas Systems	692,231
Petroleum Systems	6,533,999
Power Plants (excluding waste-to-energy)	4,873,650
Pulp and Paper	1,034,812
Subtotal	68,052,220
Sectors covered in 2027	n/a
Power Plants (waste-to-energy)	98,851
Total	68,151,071

Based on observations in other GHG emissions allowance markets, we assumed that likely zero or very few opt-in entities would participate in the program. Opt-in entities would only choose to participate if their perceived private net benefit was positive.

The total program emissions baseline was based on total covered emissions for sectors covered starting in 2023. As seen in Table 21, this is 68,052,220 MT CO_2e.

We also subtracted one-third of one percent for the VRERA, 2 percent for the ECR, and 5 percent for the APCR, in each year. While not specified in the rule, we assumed that the one-third of one percent allocation to the VRERA would continue throughout the program.

The rule sets a total program emissions baseline of 68,052,220 MT CO_2e for the first compliance period. Future total program emissions baselines are based on future rulemakings and methods

established under the regulatory baseline and rule. As the total program emissions baseline starting in 2027 is unknown (it is based on new covered sectors entering the program), we made the simplifying assumption that the known waste-to-energy facility would be the only entrant in 2027. We conservatively assumed the total program emissions baseline would be the initial program emissions baseline plus currently known baseline emissions from the waste-to-energy facility.

2.5.2.4 Total program allowance budgets

The rule sets the total allowances in the program in each year:

- First compliance period:
    - 2023: 93 percent of total program baseline for 2023 – 2026.
    - 2024 – 2026: Decreases annually by an additional 7.0 percent of total program baseline for 2023 – 2026.
- Second compliance period:
    - 2027: The 2026 total program allowance budget plus adjustment for newly covered sectors, reduced by an additional 7.0 percent of total program baseline for 2027 – 2030.
    - 2028 – 2030: Decreases annually by an additional 7.0 percent of total program baseline for 2027 – 2030.
- 2031 - 2042:
    - 2031: The 2030 total program allowance budget plus adjustment for newly covered sectors, reduced by an additional 1.9 percent of total program baseline for 2031 and later.
    - 2032 – 2042: Decreases annually by an additional 1.9 percent of total program baseline for 2031 and later.
- 2043 – 2050: Decreases annually by an additional 2.5 percent of total program baseline for 2031 and later.

2.5.2.5 Reserves

Under the rule, Ecology must:

- Set aside 1/3 of one percent of the total program allowance budget for each year to the VRERA.
- Place 5 percent of annual allowance budgets for the years 2023 through 2030 in the APCR, make those allowances vintageless, and make them all available for auction in 2023 and succeeding years.
- Place 2 percent of annual allowance budgets in the ECR.

We subtracted 7 1/3 percent of allowances in each year for placement in the VRERA, the ECR, and the APCR.

2.5.3 Allocation of no cost allowances

For each covered entity, we estimated the allocation of no cost allowances each year. Allocations were determined by the regulatory baseline and rule, based on each covered entity's emissions baseline. Mass based allocation baselines were used for EITEs because Ecology cannot accurately forecast future production rates at those facilities.

- EITE facilities:
    - 100 percent of allocation baseline emissions during the first compliance period.
    - 97 percent of allocation baseline emissions during the second compliance period.
    - 94 percent of allocation baseline emissions during the third and subsequent compliance periods.
    - Allocation of no cost allowances after the third compliance period may be revised, but the regulatory baseline specifies that absent future determination of another allocation trajectory, the 94 percent allocation would continue.
- Electric utilities:
    - 100 percent of cost burden effect of each utility's emissions, through 2045.
    - Zero no cost allowances after 2045.
    - We assumed utilities would continue to use the same fuel mix, beyond changes required under the CETA. Under CETA – part of the regulatory baseline – electric utilities must be 80 percent clean by 2030, and 100 percent clean by 2045.
- Natural gas utilities:
    - 93 percent of allocation baseline in 2023.
    - Decreasing by 7 percent each year through 2030.
    - Decreasing by 1.9 percent each year 2031 – 2042
    - Decreasing by 2.5 percent each year 2043 - 2050.

We assumed no cost allowances would be allocated according to the requirements of the rule:

- EITE facilities:
    - First compliance period: 100 percent of allocation baseline.
    - Second compliance period: 97 percent of allocation baseline.
    - Third compliance period: 94 percent of allocation baseline.
    - Fourth compliance period and later: 94 percent of allocation baseline.
- Electric utilities:
    - 100 percent of cost burden effect

    - We assumed cost burden effect was the quantity of utility emissions, based on subtotal baselines and adjusted over time to match emission reduction trajectory in total electricity consumption emissions modeled for Washington.[20]
- Natural gas utilities:
    - 2023: 93 percent of allocation baseline.
    - 2024 – 2030: Decreases by an additional 7 percent of their allocation baseline.
    - 2031 - 2042: Decreases annually by an additional 1.9 percent of their allocation baseline.
    - 2043 – 2050: Decreases annually by an additional 2.5 percent of their allocation baseline.

Electric utilities and natural gas utilities can consign up to 100 percent of their no cost allowances to auction. There is no minimum consignment requirement for electric utilities, while natural gas utilities are required to consign at least:

- 65 percent in 2023
- 70 percent in 2024.
- 75 percent in 2025.
- 80 percent in 2026.
- 85 percent in 2027.
- 90 percent in 2028.
- 95 percent in 2029.
- 100 percent in 2030.

We conservatively assumed electric utilities would not consign any of their no cost allowances to auction, and would instead use them for compliance as needed. Similarly, we assumed natural gas utilities would consign the required minimum numbers of no cost allowances to auction, as a fraction of the no cost allowances allocated to them.

2.5.4 Offsets

Use of offset credits would reduce demand for allowances, but would require available and appropriate offset credits at prices that would be the lowest cost option available to covered parties. This would depend on the development time for offset projects. Since we are uncertain of the degree and timing of offset credit use, we examined results reflecting no offset credit

[20] WA Department of Commerce, 2021. Carbon Tax Assessment Model (CTAM). Version 4.2. Jan 11, 2021. https://www.commerce.wa.gov/growing-the-economy/energy/washington-state-energy-office/carbon-tax/

use, as well as results assuming maximum offset credit use and banking of additional allowances for future use.

In our model structure, the availability and use of offset credits does not change allowance market behavior. This is a result of the allowance market model excluding an interrelated offset credit market, due to limited resources and time to complete modeling of multiple allowance market scenarios, as well as the inherent complexity and high level of uncertainty about offset credit market attributes for Washington. Instead, in this model, use of offset credits allows for additional accumulation of banked allowances (to be used or sold at a later date), while reducing the average cost of compliance within each year. This results in a higher total present value cost estimate than in the scenario with no offsets, and is a highly conservative assumption, as purchases of offset credits in lieu of allowances would only serve to decrease total compliance costs.

If covered and opt-in entities purchased offset credits in lieu of purchasing allowances, it would reduce market demand, putting downward pressure on allowance prices, counteracting upward pressure that would result from reductions in allowance supply corresponding to offset use. Absent a combined allowance-offset credit market model, we cannot estimate the size of these effects, but allowance prices would still reflect the marginal emissions abatement costs of remaining market participants, and could not fall below the auction floor price in a given year. Greenhouse gas emissions reductions would remain the same in either scenario.

Entities might choose to retain a surplus of banked allowances through 2050 as a precautionary measure in the face of uncertainty about future regulation, or as a source of potential revenue if the market has been linked with ongoing programs in other jurisdictions. They might choose to sell any remaining banked allowances at the end of the program. Due to the allowance market model considering offset credit use as an factor external to allowance market decisions, combined with uncertainty in banking behavior at the end of the program, we could not make a confident assumption about the eventual disposition of surplus credits banked at the end of the program.

We based the cost of using offset credits on offset credit price trajectories, assuming a 15 percent discount relative to allowance prices.

2.5.5 Decision to reduce emissions or purchase allowances

We did not make entity-specific or industry-specific assumptions about which entities would choose GHG emissions reductions, offset credits, or emissions allowances at different points in time or under different market or economic circumstances. This means estimated allowance demand reflects aggregate demand.

2.5.6 Emissions abatement

If emissions exceed the available auction allowances, the remainder of emissions reductions would be made using abatement options with:

- Costs below the market allowance price, by entities that would choose lower abatement costs available to them over purchasing allowances.
- Costs above the allowance market price, by entities that would have purchased additional allowances if they were available, but which must use other abatement options due to limited allowance supply (mitigated by additional allowance releases based on price controls).

We made the simplifying structural assumption that market price would reflect the break-even point of these abatement costs relative to allowance supply and demand, in terms of willingness to pay for allowances as well as volume of allowances demanded.

2.5.7 Total emissions reductions

Total actual emissions reductions are the difference between GHG emissions under the rule and under the regulatory baseline:

- Under the regulatory baseline, absent the Cap and Invest Program created under the rule, GHG emissions would be baseline emissions plus likely growth or reduction in emissions in each year based on doing business as usual.
- Under the rule, using the Cap and Invest Program, emissions in each year would be the total allowance budget.

We note that because we could not analytically separate the rule from the regulatory baseline, the analytic structure assigns responsibility for both costs and benefits of emissions reductions to the rule. This means we are less likely to underestimate actual costs of the elements of the rule for which Ecology used its discretion.

2.5.8 Impacts of carbon emissions

To estimate the benefits of avoiding a metric ton of GHG emissions, Ecology uses the Social Cost of Carbon (SCC). The SCC is an estimate of the global costs resulting from climate change associated with one additional metric ton of GHG emissions.

Many estimates of the Social Cost of Carbon exist, each carrying its own assumptions regarding elements such as (but not limited to):

- The trajectory of worldwide emissions.
- Expected development and growth rates.
- The rate at which we discount the future.
- How much we value impacts that do not occur locally.

We (as well as the federal Interagency Working Group (IWG) that developed the SCC used in this analysis) acknowledge the limitations of any quantitative estimate of the SCC. IWG states in its original analysis:

> "As noted, any estimate of the SCC must be taken as provisional and subject to further refinement (and possibly significant change) in accordance with evolving scientific, economic, and ethical understandings. During the course of our modeling, it became apparent that there are several areas in particular need of additional exploration and research. These caveats, and additional observations in the following section, are necessary to consider when interpreting and applying the SCC estimates."[21]

The workgroup follows up in the technical update:

> "The 2010 interagency SCC TSD [technical support document] discusses a number of important limitations for which additional research is needed. In particular, the document highlights the need to improve the quantification of both non-catastrophic and catastrophic damages, the treatment of adaptation and technological change, and the way in which inter-regional and inter-sectoral linkages are modeled. While the new version of the models discussed above offers some improvements in these areas, further work remains warranted. The 2010 TSD also discusses the need to more carefully assess the implications of risk aversion for SCC estimation as well as the inability to perfectly substitute between climate and non-climate goods at higher temperature increases, both of which have implications for the discount rate used."[22]

We note that these issues, among others, exist for all SCC estimates, and indicate neither specific overestimation nor specific underestimation in overall estimates when all of the variables and assumptions are considered. For example, estimates require development in valuing catastrophic endpoints, which might indicate underestimation, but estimates also require development in how they include adaptation, which might indicate overestimation.

Uncertainty is common in economic value estimates, and is tied to not only the certainty of the inputs and assumptions, but to the number of inputs dealt with. Understandably, models of climate change and their interrelationship with economic models and assumptions – with the sheer number of variables involved – carry greater uncertainty. We chose to use the SCC developed by the federal Interagency Working Group (IWG) on Social Cost of Carbon estimate because it attempts to broadly deal with some of these uncertainties, because it was developed by a wide range of federal experts, and because we wanted to use the estimate that uses the

[21] Interagency Working Group on Social Cost of Carbon, 2010. Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866. February 2010. United States Government. http://www.whitehouse.gov/sites/default/files/omb/inforeg/for-agencies/Social-Cost-of-Carbon-for-RIA.pdf

[22] Interagency Working Group on Social Cost of Carbon, 2013. Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866. May 2013. United States Government.

inputs most closely resembling those typically made in Ecology analyses in discounting social values.[23]

In 2021, the federal government issued new interim values for the Social Cost of Carbon (SCC).[24] These included median values estimated using three discount rates, as well as a set of values reflecting highly damaging scenarios. Depending on the multiple assumptions chosen for underlying climate and economic models, the SCC has a distribution around these median values. The 95th percentile set of SCC values best reflects increased catastrophic events and changes in the environment and economy that are difficult or impossible to correct.

[23] We note that the federal SCC was called into question by a federal district court in 2022 (*Louisiana v. Biden*, Federal District Court for the District of Louisiana, Case No. 2:21-CV-01074. Memorandum Decision, 2/11/2022). This decision was subsequently stayed by the 5th Circuit Court. The three-judge panel stated, "We conclude the standing inquiry shows the Government Defendants' likelihood of success on the merits in this appeal, and the other factors, including the public interest, favor granting a stay of the injunction." (*Louisiana v. Biden*, United States Court of Appeals for the Fifth Circuit, Case No. 22-30087. Document: 00516220740. Filed: 03/01/2022).

[24] Interagency Working Group on Social Cost of Greenhouse Gases, 2021. Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990. United States Government. https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf

Table 22: Social Cost of Carbon (2022$)[25]

Year	Median SCC at 5% Discount Rate	Median SCC at 3% Discount Rate	Median SCC at 2.5% Discount Rate	95th Percentile SCC at 3% Discount Rate
2020	$16.13	$56.93	$85.17	$168.96
2021	$16.68	$58.12	$86.63	$172.88
2022	$17.22	$59.31	$88.08	$176.79
2023	$17.77	$60.50	$89.54	$180.70
2024	$18.31	$61.69	$90.99	$184.61
2025	$18.86	$62.88	$92.45	$188.53
2026	$19.40	$64.07	$93.90	$192.44
2027	$19.95	$65.26	$95.36	$196.35
2028	$20.49	$66.45	$96.81	$200.26
2029	$21.03	$67.64	$98.27	$204.17
2030	$21.58	$68.83	$99.72	$208.09
2031	$22.23	$70.11	$101.24	$212.35
2032	$22.88	$71.38	$102.76	$216.61
2033	$23.53	$72.66	$104.28	$220.87
2034	$24.18	$73.93	$105.80	$225.13
2035	$24.83	$75.21	$107.32	$229.39
2036	$25.48	$76.48	$108.84	$233.66
2037	$26.13	$77.76	$110.36	$237.92
2038	$26.78	$79.03	$111.88	$242.18
2039	$27.43	$80.31	$113.40	$246.44
2040	$28.08	$81.58	$114.92	$250.70
2041	$28.80	$82.86	$116.41	$254.60
2042	$29.52	$84.14	$117.90	$258.50
2043	$30.24	$85.42	$119.38	$262.40
2044	$30.96	$86.69	$120.87	$266.30
2045	$31.68	$87.97	$122.36	$270.20
2046	$32.40	$89.25	$123.85	$274.10
2047	$33.12	$90.52	$125.34	$278.00
2048	$33.84	$91.80	$126.83	$281.90
2049	$34.56	$93.08	$128.32	$285.80
2050	$35.28	$94.35	$129.80	$289.70

As of our analysis, the federal government has not issued new final SCC estimates. In August 2022, Resources for the Future and researchers at the University of California, Berkeley, working with multiple expert institutions, released an updated set of SCC estimates intended in

[25] SCC values were updated for inflation to March 2022 value for the Preliminary Regulatory Analyses for this rulemaking. To maintain consistency across analyses, we have not added further inflation across these values to September 2022 values. Note that since all costs and benefits reflect March 2022 values, and we have retained them in this Final Regulatory Analysis, any additional inflation would affect all values to the same degree and would not affect the results or conclusions of this analysis.

part to help inform the final federal SCC estimates.[26] The Resources for the Future estimates reflect a more comprehensive set of climate change impacts, and up to date scientific research and modeling regarding the magnitude of these impacts. While they are also not fully comprehensive, the authors' preferred set of estimates (using a two percent discount rate supported in a separate discussion[27]) are significantly higher than the interim federal SCC estimates. The authors' SCC estimates (in 2020 dollars) include:

- 2020 SCC of $185/MT CO_2e.
- 2030 SCC of $226/MT CO_2e.
- 2040 SCC of $263/MT CO_2e.
- 2050 SCC of $329/MT CO_2e.

[26] Kevin Rennert, Frank Errickson, Brian C. Prest, Lisa Rennels, Richard G. Newell, William Pizer, Cora Kingdon, Jordan Wingenroth, Roger Cooke, Bryan Parthum, David Smith, Kevin Cromar, Delavane Diaz, Frances C. Moore, Ulrich K. Müller, Richard J. Plevin, Adrian E. Raftery, Hana Ševčíková, Hannah Sheets, James H. Stock, Tammy Tan, Mark Watson, Tony E. Wong & David Anthoff, 2022. Comprehensive Evidence Implies a Higher Social Cost of CO_2. Nature (2022). https://doi.org/10.1038/s41586-022-05224-9.

[27] See https://www.resources.org/archives/improving-discounting-in-the-social-cost-of-carbon/. Resources for the Future also notes at https://www.resources.org/archives/the-social-cost-of-carbon-reaching-a-new-estimate/?mc_cid=d956ec036e&mc_eid=485db02a02, "Recent research has consistently documented persistent declines in long-run interest rates, suggesting that lower discount rates are appropriate, particularly for long-lived impacts like climate change. Reasonable discount rates suggested by the economics literature are typically around 2 percent, which we adopt as our preferred value for the SCC calculation. As mentioned previously… this preferred estimate of the average SCC is $185 per ton of CO_2, which is much higher than the value of $80 per ton under a 3 percent discount rate because the long-lived impacts of CO_2 emissions are discounted less." This quote above includes links to relevant documentation:
https://obamawhitehouse.archives.gov/sites/default/files/page/files/201701_cea_discounting_issue_brief.pdf
https://link.springer.com/article/10.1057/be.2016.23
https://muse.jhu.edu/article/671750
https://www.brookings.edu/bpea-articles/on-falling-neutral-real-rates-fiscal-policy-and-the-risk-of-secular-stagnation/
https://academic.oup.com/qje/article/130/1/1/2337985?login=false
https://www.nber.org/system/files/working_papers/w21767/w21767.pdf
https://direct.mit.edu/rest/article-abstract/101/5/933/58554/A-New-Normal-for-Interest-Rates-Evidence-from?redirectedFrom=fulltext
https://www.frbsf.org/economic-research/publications/working-papers/2020/25/
https://www.sciencedirect.com/science/article/abs/pii/S0095069621000115
https://www.nber.org/system/files/working_papers/w21767/w21767.pdf
https://www.aeaweb.org/articles?id=10.1257/pol.20160240
https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3764255
https://www.sciencedirect.com/science/article/abs/pii/S009506969891052X?via%3Dihub

We note also that based on 95-percent confidence intervals reported for the recent estimates above, the SCC is more likely to be higher than to be lower than the presented values.[28]

For consistency across analyses for this rulemaking, we have chosen to use the more conservative interim federal (IWG) estimates of the SCC in this analysis. Using the Resources for the Future estimates of SCC would result in significantly higher quantified net benefits of the rule, reflecting additional or updated quantification of elements excluded from, or limited in, the interim federal SCC estimates (see Section 2.5.8.2 for general discussion, and Section 4.3.1 for detailed list).

Note also that estimates are presented in 2022-dollars as of calculations performed for the Preliminary Regulatory Analyses for this rulemaking (March 2022). For consistency and to limit potential confusion across analyses, we have retained this point of reference for dollar values. As all estimates are presented in real dollars, this does not affect the relative size of costs and benefits.

2.5.8.1 Global emissions context

Comments received on the Preliminary Regulatory Analyses for this rulemaking expressed concern that the SCC was not an appropriate measure of the benefits of a rule. We believe, however, that while it is not possible to specify the local benefits to climate change resulting from control of local emissions, it is appropriate to acknowledge that local emissions contribute to the global pool of GHGs that cause global impacts, including local impacts directly and indirectly through:

- International markets.
- Multinational businesses and supply chains.
- Trade.

These impacts affect local ecology, people, industry, agriculture, and infrastructure. Establishing a direct 100-percent relationship between local emissions and local impacts is inherently impossible. This is precisely why Ecology and other government agencies have chosen to represent the costs of GHG emissions and the benefits of reducing them on a global scale.[29] This approach is consistent with our analytic practices and the requirements of the APA for cost and benefit analysis (RCW 34.05.328).

For typical costs and benefits, Ecology uses Washington State-only values (for example, state-specific wages or costs of goods and services) although our analyses reflect impacts to entities both within Washington and beyond Washington that do business, transit through, or would otherwise incur costs or receive benefits. But GHG emissions are unique, and require a broader

[28] See https://www.rff.org/publications/data-tools/scc-explorer/

[29] For clarity and consistency, both global costs and benefits are included, where all costs are incurred locally or by entities that operate locally but are located in other states or countries. This means if costs estimated in Chapter 3 are incurred by a facility owned by a firm headquartered outside of Washington, those costs are included in the Cost-Benefit Analysis.

approach to valuation, especially as it applies to the co-externality impacts of carbon emissions. Ecology believes the use of a global SCC is the appropriate carbon cost to use in analyses, because of the unique nature of GHG emissions and climate change. This has been reaffirmed at the federal level multiple times:

- The IWG addresses global SCC twofold in its interim 2021 Technical Support Document:[30]

> "First, the IWG found previously and is restating here that a global perspective is essential for SC-GHG estimates because climate impacts occurring outside U.S. borders can directly and indirectly affect the welfare of U.S. citizens and residents. Thus, U.S. interests are affected by the climate impacts that occur outside U.S. borders. Examples of affected interests include: direct effects on U.S. citizens and assets located abroad, international trade, tourism, and spillover pathways such as economic and political destabilization and global migration. In addition, assessing the benefits of U.S. GHG mitigation activities requires consideration of how those actions may affect mitigation activities by other countries, as those international mitigation actions will provide a benefit to U.S. citizens and residents by mitigating climate impacts that affect U.S. citizens and residents.
>
> Second, the IWG found previously and is restating here that the use of the social rate of return on capital to discount the future benefits of reducing GHG emissions inappropriately underestimates the impacts of climate change for the purposes of estimating the SC-GHG (see Section 3.1 [of the TSD]). Consistent with the findings of the National Academies (2017) and the economic literature, the IWG continues to conclude that the consumption rate of interest is the theoretically appropriate discount rate in an intergenerational context (IWG 2010, 2013, 2016). The IWG recommends that discount rate uncertainty and relevant aspects of intergenerational ethical considerations be accounted for in selecting future discount rates."

- The IWG previously addressed global SCC (as well as OMB guidance), and stated in its 2015 revised Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis:[31]

[30] Interagency Working Group on Social Cost of Greenhouse Gases, 2021. Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990. United States Government. https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf

[31] Interagency Working Group on Social Cost of Carbon, 2015. Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866. May 2013. United States Government. May 2013, revised July 2015.

> "Under current OMB guidance contained in Circular A-4, analysis of economically significant proposed and final regulations from the domestic perspective is required, while analysis from the international perspective is optional. However, the climate change problem is highly unusual in at least two respects. First, it involves a global externality: emissions of most greenhouse gases contribute to damages around the world even when they are emitted in the United States. Consequently, to address the global nature of the problem, the SCC must incorporate the full (global) damages caused by GHG emissions. Second, climate change presents a problem that the United States alone cannot solve. Even if the United States were to reduce its greenhouse gas emissions to zero, that step would be far from enough to avoid substantial climate change. Other countries would also need to take action to reduce emissions if significant changes in the global climate are to be avoided. Emphasizing the need for a global solution to a global problem, the United States has been actively involved in seeking international agreements to reduce emissions and in encouraging other nations, including emerging major economies, to take significant steps to reduce emissions. When these considerations are taken as a whole, the interagency group concluded that a global measure of the benefits from reducing U.S. emissions is preferable."

- The 2015 Technical Support Document refers back to the 2010 Technical Support Document – Social Cost of Carbon for Regulatory Impact Analysis for further discussion, including the topic of whether it is permissible under law:[32]

> "As a matter of law, consideration of both global and domestic values is generally permissible; the relevant statutory provisions are usually ambiguous and allow selection of either measure.[6] [Footnote 6: It is true that federal statutes are presumed not to have extraterritorial effect, in part to ensure that the laws of the United States respect the interests of foreign sovereigns. But use of a global measure for the SCC does not give extraterritorial effect to federal law and hence does not intrude on such interests.]"

- The 2010 TSD addresses scaling of global benefits of reducing global GHG emissions, and states, "It is recognized that [scaling to domestic (US) SCC is] approximate, provisional, and highly speculative. There is no a priori reason why domestic benefits should be a constant fraction of net global damages over time." The same is true for any output-based scaling to state, region, county, or other geographic level.

[32] Interagency Working Group on Social Cost of Carbon, 2010. Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866. February 2010. United States Government.

- The IWG responded to comments in support of global SCC:[33]

> "A number of commenters supported the IWG's decision to base the SCC estimates on global damages. Commenters explained that climate change is a global commons problem because carbon pollution does not remain within one country's borders, and that the use of global damages in the SCC is consistent with the economic theory of the commons. One commenter further stated that if damage estimates are limited to only those within each country's borders, any actions based on those estimates would lead to a collective failure to optimally mitigate GHG emissions. Another commenter referred to the importance of this effect by stating that the consideration of global damages in domestic rulemaking can be based on an expectation of reciprocity from other countries. Several commenters stressed the importance of the use of global SCC estimates as a tool in international negotiations. Finally, some commenters offered other reasons for considering damages in regions outside of the United States, including liability, national security concerns, trade-related "spillover effects", and the principle in international environmental law of reducing cross-border harm."
>
> *Response*
>
> "The IWG agrees that a focus on global SCC estimates in RIAs is appropriate. As discussed in the 2010 TSD, the IWG determined that a global measure of SCC is appropriate in this context because emissions of most greenhouse gases contribute to damages around the world and the world's economies are now highly interconnected. To reflect the global nature of the problem, the SCC incorporates the full damages caused by CO2 emissions and we expect other governments to consider the global consequences of their greenhouse gas emissions when setting their own domestic policies.
>
> The IWG also agrees that if all countries acted independently to set policies based only on the domestic costs and benefits of carbon emissions, it would lead to an economically inefficient level of emissions reductions which could be harmful to all countries, including the United States, because each country would be underestimating the full value of its own reductions. This is a classic public goods problem because each country's reductions benefit everyone else and no country can be excluded from enjoying the benefits of other countries' reductions, even if it provides no reductions itself. In this situation, the only way to achieve an economically efficient level of emissions reductions is for countries to cooperate in providing mutually beneficial reductions beyond the level that would be

[33] Interagency Working Group on Social Cost of Carbon, 2015. Response to Comments: Social Cost of Carbon for Regulatory Impact Analysis. July 2015. United States Government.

justified only by their own domestic benefits. By adopting a global estimate of the SCC, the U.S. government can signal its leadership in this effort. In reference to the public good nature of mitigation and its role in foreign relations, thirteen prominent academics noted that these "are compelling reasons to focus on a global SCC" in a recent article on the SCC (Pizer et al., 2014). In addition, as noted by commenters, there is no bright line between domestic and global damages. Adverse impacts on other countries can have spillover effects on the United States, particularly in the areas of national security, international trade, public health and humanitarian concerns."

- In its response to public comments, the IWG also responded to concerns regarding domestic damages: [34]

> "A number of commenters suggested that the use of global damages creates a mismatch between estimates of costs and benefits in agency RIAs. Use of a global rather than domestic SCC may overstate the net benefits to the United States of reducing emissions, because global benefits are compared to domestic costs. A policy that appears cost-justified from a global perspective may not be from a purely domestic U.S. perspective. Therefore, these commenters suggest that a global SCC is only appropriate when the analysis considers global costs and benefits in the context of a global carbon mitigation program.
>
> Other commenters indicated that the IWG should update and report domestic climate damages separately from global estimates for several reasons, including the public's right to know the domestic benefits of domestic regulatory actions. A few comments stated that the IWG should more clearly articulate that the SCC includes global damages, which they felt was particularly unclear in the 2013 TSD.
>
> Finally, commenters also addressed the provisional range of domestic damages that was presented in the 2010 TSD. Several comments stated that the range discussed in the 2010 TSD for the domestic SCC was too high. Two commenters suggested a range for the domestic share of total global damages of 6 to 8.7 percent based on a paper by Nordhaus (2011). One commenter stated that the methods used to estimate the domestic damages as 7 to 23 percent of global damages is too speculative for quantification of the SCC.
>
> *Response*
>
> As stated in the prior section, GHG emissions in the United States will have impacts abroad, some of which may, in turn, affect the United States. For

[34] Interagency Working Group on Social Cost of Carbon, 2015. Response to Comments: Social Cost of Carbon for Regulatory Impact Analysis. July 2015. United States Government.

this reason, a purely domestic measure is likely to understate actual impacts to the United States. Also, as stated above, the IWG believes that accounting for global benefits can encourage reciprocal action by other nations, leading ultimately to international cooperation that increases both global and U.S. net benefits relative to what could be achieved if each nation considered only its own domestic costs and benefits when determining its climate policies.

Further, as explained in the 2010 TSD, from a technical perspective, the development of a domestic SCC was greatly complicated by the relatively few region-or country-specific estimates of the SCC in the literature, and impacts beyond our borders have spillover effects on the United States, particularly in the areas of national security, international trade, and public health. As a result, it was only possible to include an "approximate, provisional, and highly speculative" range of 7 to 23 percent for the share of domestic benefits in the 2010 TSD. This range was based on two strands of evidence: direct domestic estimates resulting from the FUND model, and an alternative approach under which the fraction of GDP lost due to climate change is assumed to be similar across countries. We note that the estimated U.S. share of global damages based on the Nordhaus (2011) study cited by several commenters largely falls within the provisional range offered in the 2010 TSD.

In conclusion, the IWG believes that the only way to achieve an efficient allocation of resources for emissions reduction on a global basis is for all countries to base their policies on global estimates of damages and will therefore continue to recommend the use of global SCC estimates in regulatory impact analyses. The IWG will also continue to review developments in the literature, including more robust methodologies for estimating SCC values based on purely domestic damages, and explore ways to better inform the public of the full range of carbon impacts, both global and domestic."

- On August 8th, 2016, the US Court of Appeals for the Seventh Circuit issued a ruling supporting not only the use of SCC, but the use of global SCC values:[35]

> "AHRI and Zero Zone next contend that DOE arbitrarily considered the *global* benefits to the environment but only considered the *national* costs. They emphasize that the EPCA only concerns "national energy and water conservation." 42 U.S.C. § 6295(o)(2)(B)(i)(VI). In the New Standards Rule, DOE did not let this submission go unanswered. It explained that climate change "involves a global externality," meaning that carbon released in the United States affects the climate of the entire world. 79 Fed. Reg. at

[35] Zero Zone, Inc., et al. v. United States Department of Energy, et al., Nos. 14-2147, 14-2159, & 14-2334. Argued September 30, 2015 — Decided August 8, 2016.

> 17,779. According to DOE, national energy conservation has global effects, and, therefore, those global effects are an appropriate consideration when looking at a national policy. *Id.* Further, AHRI and Zero Zone point to no global costs that should have been considered alongside these benefits. Therefore, DOE acted reasonably when it compared global benefits to national costs."

- On July 15, 2020, the US District Court in the Northern District of California ruled to reinstate a 2016 US Bureau of Land Management Waste Prevention Rule that had been rolled back in 2018 based on an "interim domestic social cost of methane" that resulted in significantly lower estimates of benefits than had been found during the 2016 rulemaking. The Court found the 2018 rescission to be arbitrary and capricious, stating:[36]

> "The analysis ignores impacts on 8 million United States citizens living abroad, including thousands of United States military personnel; billions of dollars of physical assets owned by United States companies abroad; United States companies impacted by their trading partners and suppliers abroad; and global migration and geopolitical security."

The discussion above concerning the application of the global SCC to valuation of domestic US GHG emissions reduction benefits applies equally to the application of the global SCC to the benefits of GHG emissions reductions in Washington. Washington's economy is tied to the world economy through trade, international supply chains, and local employment by international firms.

- Washington exported an estimated $69.9 billion in goods and $28.8 billion in services in 2018.[37]
- International trade, including exports and imports, supported 940,800 Washington jobs in 2018.[38]
- 140,600 people in Washington are directly employed by US affiliates of foreign multinational companies.[39]

[36] State of California and Sierra Club, et al. v. David Bernhardt, et al., Case No. 4:18-cv-05712-YGR, Consolidated case, Re: Dkt. Nos. 108, 109, 123, 125, 126, 127. US District Court, Northern District of California. Decided July 15, 2020.
[37] Delaney, P, 2020. How Washington's Economy Benefits from Trade and Investment. Business Roundtable. https://s3.amazonaws.com/brt.org/BRT_General_Trade_WA_2020.pdf
[38] Ibid.
[39] US Bureau of Economic Analysis, 2020. Activities of U.S. Affiliates of Foreign Multinational Enterprises, 2018. https://www.bea.gov/sites/default/files/2020-11/imne1120.pdf

As with the US economy as a whole, Washington is impacted directly and indirectly by economic disruptions outside the state.[40, 41] Therefore, we used the global SCC in evaluating the benefits of emissions reductions resulting from the adopted rule.

In 2017, authors at Carbon Brief addressed criticisms of the global SCC[42], noting:

- Scaling of global SCC to sub regions or populations:
    - Was rejected by the U.S. Seventh Circuit Court of Appeals.[43]
    - Is not appropriate for global problems. For a global problem like climate change, consideration of local effects only is untenable, stating, "It's worth asking what would happen if the US were to ignore global effects. If other countries were to follow suit, then a large proportion of global climate impacts would be ignored, falling between the cracks."
    - Contradicts ethical arguments in favor of considering irreversible impacts of climate change like species extinction in other regions.
- While arguments have been made to use higher discount rates for the SCC, such as a 7 percent rate consistent with past federal government practice and internal corporate rates of return, there are valid arguments in favor of much lower or zero discount rates:
    - Accounting for the various uncertainties surrounding estimates of the SCC would increase the SCC value by 70 percent to 420 percent over current estimates.[44]
- The federal SCC was ruled "reasonable and the best available measure to determine the environmental cost of CO_2" in 2016.[45]

---

[40] For example, during 2014-2015 disruptions to west coast port services, Washington lost nearly $770 million in economic activity, and over $550 million in exports were not shipped, despite $153 million shifting to air transportation. https://www.joc.com/port-news/longshoreman-labor/international-longshore-and-warehouse-union/us-west-coast-congestion-cost-washington-770-million-study-says_20160222.html

[41] During the significant worldwide disruption caused by the COVID-19 pandemic, Washingtonians encountered inconsistencies in product availability, and higher or uncertain prices due to worldwide disruptions to supply chains. https://www.whitehouse.gov/cea/written-materials/2021/04/12/pandemic-prices-assessing-inflation-in-the-months-and-years-ahead/

[42] CarbonBrief, 2017. Q & A: The social cost of carbon. February 14, 2017. https://www.carbonbrief.org/qa-social-cost-carbon

[43] *Zero Zone, Inc., et al. v. United States Department of Energy, et al.*, Nos. 14-2147, 14-2159, & 14-2334. Argued September 30, 2015 — Decided August 8, 2016. http://media.ca7.uscourts.gov/cgi-bin/rssExec.pl?Submit=Display&Path=Y2016/D08-08/C:14-2159:J:Ripple:aut:T:fnOp:N:1807496:S:0

[44] van den Bergh, J and W Botzen, 2014. A lower bound to the social cost of CO2 emissions. Nature Clim Change 4, 253–258 (2014). https://doi.org/10.1038/nclimate2135

[45] *In the Matter of the Further Investigation into Environmental and Socioeconomic Costs under Minnesota Statutes Section 216B.2422, Subdivision 3*. State of Minnesota Office of Administrative Hearings. For the Public Utilities Commission. OAH 80-2500-31888. MPUC E-999/CI-14-643. https://mn.gov/oah/assets/2500-31888-environmental-socioeconomic-costs-carbon-report_tcm19-222628.pdf

In 2021, a group of prominent economists published arguments in favor of the global SCC, particularly as compared to a cost-based or cost-effectiveness approach to policy analysis that does not reflect the benefits of reduced or avoided climate change.[46] The authors argue that in contrast to more limited scope approaches, "the SCC inherently builds in the notion of reciprocity among countries because it reflects the global damages of emissions. A future in which all countries seek to guide domestic policy by using the SCC can lead to progress on addressing climate change in a globally efficient and least-cost way."[47]

We note that the federal SCC was called into question by a federal district court in 2022.[48] This decision was subsequently stayed by the Fifth Circuit Court of Appeals.[49] The Fifth Circuit stated, "We conclude the standing inquiry shows the Government Defendants' likelihood of success on the merits in this appeal, and the other factors, including the public interest, favor granting a stay of the injunction." This ruling indicates that the Louisiana District Court's injunction was unwarranted and issued in error. The U.S. District Court for the Eastern District of Missouri denied a similar challenge to the SCC. It should be noted that the claims brought in these legal challenges focused in part on statutory and regulatory structures for federal rulemaking that do not apply to Ecology's rulemaking processes.

We acknowledge that carbon emissions and climate change pose a uniquely complex context:

- The adopted rule reduces GHG emissions in Washington, which reduces the contribution of GHG emissions to climate change.
- Climate change has impacts on Washingtonians and our economy, as well as on Washington's partners in the interstate and global economy, and Washingtonians and our interests abroad.
- Reducing GHG emissions in Washington will not eliminate the impacts of climate change on Washington or as a whole. This is why the SCC is defined on the basis of an additional MT CO_2e, rather than a bimodal climate change impact versus no impact.
- Emissions trajectories beyond Washington are part of the baseline, and emissions outside of a jurisdiction imposing GHG emissions regulations can be impacted by regulatory choices (for example, due to emissions leakage). This is why the rule includes significant provisions for EITE facilities, to prevent leakage.

[46] Aldy, JE, MJ Kotchen, RN Stavins, and JH Stock, 2021. Keep climate policy focused on the social cost of carbon. Science, Vol. 373, Issue 6557. 20 August 2021.

[47] That same year, using an empirical approach involving risk-free real rates of return on assets – consistent with Ecology's approach to discount rates – economists at University of California Santa Barbara and University of Chicago argued for a maximum discount rate of 2 percent based on current trajectories.[47] The authors also noted the discount rate appears to have entered a phase of decline over time (following a downward trend since about 1985), which could support arguments for using a diminishing discount rate.

[48] *Louisiana v. Biden*, Federal District Court for the District of Louisiana, Case No. 2:21-CV-01074. Memorandum Decision, 2/11/2022

[49] *Louisiana v. Biden*, United States Court of Appeals for the Fifth Circuit, Case No. 22-30087. Document: 00516220740. Filed: 03/01/2022.

- Specific avoided damages of climate change at a given time may not be focused specifically in Washington. There is no legitimate basis for scaling the global SCC to a jurisdiction (see discussion above), and while the SCC scope is global, it also underestimates likely impacts to Washington and beyond due to inherent limitations in modeling and quantification, as well as its quantification scope.
- As a result, current quantified estimates of the SCC, and benefits estimates quantified based on them, suffer from uncertainty, and median estimates are intended to reflect central expectations for a distribution of potential impacts. Moreover, qualitatively described benefits of avoided climate change, including illustrative quantified values where possible, further inform the true costs of climate change to Washingtonians – through climate change impacts to which Washington is particularly vulnerable through our economy and trade, geography and climate, and overburdened and vulnerable populations.

Choice of SCC discount rate

We note that the choice of discount rate was also addressed in elements of the above discussion (or in cited materials), including court decisions indicating use of multiple discount rates. The use of the global SCC is a separate determination from the choice of discount rate applied to the SCC in an analysis. See Section 2.5.11 for discussion of the choice of SCC discount rate, social rate of time preference, and universal discount rate applied in this analysis.

2.5.8.2 Benefits of reduced climate change not reflected in the SCC

The SCC reflects many impacts of climate change, including impacts to agricultural productivity, human health, and property damages from increased flood risk, and changes in energy system costs, such as reduced costs for heating and increased costs for air conditioning. However, at this point it does not include other important values, which include both quality of life impacts and further economic impacts. As we do not know the extent to which these environmental and human costs would be avoided under the rule, we discuss them qualitatively with numeric information where possible to further illustrate them.

2.5.8.3 Wildfire risk and costs

Washington is particularly vulnerable to losing forestlands, bushlands, and other habitats including residential, commercial, or industrial areas to wildfire. We have already experienced significant wildfires, causing direct damage as well as contributing to poor or hazardous air quality throughout the region. The UN Environment Programme recently estimated that globally wildfires would increase by an additional 50 percent by 2100. As we do not know the extent to which these environmental and human costs would be avoided under the rule, we discuss them qualitatively with numeric information where possible to further illustrate them.

2.5.8.4 Heat-related deaths

Recent analyses using data from the 2021 Northwest heat wave (“heat dome”) indicate that existing estimates of heat-related deaths and associated costs are likely too low. As we do not know the extent to which reductions in GHG emissions would reduce the frequency or severity

of heat waves, we discuss them qualitatively with numeric information where possible to further illustrate them.

A 2021 study found that the SCC also likely underrepresents the value of heat-related mortality due to climate change[50], consistent with previous studies and meta-analyses.[51,52]

2.5.8.5 Flood damages

A recent study by the Center for Western Weather and Water Extremes, at the University of California San Diego, modeled the impacts of various climate change scenarios on atmospheric rivers (long, flowing regions of the atmosphere that carry water vapor) impacting western states.[53] Using flood insurance data, the study estimated county-level increases in annual costs of flood damage, through 2090, due to the contribution of climate change to frequency, duration, and magnitude of atmospheric rivers.

For most counties around Puget Sound, this forecast increase in costs is between $10 million and $100 million each year (per county) compared to what they spent in the 1990s, while for Snohomish, King, and Lewis counties, the forecast increase in costs is over $100 million per year (per county). This is at least a doubling of annual flood damage costs in western Washington.

The east side of the state is largely forecast to incur an additional up to $1 million each year (per county), with some counties incurring up to $10 million more annually. This is up to a doubling of annual costs for most eastern Washington counties, except for Pend Oreille, Spokane, Whitman, Columbia, and Asotin counties, where the increase in flood damage costs is forecast to be between two and four times as high as it was in the 1990s.

2.5.8.6 Other air pollutants

Depending on how covered parties meet their GHG emission reduction pathways, there may be associated reductions in other emissions, such as criteria pollutants and toxic air pollutants. Associated emissions that might also be reduced include nitrogen oxides, sulfur oxides, fine particulates, and various toxic air pollutants. Avoiding or reducing these emissions would improve air quality and may reduce associated health impacts, such as asthma and other lung disorders, and contributors to certain cancers.

---

[50] Bressler, RD, FC Moore, K Rennert, and D Anthoff, 2021. Estimates of country level temperature-related mortality damage functions. Scientific Reports, Nature Portfolio 11:20282. https://doi.org/10.1038/s41598-021-99156-5

[51] Bressler, RD, 2021. The mortality cost of carbon. Nat. Commun. 12, 4467 (2021).

[52] Silva, RA, JJ West, JF Lamarque, DT Shindell, WJ Collins, G Faluvegi, GA Folberth, LW Horowitz, T Nagashima, V Naik, ST Rumbold, K Sudo, T Takemura, D Bergmann, P Cameron-Smith, RM Doherty, B Josse, IA MacKenzie, DS Stevenson, and G Zeng, 2017. Future global mortality from changes in air pollution attributable to climate change. Nat. Clim. Change, 7, no. 9, pp. 647-651. DOI:10.1038/nclimate3354

[53] Corringham, TW, J McCarchy, T Shulgina, A Gershunov, DR Cayan, and FM Ralph, 2022. Climate change contributions to future atmospheric river flood damages in the western United States. Nature Scientific Reports 12:13747. https://doi.org/10.1038/s41598-022-15474-2

While estimation of actual avoided costs of associated emissions, in addition to avoided GHG emissions, would require knowledge of the methods and locations of emissions reduction activities, the estimates of health damages below illustrate the magnitude of damage per MT of certain criteria pollutants.[54]

Table 23: Value of damages from select criteria pollutants as reported in EPA rulemakings

Criteria Pollutant	Damages per MT in Current Dollars
$PM_{2.5}$	$1.78 million – $1.97 million
Volatile Organic Compounds (VOCs)	$1,377 – $1,501
Nitrogen Oxides (NOx)	$5,751 – $6,249

While we cannot confidently estimate the degree to which emissions of these pollutants will be reduced under the adopted rule, we note that in the case of maximum offset credit use, rule requirements for direct environmental benefits to the state would further facilitate potential reductions in these other pollutant emissions specific to Washington.

2.5.9 Environmental justice

Overburdened communities are more likely to suffer the impacts of climate change and other air pollutant emissions, and to lack healthcare and financial resources to deal with their impacts. Reducing GHG emissions and contributing to a flattening of the trajectory of climate change would provide additional benefits to the overburdened communities that otherwise disproportionately bear these costs. As we do not know the extent to which reduced climate change impacts would specifically benefit these communities, we discuss them qualitatively with numeric or geographic information where possible to further illustrate them.

The rule also includes considerations specifically supporting environmental justice, including its consideration in offset decisions, as well as through no cost allowance allocations that reduce the potential cost impacts on electricity and natural gas users (either through sales or by offsetting compliance needs). While we do not know the extent to which these elements would quantifiably impact overburdened communities, we discuss energy and fuel price impacts in Chapter 7.

[54] ICF International (2014). California's Low Carbon Fuel Standard: Compliance Outlook & Economic Impacts. In turn, this cites specifically:

- US Environmental Protection Agency (2010). Diesel Emissions Quantifier Health Benefits Methodology, EPA, EPA-420-B-10-034, August 2010.
- US Environmental Protection Agency and National Highway Traffic Safety Administration (2011). Draft Joint Technical Support Document: Proposed Rulemaking for 2017-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards, EPA-420-D-11-901, November 2011.

2.5.10 Forecast of allowance prices, volumes, and emissions

We based allowance market attributes – including price trajectories, allowance volumes, and total emissions in each year – on analysis performed by Vivid Economics and McKinsey & Company (referred to hereafter as "Vivid Economics"), for Ecology.[55, 56] The modeling reflected allowance market structures in the rule, as well as technological assumptions about sectoral decarbonization rates, and behavioral assumptions about intertemporal optimization and financial sector attributes.

In addition to modeling for a scenario reflecting the rule's contents and most-likely market attributes, Vivid Economics modeled 24 alternative scenarios to further inform the sensitivity of our results to various parameters or rule specifications. These results are discussed in the appendices to this analysis, as well as in Chapter 6 in the context of alternative rule contents considered.

The following tables and graphs summarize modeling results for our primary analysis (called "Frontload" in the Vivid Economics analysis), reflecting APCR frontloading and all price controls in the rule, assuming an allowance market that is not linked with any other jurisdictions. While the rule and our primary analysis do not reflect linkage with programs in other jurisdictions, the expectation of linkage (based on regulatory baseline requirements to design a Cap and Invest Program with attributes that facilitate linkage, or other signals affecting expectation of linkage) would affect price levels.[57] For analysis of the impacts of the rule based on market modeling under alternative assumptions, see the appendices for this analysis.[58]

Accounting for banking and general market participants, the modeling further estimated price trajectories with varying assumptions about banking incentives (lower or higher covered party foresight) and the financial decisions made by such entities (see appendices: lower or higher

[55] Vivid Economics, 2022. Washington State Climate Commitment Act, Summary of market modeling and analysis of the proposed Cap and Invest Program. September 2022.

[56] Due to the necessity of modeling based on a selected Total Program Baseline while GHG emissions reporting was ongoing, Vivid Economics modeling forecasts were based on a Total Program Baseline approximately 4% lower than the Total Program Baseline in the rule. One element of this difference is a difference in estimated electricity import emissions. Note that this is also only a minor change of approximately 80 thousand MT CO_2e from the Total Program Baseline initially proposed during this rulemaking. These differences are not expected to significantly affect modeled prices. Moreover, we assessed multiple price trajectory scenarios (reflecting various sets of assumptions, acknowledging any model will not precisely forecast the future, but a range of scenarios is likely to capture reality within it; see appendices), and any variance resulting from the difference between adopted versus modeled Total Program Baseline is likely to result in allowance prices and emissions impacts – and therefore costs, benefits, and macroeconomic impacts of the rule – within the overall range across all scenarios.

[57] For modeling and discussion of allowance prices reflecting linkage expectations, see Appendix B. For sensitivity analysis of the timing of linkage expectations, see Appendix D.

[58] We acknowledge that higher allowance demand based on, e.g., unexpectedly high levels of general market participation, could lead to long holds on banked allowances if general market participants expect significant returns (compared to other investment opportunities) to holding allowances for sale at later dates. This would increase the likelihood of price ceiling unit sales, as well as put upward pressure on allowance prices, but Vivid Economics modeling results do not bear this out in our primary analysis or under multiple alternative modeling assumptions and scenarios.

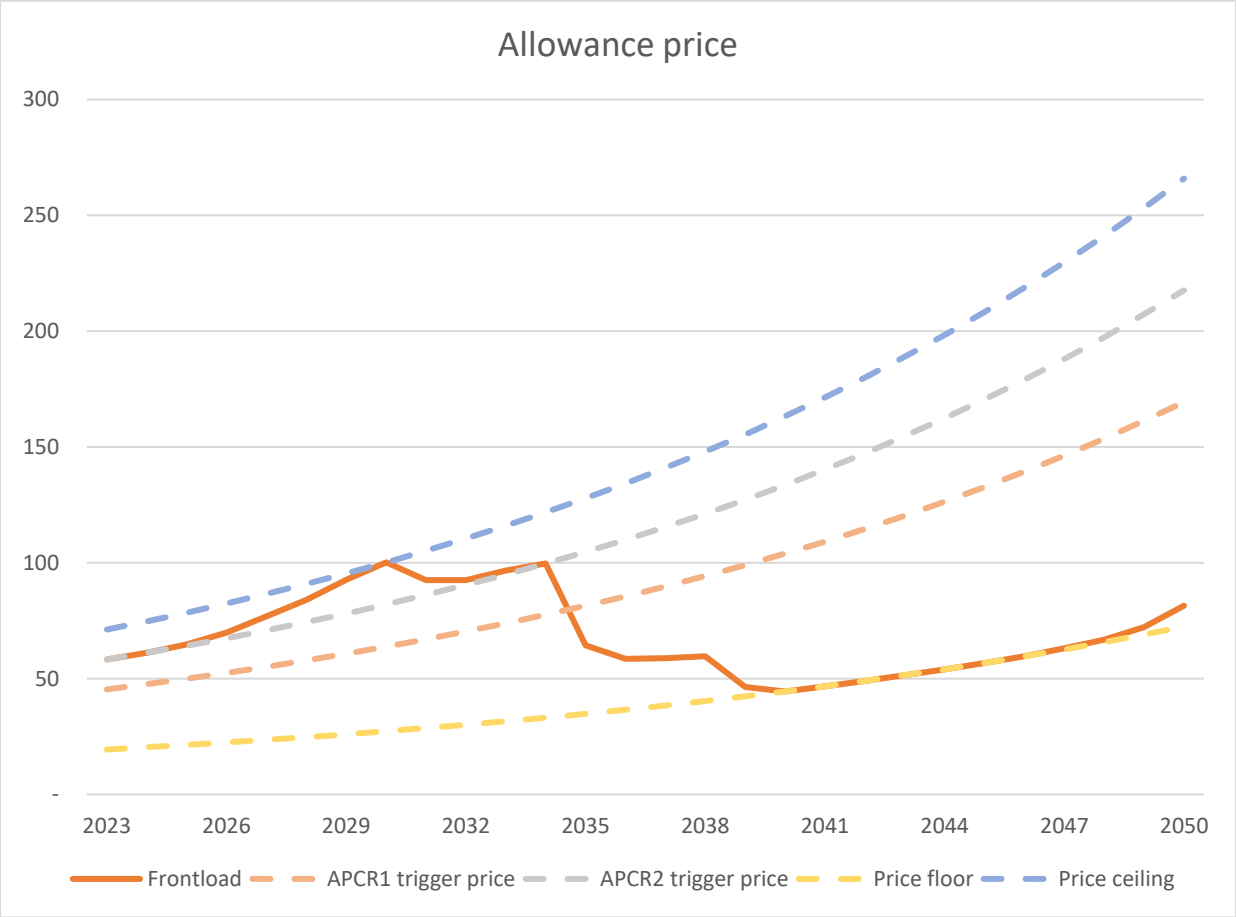
financial entity sensitivity to allowance prices; lower or higher hurdle rate). Across all scenarios modeled, only in the case of slower decarbonization in the power sector did model results reflect sale of price ceiling units.

Table 24: Modeled allowance prices, primary ("frontload") scenario

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2023	58.31	45.37	58.31	19.41	71.23
2024	61.21	47.65	61.21	20.39	74.79
2025	64.76	50.03	64.28	21.40	78.54
2026	69.96	52.53	67.49	22.47	82.46
2027	76.91	55.15	70.87	23.60	86.59
2028	84.01	57.91	74.41	24.77	90.92
2029	92.76	60.81	78.13	26.02	95.46
2030	100.23	63.85	82.04	27.32	100.23
2031	92.57	67.04	86.15	28.69	105.24
2032	92.63	70.40	90.45	30.11	110.50
2033	96.74	73.91	94.98	31.62	116.03
2034	99.73	77.61	99.73	33.20	121.83
2035	64.35	81.49	104.71	34.86	127.92
2036	58.58	85.57	109.95	36.60	134.32
2037	58.79	89.84	115.44	38.43	141.04
2038	59.72	94.33	121.21	40.35	148.08
2039	46.39	99.05	127.27	42.38	155.49
2040	44.49	104.00	133.63	44.49	163.27
2041	46.72	109.20	140.32	46.72	171.43
2042	49.05	114.66	147.34	49.05	180.00
2043	51.50	120.39	154.70	51.50	189.00
2044	54.08	126.42	162.43	54.08	198.46
2045	56.78	132.74	170.56	56.78	208.37
2046	59.62	139.38	179.09	59.62	218.80
2047	63.20	146.34	188.04	62.61	229.73
2048	66.91	153.66	197.44	65.74	241.22
2049	72.30	161.35	207.31	69.03	253.28
2050	81.47	169.41	217.68	72.48	265.95

Source: Vivid Economics

Figure 1: Modeled allowance prices, primary ("frontload") scenario



Source: Vivid Economics

Modeled allowance prices begin at $58.31, triggering the higher APCR price tier. They then rise until they reach the ceiling price of $100.23 in 2030. This rise is due to the rapidly increasing stringency of the regulatory baseline emissions cap through 2030. Prices then reach a curved plateau, reflecting a lower emissions cap reduction rate after 2030, and intertemporal optimization across years within compliance periods. Subsequently, prices drop until they reach and follow the price floor.

We note that Washington-specific GHG emissions abatement costs and allowance volumes underlie these allowance prices, and they do not reflect any market linkage expectations facilitated by regulatory baseline requirements to develop a Cap and Invest Program that facilitates linkage with other jurisdictions. [59]

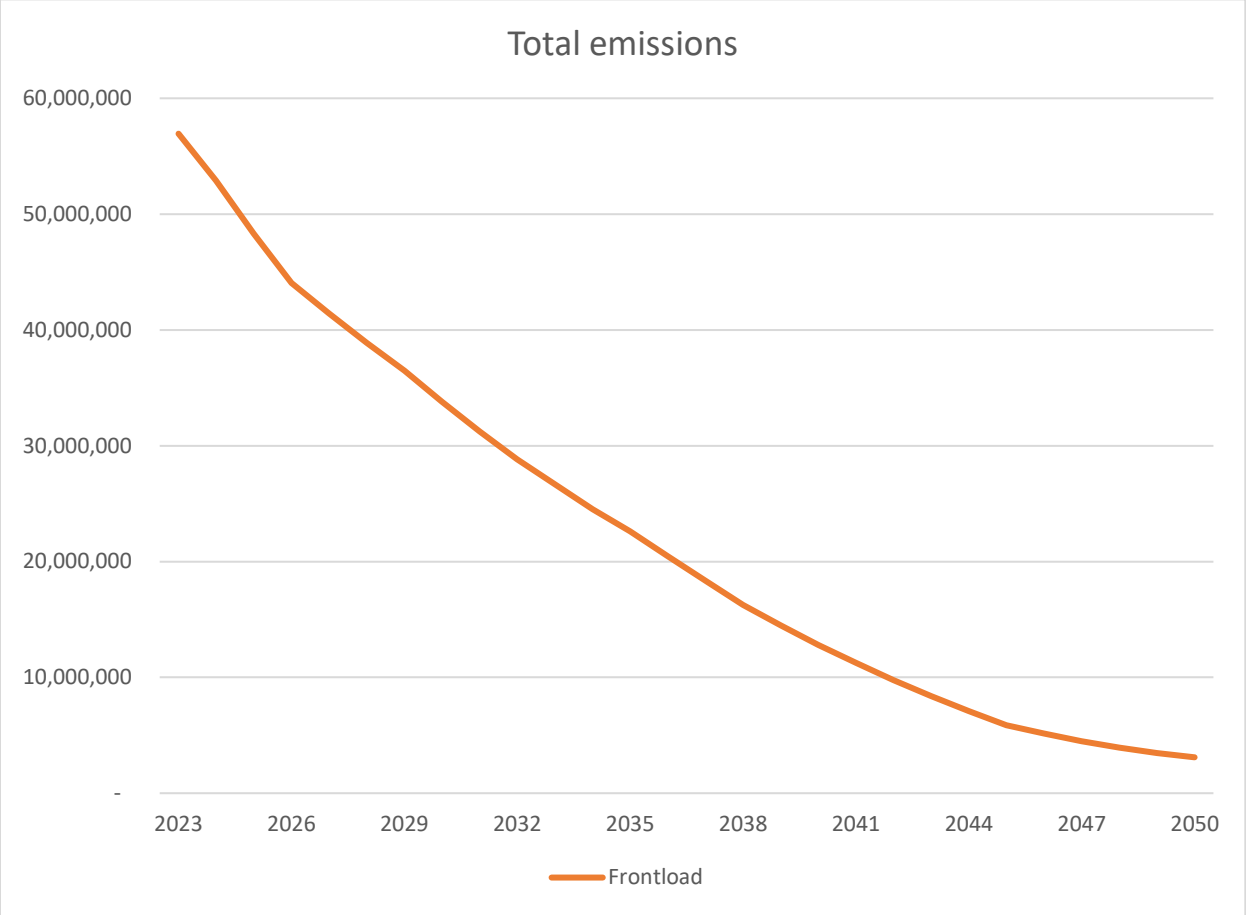
[59] For modeling and discussion of allowance prices reflecting linkage expectations, see Appendix B. For sensitivity analysis of the timing of linkage expectations, see Appendix D.

Table 25: Modeled emissions, primary (“frontload”) scenario

Year	Total emissions (MT CO_2e)	Industry emissions (MT CO_2e)	Power emissions (MT CO_2e)	Building emissions (MT CO_2e)	Transport emissions (MT CO_2e)	No cost emissions (MT CO_2e)
2023	56,944,519	12,225,474	10,972,931	8,423,494	25,322,621	27,770,514
2024	52,905,144	11,260,997	9,094,768	8,224,713	24,324,667	24,313,109
2025	48,306,209	10,622,797	6,959,114	7,943,011	22,781,288	20,911,727
2026	44,062,212	9,993,411	5,353,109	7,145,714	21,569,978	17,863,091
2027	41,441,506	9,331,932	5,292,773	6,541,876	20,274,925	16,472,860
2028	38,893,574	8,634,916	5,379,086	5,954,099	18,925,473	15,549,870
2029	36,491,645	7,936,620	5,569,488	5,419,721	17,565,816	14,775,690
2030	33,801,018	7,230,163	5,256,464	5,100,676	16,213,716	13,379,075
2031	31,231,324	6,592,729	4,932,744	4,760,226	14,945,625	12,301,798
2032	28,841,787	6,000,788	4,622,529	4,450,556	13,767,914	11,291,038
2033	26,668,227	5,454,999	4,307,624	4,183,143	12,722,462	10,339,180
2034	24,523,838	4,941,580	3,987,465	3,897,834	11,696,959	9,414,141
2035	22,625,592	4,494,104	3,662,372	3,676,915	10,792,201	8,571,184
2036	20,461,573	4,161,655	3,316,312	3,276,765	9,706,842	7,802,783
2037	18,366,041	3,935,011	2,969,775	2,851,889	8,609,366	7,147,518
2038	16,267,008	3,714,143	2,617,608	2,421,068	7,514,189	6,491,767
2039	14,487,824	3,551,699	2,259,910	2,161,719	6,514,496	5,901,589
2040	12,799,423	3,398,850	1,896,681	1,920,519	5,583,374	5,318,133
2041	11,267,576	3,239,314	1,527,591	1,754,576	4,746,096	4,739,229
2042	9,776,759	3,074,447	1,153,276	1,577,985	3,971,051	4,156,872
2043	8,380,972	2,922,101	773,906	1,407,469	3,277,496	3,589,647
2044	7,078,296	2,780,871	389,463	1,231,213	2,676,750	3,035,493
2045	5,874,851	2,650,586	-	1,059,046	2,165,219	2,494,728
2046	5,146,143	2,535,787	-	870,178	1,740,178	2,383,640
2047	4,488,553	2,433,252	-	700,336	1,354,965	2,287,257
2048	3,923,159	2,337,644	-	560,440	1,025,075	2,197,385
2049	3,461,055	2,246,945	-	436,474	777,636	2,112,128
2050	3,097,227	2,166,721	-	333,554	596,952	2,036,717

Source: Vivid Economics

Figure 2: Modeled total emissions, primary (“frontload”) scenario, MT CO_2e



Source: Vivid Economics

Table 26: Modeled allowance cap and price control allowance releases, primary (“frontload”) scenario

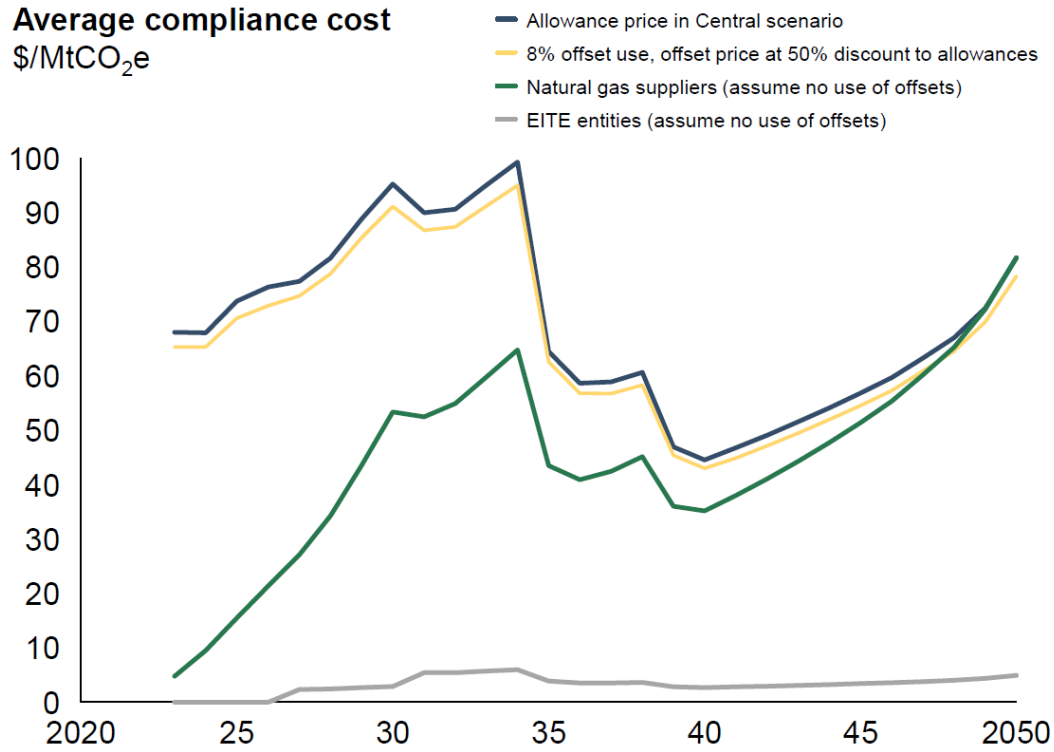
Year	Cap excluding all reserves (MT CO_2e)	APCR1 releases (MT CO_2e)	APCR2 releases (MT CO_2e)	Price ceiling/floor releases (MT CO_2e)
2023	58,501,299	9,299,594	1,043,573	-
2024	54,097,976	-	693,049	-
2025	49,694,652	-	7,562,971	-
2026	45,291,328	-	-	-
2027	40,888,005	-	-	-
2028	36,484,681	-	-	-
2029	32,081,358	-	-	-
2030	27,678,034	-	-	-
2031	26,482,846	714,440	714,034	-
2032	25,287,658	682,196	682,602	-
2033	24,092,471	649,953	649,831	-
2034	22,897,283	617,710	269,465	-
2035	21,702,095	-	-	-

Year	Cap excluding all reserves (MT CO_2e)	APCR1 releases (MT CO_2e)	APCR2 releases (MT CO_2e)	Price ceiling/floor releases (MT CO_2e)
2036	20,506,907	-	-	-
2037	19,311,719	-	-	-
2038	18,116,531	-	-	-
2039	16,921,344	-	-	-
2040	15,726,156	-	-	- 815,017
2041	14,530,968	-	-	- 2,617,093
2042	13,335,780	-	-	- 2,527,650
2043	11,763,164	-	-	- 4,611,811
2044	10,190,549	-	-	- 3,553,613
2045	8,617,933	-	-	- 2,352,850
2046	7,045,318	-	-	- 3,028,763
2047	5,472,702	-	-	-
2048	3,900,087	-	-	-
2049	2,327,471	-	-	-
2050	754,855	-	-	-

Source: Vivid Economics

Vivid Economics also noted that average compliance costs would be lower for some entities, including natural gas utilities, EITE facilities, and entities using offset credits. The graph below illustrates this effect, relative to a central modeled scenario (the rule without frontloading of APCR allowances), and this effect holds for all modeled scenarios including our primary scenario.

Figure 3: Average compliance costs, “Central” (no frontloading) scenario

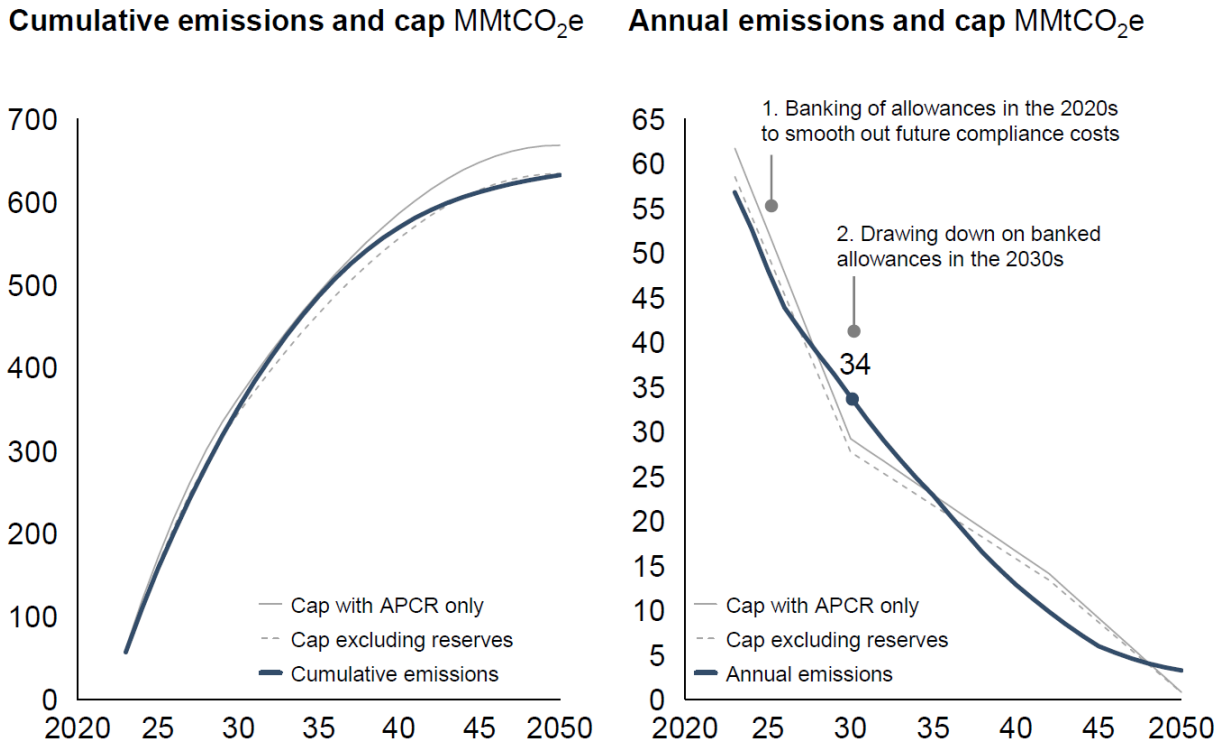


Source: Vivid Economics

Vivid Economics also noted, “Modeling suggests that banking would allow covered entities to intertemporally optimize while maintaining the cumulative 2050 emissions cap.” [60] The graphs below illustrate this, reflecting cumulative emissions consistently below the statutory cap, as entities initially bank allowances and draw on them in later years.

[60] Vivid Economics, 2022. Washington State Climate Commitment Act, Summary of market modeling and analysis of the proposed Cap and Invest Program. September 2022.

Figure 4: Cumulative and annual emissions, and emissions cap



Source: Vivid Economics

2.5.11 Discount rates, present values, and inflation

Discount rate

The current long-run average rate of risk-free return, based on historic rates of US Treasury I Bonds, is 0.9 percent[61] and best reflects social opportunity costs (the social rate of time preference). I bonds are guaranteed one-year bonds, indexed to the rate of inflation, so in addition to an I bond's identified percentage return, it also returns an additional percentage based on inflation.

Individuals can use I bonds to insulate themselves from expected inflation while also making a current investment in exchange for a real return that is tied to their discounting of the future. An example I Bond return rate of 0 percent with 2 percent inflation would return 2 percent on each dollar of investment, not resulting in a real gain (a dollar invested would result in a return of $1.02 with the same purchasing power as the original dollar), but also not losing purchasing power due to inflation as an uninvested dollar would. Similarly, an example I Bond return rate of 3 percent with 2 percent inflation would return $1.05 (a nominal 5 percent return) on each

[61] US Department of the Treasury, 2022. Series I Savings Bonds Rates & Terms: Calculating Interest Rates. https://www.treasurydirect.gov/indiv/research/indepth/ibonds/res_ibonds_iratesandterms.htm Historic I bond rates 1998 – present.

dollar of investment, but due to inflation this would have a purchasing power of $1.03 (a real 3 percent return) compared to the purchasing power of each dollar originally invested.

To maintain consistent discount rates across this analysis, we assumed the nearest available SCC discount rate (2.5 percent) in the interim federal government SCC estimates, as the discount rate for all present value calculations. The 2.5 percent discount rate is nearest to the current long-run social rate of time preference of 0.9 percent. While multiple (higher) discount rates are also available based on past approaches to discounting reflecting rates of return on corporate or government investment, these rates are not appropriate for the SCC. Modern discount rate literature indicates a rate of at most two percent is appropriate. [62] While higher discount rates are not appropriate, we note that use of a higher discount rate in choice of SCC values would significantly reduce quantified benefits of the rule. Similarly, 95th percentile values for the SCC reflect more catastrophic impacts of climate change, including possible irreversible or systemic changes, that result in higher costs. Use of these SCC values from the upper end of the distribution of estimated values would significantly increase quantified benefits of the rule.

Present values

Ecology reflects flows of costs and benefits over time using present values. A present value is a discounted sum of impacts over time, accounting for inflation as well as the opportunity cost of having money later versus now (the opportunity cost of capital). For example, the opportunity cost of having one dollar in five years instead of immediately is the lost five years of interest and coverage against inflation a person could get by investing a dollar now for five years.

---

[62] See referenced documentation summarized in https://www.resources.org/archives/the-social-cost-of-carbon-reaching-a-new-estimate/?mc_cid=d956ec036e&mc_eid=485db02a02 for example discussion from Resources for the Future: "Recent research has consistently documented persistent declines in long-run interest rates, suggesting that lower discount rates are appropriate, particularly for long-lived impacts like climate change. Reasonable discount rates suggested by the economics literature are typically around 2 percent, which we adopt as our preferred value for the SCC calculation. As mentioned previously… this preferred estimate of the average SCC is $185 per ton of CO_2, which is much higher than the value of $80 per ton under a 3 percent discount rate because the long-lived impacts of CO_2 emissions are discounted less." This quote above includes links to relevant documentation:
https://obamawhitehouse.archives.gov/sites/default/files/page/files/201701_cea_discounting_issue_brief.pdf
https://link.springer.com/article/10.1057/be.2016.23
https://muse.jhu.edu/article/671750
https://www.brookings.edu/bpea-articles/on-falling-neutral-real-rates-fiscal-policy-and-the-risk-of-secular-stagnation/
https://academic.oup.com/qje/article/130/1/1/2337985?login=false
https://www.nber.org/system/files/working_papers/w21767/w21767.pdf
https://direct.mit.edu/rest/article-abstract/101/5/933/58554/A-New-Normal-for-Interest-Rates-Evidence-from?redirectedFrom=fulltext
https://www.frbsf.org/economic-research/publications/working-papers/2020/25/
https://www.sciencedirect.com/science/article/abs/pii/S0095069621000115
https://www.nber.org/system/files/working_papers/w21767/w21767.pdf
https://www.aeaweb.org/articles?id=10.1257/pol.20160240
https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3764255
https://www.sciencedirect.com/science/article/abs/pii/S009506969891052X?via%3Dihub

Ecology typically analyzes the impacts of rules for 20 years, which would cover the rule's Cap and Invest Program through 2043. Since the regulatory baseline defines the program through 2050, we chose to extend the timeframe of this analysis and associated present value costs and benefits (where quantifiable) to 2050.

Inflation and real dollars

Finally, our analyses present results in real (inflation-adjusted) current dollars, in order to reflect the real purchasing power of a dollar, regardless of the level of inflation. This way, if a future year's nominal costs are of interest, the expected inflation rate can be applied to the real dollar estimates, keeping in mind that inflation raises the general price level across the entire economy – including goods, services, and wages. Our results are presented to allow for interpretation in the face of recent economic disruption in local and international markets.

We note that real wages (rather than nominal) will matter to consumers facing inflation in other prices in a given year. Disparity between wage inflation and other inflation (due to the "sticky" – slower to adjust – nature of wages) will result in higher or lower real impacts to consumer purchasing power relative to their wages. To reflect the most current economic situation and data possible, we have also used the newest version of the REMI macroeconomic model available in our analysis of the impacts of the rule on the state economy (see Chapter 7).

2.5.12 Spending of market revenues

Market revenues to Washington have required allocations to specified accounts under the regulatory baseline. These were further informed by the transportation funding bill in the 2022 legislative session[63], which would fund multiple transportation projects using Cap and Invest Program revenues:

- The total $12.8 billion package includes $5.4 billion from the Cap and Invest Program.
- The package would fund multiple transportation infrastructure improvements:
    - $3.1 billion on transit.
    - $3.0 billion on highways.
    - $2.6 billion on culvert replacement.
    - $1.3 billion on electrification of the ferry system.
    - $1.2 billion on infrastructure improvements supporting walking and biking.
    - Free public transit for school-age children.

Market revenues to natural gas utilities, from sale of consigned allowances, are required to be used to offset cost impacts on consumers.

[63] Engrossed Substitute Senate Bill 5689. 2022 Regular Session. https://lawfilesext.leg.wa.gov/biennium/2021-22/Pdf/Bills/Senate%20Passed%20Legislature/5689-S.PL.pdf

2.5.13 Sensitivity analyses

While we estimated ranges of costs and benefits for the primary scenario consistent with the requirements of the APA, we also investigated the significance of our assumptions, including:

- Impacts of linkage expectations – Appendix B.
- Alternative baseline: Impacts of complementary policies, including rulemakings currently in progress – Appendix C.
- Sensitivity analysis of linkage expectation timing – Appendix D.
- Sensitivity analysis of behavioral assumptions – Appendix E.
- Sensitivity analysis of technology assumptions – Appendix F.
- Alternative macroeconomic modelling assumptions – Appendix G.
- Alternative specifications of APCR frontloading and price controls – Chapter 6.

Chapter 3: Likely Costs of the Rule

3.1 Introduction

We analyzed the likely costs associated with the adopted rule, as compared to the regulatory baseline. The requirements of the adopted rule and the regulatory baseline are discussed in detail in Chapter 2 of this document.

3.2 Combined Cap and Invest Program costs

The various requirements in the adopted rule will interact to implement the Cap and Invest Program. To estimate the costs resulting from the adopted rule, we estimated the costs of the combined requirements. These include combined costs of:

- Allowance purchases.
- Offset credit purchases.
- Emissions reductions.

Recall (see discussion in Chapter 2) that allowance prices account for various transaction costs of being a covered entity, opt-in entity, or general market participant under the rule, and allowance auction participation.

We calculated total costs in each year based on allowance price and emissions estimates modeled by Vivid Economics (see Section 2.5.10):

- Allowance purchase costs were calculated using the product of allowance price and total volume of allowance supply (including allowances purchased for immediate compliance and those purchased to bank for later use).
- Abatement costs were calculated using the product of allowance price (as an estimate of marginal abatement costs across allowance market participants; see Section 2.5.6 for discussion) and the difference between regulatory baseline emissions and estimated emissions.

See Section 2.5 for discussion of our overall analytic structure and assumptions, as well as present value and discount rate assumptions.

Table 27: Estimated costs, primary scenario, no offsets

Year	Allowance Purchases (billions of $)	Abatement Costs (billions of $)	Total Costs (billions of $)
2030	$1.43	$0.88	$2.31
2040	$0.43	$0.44	$0.87
2049*	$0.02	$0.54	$0.54

Year	Allowance Purchases (billions of $)	Abatement Costs (billions of $)	Total Costs (billions of $)
Present Value (including interim years) through 2050	$21.88	$11.11	$32.98

Due to limited allowance allocation in 2050 other than the required allocation of no cost allowances, entities are assumed to use banked allowances purchased in prior years to satisfy the remainder of their compliance obligations, and thus incur only abatement costs. We estimate sufficient banked allowances for this in all scenarios, regardless of offset credit use.

We also estimated total costs with maximum allowed use of offset credits.

Table 28: Estimated costs, primary scenario, with offsets

Year	Allowance Purchases (billions of $)	Offset Purchases (billions of $)	Abatement Costs (billions of $)	Total Costs (billions of $)
2030	$1.43	$0.23	$0.88	$2.54
2040	$0.43	$0.04	$0.44	$0.91
2049*	$0.02	$0.02	$0.54	$0.03
Present Value (including interim years) through 2050	$21.88	$2.56	$11.11	$35.54

Due to limited allowance allocation in 2050 other than the required allocation of no cost allowances, entities are assumed to use banked allowances purchased in prior years to satisfy the remainder of their compliance obligations, and thus incur only abatement costs. We estimate sufficient banked allowances for this in all scenarios, regardless of offset credit use.

In our model structure, the availability and use of offset credits does not change allowance market behavior. This is a result of the allowance market model excluding an interrelated offset credit market, due to limited resources and time to complete modeling of multiple allowance market scenarios, as well as the inherent complexity and high level of uncertainty about offset credit market attributes for Washington. Instead, in this model, use of offset credits allows for additional accumulation of banked allowances (to be used or sold at a later date), while reducing the average cost of compliance within each year. This results in a higher total present value cost estimate than in the scenario with no offsets, and is a highly conservative assumption, as purchases of offset credits in lieu of allowances would only serve to decrease total costs.

If covered and opt-in entities purchased offset credits in lieu of purchasing allowances, it would reduce market demand, putting downward pressure on allowance prices, counteracting upward pressure that would result from reductions in allowance supply corresponding to offset use. Absent a combined allowance-offset credit market model, we cannot estimate the size of

these effects, but allowance prices would still reflect the marginal emissions abatement costs of remaining market participants, and could not fall below the auction floor price in a given year. Greenhouse gas emissions reductions would remain the same in either scenario.

Entities might choose to retain a surplus of banked allowances through 2050 as a precautionary measure in the face of uncertainty about future regulation, or as a source of potential revenue if the market has been linked with ongoing programs in other jurisdictions. They might choose to sell any remaining banked allowances at the end of the program. Due to the allowance market model considering offset credit use as an factor external to allowance market decisions, combined with uncertainty in banking behavior at the end of the program, we could not make a confident assumption about the eventual disposition of surplus credits banked at the end of the program.

If entities seek only to reduce average compliance costs in any given year using offset credits, but do not exhibit this additional planning behavior (e.g., because of myopic or highly discounting private views of the future), they will not make these additional allowance purchases, and present value costs of the program will be lower. We have therefore made the simplifying assumption of no offset credit use in sensitivity and alternatives analyses, which also conservatively estimates the high end of potential costs for relevant scenarios, regardless of potential behavioral choices in the case of maximum offset credit use.

The costs in the tables above reflect maximum cost estimates for each scenario, since abatement calculations assume a unit cost equivalent to the allowance market price. In reality, covered entities with emissions abatement options available to them at costs below the allowance price would first choose to reduce emissions before using allowances. The inverse holds for entities with high marginal abatement costs, which would inform their greater demand for allowances, which is in turn reflected by higher allowance market prices.

For the CBA, we consider direct costs summarized above, but as this rule could potentially have broad impacts across the state economy, we also considered indirect (upstream or downstream) and induced (resulting from relative price changes and substitution across goods and services markets) impacts that could potentially result from changes in economic activity, including impacts to output and jobs. These results help decisionmakers, the public, and other stakeholders to understand the full range of potential implications of the rule (see Chapter 7 for modeling discussion and results).

Chapter 4: Likely Benefits of the Rule

4.1 Introduction

We analyzed the likely benefits associated with the adopted rule, as compared to the regulatory baseline. The requirements of the adopted rule and the regulatory baseline are discussed in detail in Chapter 2 of this document.

4.2 Combined Cap and Invest Program benefits

The various requirements in the adopted rule will interact to implement the Cap and Invest Program. To estimate the benefits resulting from the adopted rule, we estimated the benefits of the combined requirements. These include benefits of:

- Reduced GHG emissions, including avoided Social Cost of Carbon (SCC) and other benefits of reduced climate change impacts.
- Revenue from sales of no cost allowances by natural gas utilities.
- Allowance market revenues to the state and to sellers of no cost allowances.
- Revenue from sales of offset credits.
- Environmental justice improvements.
- Ancillary emissions reductions, including reduced or avoided costs of health impacts.

Recall (see discussion in Chapter 2) that allowance prices account for various transaction costs of being a covered entity, opt-in entity, or general market participant under the rule, and allowance auction participation.

See Section 2.5 for discussion of our overall analytic structure and assumptions, and particularly Section 2.5.10 for underlying estimates of allowance market prices, allowance volumes, and emissions levels.

For the CBA, we consider direct benefits, but as this rule could potentially have broad impacts across the state economy, we also considered indirect (upstream or downstream) and induced (resulting from relative price changes and substitution across goods and services markets) impacts that could potentially result from changes in economic activity, including impacts to output and jobs. These results help decisionmakers, the public, and other stakeholders to understand the full range of potential implications of the rule (see Chapter 7 for modeling discussion and results).

4.3.1 Benefits of reduced GHG emissions

Table 29: Emissions reductions and avoided SCC

Year	Total Emissions Reduction (millions of MT CO_2e)	Total Avoided Social Cost of Carbon (billions of $)
2030	8.75	$0.87
2040	9.91	$1.14
2050	6.62	$0.86
Present Value (including interim years) through 2050	n/a	$17.27

Emissions reductions compared to business-as-usual emissions remain the same, regardless of whether compliance obligations are met using allowances or offset credits.

Values not included in SCC

While the estimates of the Total Avoided SCC reflected in Table 29 include values of economic activity and some avoided health impacts, they are not all-inclusive. These estimates exclude the values of other avoided impacts of climate change, which affect quality of life as well as economic activity. Values not included in SCC estimates include:

- Health:
  - Respiratory illness
  - Lyme disease
  - Death, injuries, and illnesses from natural disaster and migration
  - Water, food, sanitation, shelter
- Agriculture:
  - Weeds, pests, pathogens
  - Food price spikes
  - Heat and precipitation extremes
- Oceans:
  - Acidification, temperature, and extreme weather impacts on fisheries, extinction, reef losses
  - Storm surge interaction with sea level rise
- Forests:
  - Pest infestations
  - Pathogens
  - Species invasion and migration
  - Flooding and soil erosion
- Wildfire:
  - Burned acreage
  - Public health
  - Property losses
  - Fire management costs
- Ecosystems:

    - Biodiversity
    - Habitat
    - Species extinction
    - Outdoor recreation and tourism
    - Ecosystem services
    - Rising value of ecosystems due to increased scarcity
    - Accelerated decline due to mass migration
- Productivity and economic growth:
    - Labor productivity and supply, public health
    - Infrastructure impacts from severe events
    - Diversion of resources to climate adaptation
- Water:
    - Availability and competing needs
    - Flooding
- Transportation:
    - Changes to land and ocean transportation
- Energy:
    - Energy supply disruptions
- Catastrophic impacts and tipping points:
    - Rapid sea level rise
    - Methane releases from permafrost
    - Damages at very high temperatures
    - Unknown catastrophic events
- Inter- and intra-regional conflict:
    - National security
    - Increased violent conflicts

Wildfires

Climate change and land-use change are projected to make wildfires more frequent and intense, with a global increase of extreme fires of up to 14 percent by 2030, 30 percent by the end of 2050, and 50 percent by the end of the century, according to a recent report by the UN Environment Programme.[64] The report notes, "the true cost of wildfires – financial, social, and environmental – extends for days, weeks, and even years after the flames subside." It also recommends developing an understanding of full wildfire costs, noting that, "One assessment estimated the annualized economic burden from wildfire for the United States to be between $71.1 billion to $347.8 billion." That corresponds to **$216 to $1,056 per every person in the country each year**, on average. Based on the 7.615 million population of Washington[65], this would be **between $1.6 billion and $8.0 billion every year**, on average, but this range is likely

[64] United Nations Environment Programme, 2022. Spreading like Wildfire – The Rising Threat of Extraordinary Landscape Fires. A UNEP Rapid Response Assessment. Nairobi.
[65] US Census Bureau, 2022. QuickFacts: Washington. https://www.census.gov/quickfacts/WA

higher in the western states, since we experience a larger proportion of wildfires than the country in general.

Washington is particularly vulnerable to wildfire losses, not only from direct fire impacts to valuable natural spaces (as we saw in the over 600 thousand acres of Washington burned by just the large and highly significant wildfires in 2021) and human landscapes (as we saw in 2020's devastation of 85 percent of Malden and Pine City), but also from secondary impacts to forestlands, wildlife and habitat, soil erosion, and stream and river quality and temperature. Wildfires are also a risk to businesses, both private and governmental, as illustrated by our state's working forests.

In 2018, researchers found that **commercial timber forests can burn 30 percent more severely** than managed federal forestlands.[66] A study of the impact of the 2020 Labor Day wildfires in Oregon found that nearly a million acres of burned managed forest lands would have generated end products worth $30 billion, but could generate only $2.6 billion in salvage harvests.[67] That reflects a **91.3 percent value loss of managed timber lands**. The same study found that private forest owners would receive 64 percent of salvage harvest value (approximately $1.66 billion of the 2020 salvage harvest value).

In 2020, the WA Department of Natural Resources spent an estimated **$20 million on aviation readiness and support** for large fires.[68] That same year they incurred **direct costs of over $12.5 million** responding to wildfire incidents, and estimated additional damages of:[69]

- **$20 million** to utilities.
- **$15 million** to state agency infrastructure.
- **$10 million** to other government infrastructure.

Wildfires also cause hazardous air quality in broad regions, impacting rural as well as densely populated areas.

Heat impacts

Lessons learned from the extreme northwest heat wave of 2021 include assessment that climate change may result in more heat-related deaths than previously estimated. The 2021 heat dome that brought record-breaking temperatures to the Pacific Northwest and British Columbia, resulted in 138 heat-related deaths in Washington, making it the deadliest weather

[66] Zald, HSJ and C Dunn, 2018. Severe fire weather and intensive forest management increase fire severity in a multi-ownership landscape. Ecological Applications (2018). DOI: 10.1002/eap.1710.
[67] Oregon Forest Resources Institute, 2021. Economic Impacts to Oregon's Forest Sector – 2020 Labor Day Fires. September 2021.
[68] WA Department of Natural Resources, 2020. Impacts and Costs of Wildfire Season 2020. Presentation to the Senate Agriculture, Water, Natural Resources, and Parks. December 2, 2020.
[69] Ibid.

event in state history.[70] Using the risk-based value of avoiding 100 percent risk of death (called "mortality risk valuation" or the "value of statistical life (VSL)", though it is not the value of any individual's life, and is statistically extrapolated from individuals' willingness to accept fatality risks for a premium) as used by the US EPA,[71] each of these deaths resulted in losses to society of $10.5 million in current dollars, **and the heat dome resulted in at least $1.45 billion in lost lives during just one event**. Extreme heat events are forecast to happen more frequently and be more severe due to climate change.

In addition to fatal events, the US CDC assessed heat-related visits to emergency departments during the 2021 heat dome event. They found a nearly 70-fold increase in people seeking emergency care at the peak of the heat event.[72] Particularly in times of overburdened or overwhelmed medical resources (as we saw during the COVID-19 pandemic), this size of increased demand for urgent medical care could result in catastrophic delays and increased illness or death. **The average cost of a single healthcare visit related to a high heat event is $12,544.**[73]

Ongoing drought and the 2021 heat dome also affected harvests:

- At least **30 percent impact to raspberry harvests**: The aggregate Whatcom County raspberry harvest was 30 to 40 percent lower than the average harvest, with individual growers experiencing losses between 15 and 75 percent, due to the 2021 heat dome event. [74] In 2017, Washington produced nearly $200 million across all types of berry,[75] of which 30 percent would be $60 million.
- At least **ten percent impact to cherry harvests**: The value of the overall cherry harvest, largely in the Yakima Valley, was at least 10 percent lower than expected, due to the

[70] WA Department of Health, 2021. Heat Wave 2021. https://doh.wa.gov/emergencies/be-prepared-be-safe/severe-weather-and-natural-disasters/hot-weather-safety/heat-wave-2021
[71] US Environmental Protection Agency, 2022. Mortality Risk Valuation. https://www.epa.gov/environmental-economics/mortality-risk-valuation
[72] Schramm, PJ, A Vaidyanathan, L Radhakrishnan, A Gates, K Harnett, and P Breysse, 2021. Heat-Related Emergency Department Visits During the Northwestern Heat Wave — United States, June 2021. US Centers for Disease Control and Prevention. Weekly 70(90), pp. 1020-2021. July 23, 2021. https://www.cdc.gov/mmwr/volumes/70/wr/mm7029e1.htm
[73] Knowlton, K, M Rotkin-Ellman, L Geballe, W Max, and GM Solomon, 2011. Six Climate Change-Related Events in the United States Accounted for About $14 Billion in Lost Lives and Health Costs. Health Affairs 30(11), pp. 2167-2176. DOI: 10.1377/hlthaff.2011.0229. Based on total healthcare expenditures of $740 million (2011-dollars) across 760,000 individual encounters with the healthcare system, updated for inflation to 2022-dollars.
[74] Bratt, C, 2021. June 'heat dome' cut raspberry volume 30%. Lynden Tribune. December 10, 2021.
[75] US Department of Agriculture, National Agricultural Statistics Service, 2018. 2017 Census of Agriculture – State Data, Washington.

2021 heat dome event.[76] In 2021, Washington produced nearly $0.5 billion in utilized fresh and processed cherries,[77] of which 10 percent would be $50 million.

- **Over 40 percent impact to blueberry harvests and product quality**: Following the 2021 heat dome event, the Washington Blueberry Commission estimated $85 million in yield loss and quality impacts to the expected harvest that year.[78] In 2017, Washington produced nearly $200 million across all types of berry,[79] of which $85 million would be 43 percent.
- Wheat harvests:
    - A **34-fold increase in the share of "poor" or "very poor" condition spring wheat.**[80]
    - A **6-fold increase in the share of "poor" or "very poor" condition winter wheat**.[81]
- Shellfish harvests:
    - **40 percent losses of seeded oysters.**
    - A **56 percent increase in vibriosis cases**.[82] Vibriosis is an illness in humans caused by shellfish contaminated with Vibrio bacteria, which are naturally occurring but present in high concentrations in warmer temperatures.[83]
    - **5 – 30 percent oyster mortality** in the Salish Sea.[84]
    - Higher losses among shellfish species in smaller, sheltered waters, and those that live nearer the surface, such as cockles.[85]

Flood damages

[76] Zhou, A, 2021. Western lawmakers seek more federal aid for farmers, ranchers hurt by extreme heat, drought. Seattle Times. July 27, 2021.
[77] US Department of Agriculture, National Agricultural Statistics Service, 2022. Apple Utilized Production in Oregon and Washington down 1 percent from 2020, Sweet Cherry Utilized Production in Oregon and Washington up 9 percent from 2020. Press release. May 5, 2022.
[78] Zhou, A, 2021. Western lawmakers seek more federal aid for farmers, ranchers hurt by extreme heat, drought. Seattle Times. July 27, 2021.
[79] US Department of Agriculture, National Agricultural Statistics Service, 2018. 2017 Census of Agriculture – State Data, Washington.
[80] Ingwersen, J, 2021. 'Wither away and die:' US Pacific Northwest heat wave bakes wheat, fruit crops. Reuters. July 12, 2021.
[81] Ibid.
[82] Hagenbuch, B, 2021. In hot water: Heat dome recovery looks bleak for small-scale shellfish farms. National Fisherman. August 17, 2021.
[83] https://www.cdc.gov/vibrio/faq.html
[84] Royal, T, 2022. Heat dome found to be deadly for some shellfish species, but not for others. Northwest Treaty Tribes. January 10, 2022.
[85] Ibid.

A recent study by the Center for Western Weather and Water Extremes, at the University of California San Diego, modeled the impacts of various climate change scenarios on atmospheric rivers (long, flowing regions of the atmosphere that carry water vapor) impacting western states.[86] Using flood insurance data, the study estimated county-level increases in annual costs of flood damage, through 2090, due to the contribution of climate change to frequency, duration, and magnitude of atmospheric rivers.

For most counties around Puget Sound, this forecast increase in costs is between $10 million and $100 million each year (per county) compared to what they spent in the 1990s, while for Snohomish, King, and Lewis counties, the forecast increase in costs is over $100 million per year (per county). This is at least a doubling of annual flood damage costs in western Washington.

The east side of the state is largely forecast to incur an additional up to $1 million each year, with some counties incurring up to $10 million more annually (per county). This is up to a doubling of annual costs for most eastern Washington counties, except for Pend Oreille, Spokane, Whitman, Columbia, and Asotin counties, where the increase in flood damage costs is forecast to be between two and four times as high as it was in the 1990s.

4.3.2 Benefits of revenue from sales of no cost allowances – natural gas utilities

We estimated revenues to natural gas utilities from the sale of no cost allowances based on the natural gas share of baseline emissions (11 percent) and percentage of no cost allowances required to be consigned to auction in each year (65 percent in 2023, increasing by 5 percent each year to 100 percent). This scaling factor was applied to total estimated market revenues for the primary market scenario, equal to total spending on allowances (see Section 3.2).[87]

Table 30: No cost allowance auction revenues to natural gas utilities

Year	Revenues, with or without offset credit use (billions of $)
2030	$0.16
2040	$0.05
2049*	$0.001
Present Value (including interim years) through 2050	$2.11

Due to limited allowance allocation in 2050 other than the required allocation of no cost allowances, entities are assumed to use banked allowances purchased in prior years to satisfy the remainder of their

[86] Corringham, TW, J McCarchy, T Shulgina, A Gershunov, DR Cayan, and FM Ralph, 2022. Climate change contributions to future atmospheric river flood damages in the western United States. Nature Scientific Reports 12:13747. https://doi.org/10.1038/s41598-022-15474-2

[87] We note that this scaling assumption may overestimate or underestimate natural gas utility revenues in a given year, but total market revenues (allowance price multiplied by allowance volume) would not be affected. Over or underestimated values in natural gas revenues would be offset by under or overestimated values in market revenues to the state.

compliance obligations, and thus incur only abatement costs. We estimate sufficient banked allowances for this in all scenarios, regardless of offset credit use.

4.3.3 Benefits of market revenues

We estimated revenues to Washington from allowance sales based on the assumption that the share of total allowance purchase revenues not going to natural gas utilities would go to the State, in each year.

Table 31: Auction revenues to Washington

Year	Revenues, with or without offset credit use (billions of $)
2030	$1.28
2040	$0.38
2050	$0.01
Present Value (including interim years)	$19.77

4.3.4 Benefits of offset revenues

We estimated revenues to sellers of offset credits for the primary scenario, assuming maximum use of offset credits for compliance.

Table 32: Revenues to sellers of offset credits, maximum offset credit use

Year	Revenues (billions of $)
2030	$0.23
2040	$0.04
2050	$0.02
Present Value (including interim years) through 2050	$2.56

4.3.5 Environmental justice improvements

Wildfires and air quality

As noted in Section 4.3.1, **wildfires accounted for 25 – 50 percent of fine particulate matter** in the US in recent years, with **higher levels in the western states**,[88] and are expected to increase in frequency and severity. Even when wildfire smoke is ubiquitous, it impacts overburdened communities more severely, as they are less likely to have good access to air filtration or non-emergency healthcare, and may need to spend more time outside during high heat events that often coincide with wildfires and smoke events, since they are less likely to have access to air

[88] Burke, M, A Driscoll, S Heft-Neal, J Xue, J Burney, and M Wara, 2020. The changing risk and burden of wildfire in the United States. PNAS 118(2). https://doi.org/10.1073/pnas.2011048118

conditioning and other cooling options. They are also more likely to be employed in outdoor work, and to reside in areas that absorb more heat and retain it longer, due to reduced greenspace and tree canopy, proximity to industrial activity, and more paved area.[89]

Heat-related mortality

The **heat-related death risk also disproportionately affects overburdened communities.** A study in British Columbia found that heat deaths in the greater Vancouver area were **strongly tied to individuals' "material and social deprivation" as well as age, sex, and neighborhood greenness**,[90] meaning that deaths were more likely to occur in populations that:

- Had lower incomes.
- Had less shade and more impervious or paved surfaces.
- Were unsheltered or had inadequate housing.
- Had less education.
- Lived alone.
- Were elderly.
- Lacked transportation.
- Lacked recreational spaces.
- Experienced more job or income insecurity.

In short, heat deaths are more likely to occur among overburdened communities whose historically lower resource access puts them at higher risk of being in one or more of the categories above. And particularly during a time of high numbers of people living unsheltered or without consistent shelter, climate change is poised to disproportionately harm or kill the most vulnerable among us.

Other pollutants

Overburdened communities tend to be located in areas that expose them to higher historic or current pollutants. Whether in their homes, outdoors, at school, or at work, overburdened populations are more likely to interact with air emissions from vehicles or heavy-duty vehicles, contaminated nonpotable and even potable waters, or soils and shorelines contaminated by historical activities or land uses. This means if covered and opt-in entities reduce or offset their GHG emissions in ways that also reduce other pollutants (note that this requirement for offset

[89] King County, 2021. Results of heat mapping project show inequitable impact of hotter summers. https://kingcounty.gov/elected/executive/constantine/news/release/2021/June/23-heat-mapping-results.aspx. Results: https://www.arcgis.com/apps/webappviewer/index.html?id=84709c65c08a40bbb47d0723ef1c797a&extent=-13604644.7965%2C6019787.1095%2C-13561266.7829%2C6046616.5065%2C102100

[90] Henderson, SB, KE McLean, MJ Lee, and T Kosatsky, 2022. Analysis of community deaths during the catastrophic 2021 heat dome. Environmental Epidemiology (2022) 6:e189. DOI: 10.1097/EE9.0000000000000189.

projects is part of the regulatory baseline and the adopted rule's definition of providing direct benefits to the state), the rule provides additional benefits to those populations.

Changes in transportation fuels and infrastructure would also particularly benefit overburdened populations. The Washington State Department of Transportation notes:[91]

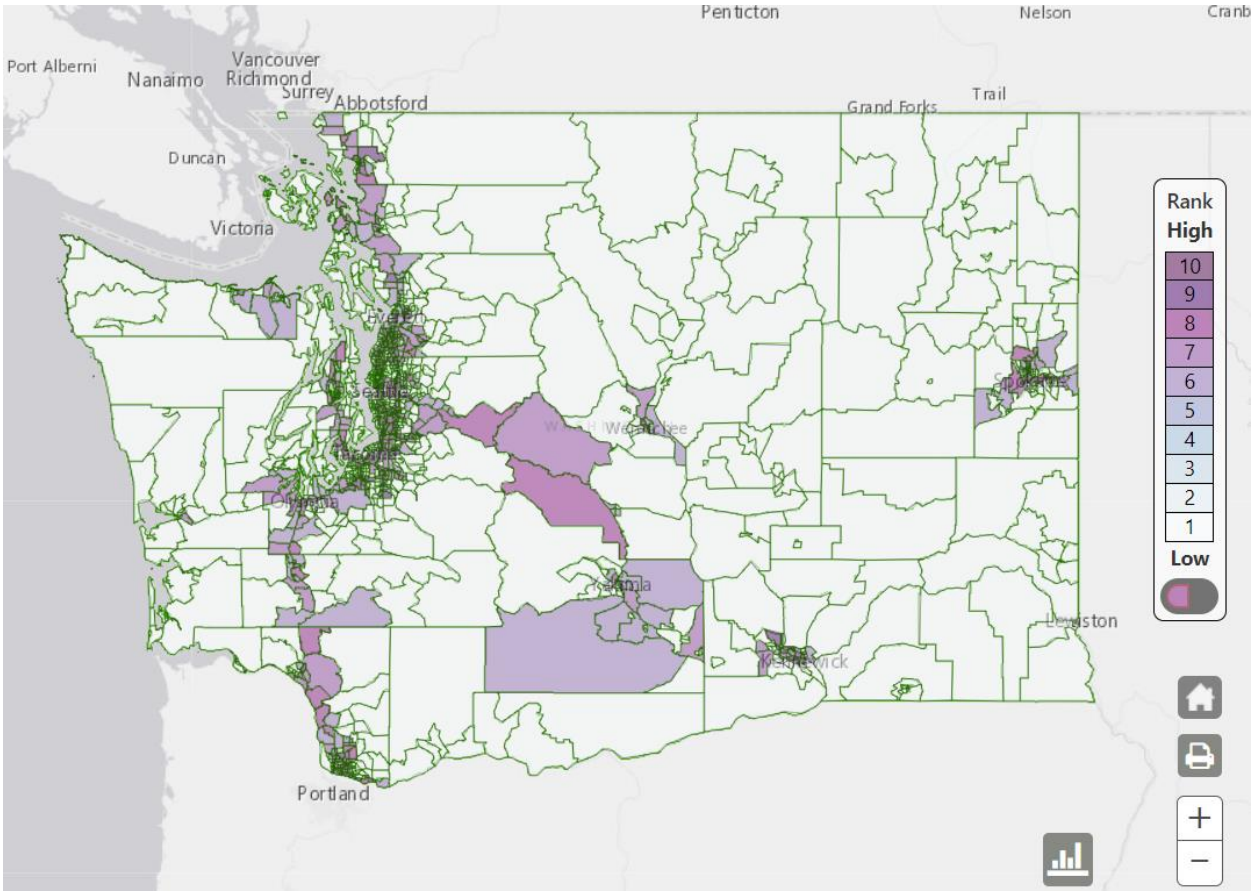
- In Washington about 1 in 7 (900,000) people live within 1/4 mile of heavy traffic roadways. These people breathe more air pollution from diesel and gasoline exhaust.
- People with an underlying health condition, like asthma or heart disease, may be especially sensitive to traffic-related air pollution, as are children and adults age 65 and older.
- Traffic air pollution is linked to adverse birth outcomes such as low birth weight and premature births.

The Washington State Department of Health Environmental Health Disparities map[92] identifies areas across the state where communities live near highways. Many of them are in urban areas around Puget Sound, but others are along interstate or state highways to the south and east.

[91] WA Department of Health, 2022. Traffic Air Pollution Data. https://doh.wa.gov/data-statistical-reports/washington-tracking-network-wtn/traffic-air-pollution

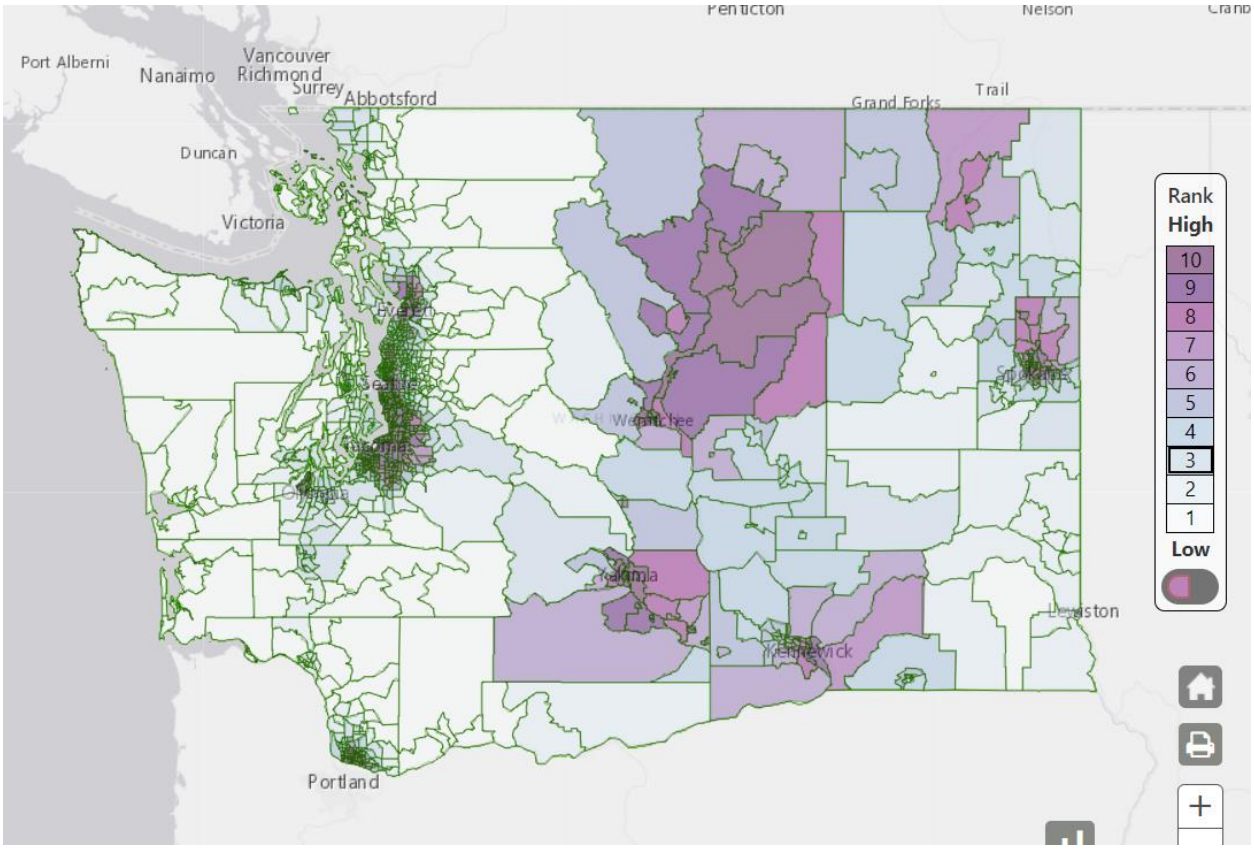
[92] WA Department of Health, 2022a. Washington Tracking Network, Environmental Health Disparities Map. https://fortress.wa.gov/doh/wtnibl/WTNIBL/

Figure 5: Populations living near high-traffic roadways



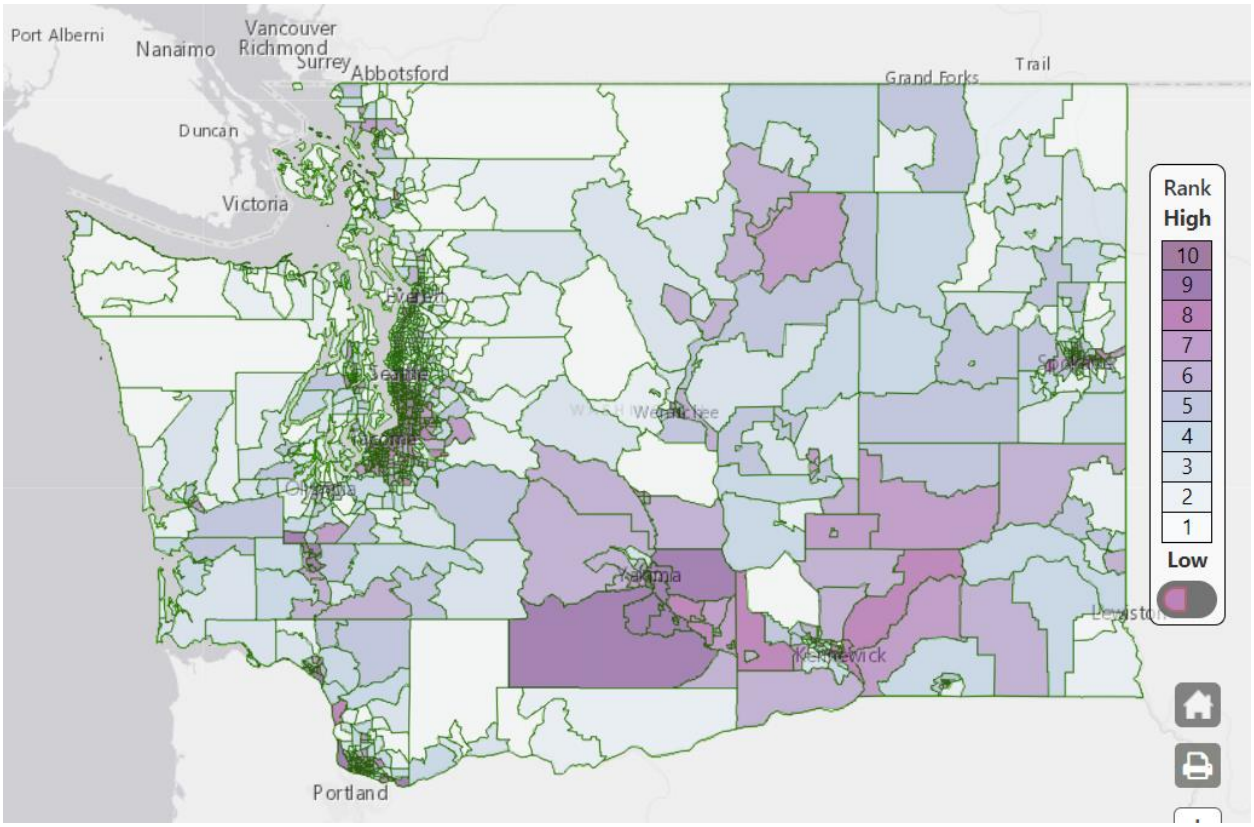
These populations overlap in many ways with areas that experience high levels of fine particulate matter. Other areas that see high particulate matter are those impacted regularly by wildfires.

Figure 6: Populations with high exposure to fine particulate matter



There are many measures of environmental health disparities, and the Health Disparities Map combines them into an overall ranking for each census tract in the state. We note that Health Disparities rankings overlap significantly with areas near roadways and/or with high fine particulate matter.

Figure 7: Environmental Health Disparities rankings



4.3.5 Benefits of ancillary emissions reductions

As we discuss in Section 2.5.2.15, the US EPA has used various values to reflect the damages caused by a metric ton of particulate matter, volatile organic compounds, and nitrogen oxides, respectively. Similar to our uncertainty about how often the adopted rule will result in reduced emissions of these pollutants, we cannot be certain about the relationship between their emissions and GHG emissions. This relationship would vary by technology, fuels, and processes. But we can connect some of the values available to us[93], to illustrate how important reductions

[93] ICF International (2014). California's Low Carbon Fuel Standard: Compliance Outlook & Economic Impacts. In turn, this cites specifically:

- US Environmental Protection Agency (2010). Diesel Emissions Quantifier Health Benefits Methodology, EPA, EPA-420-B-10-034, August 2010.
- US Environmental Protection Agency and National Highway Traffic Safety Administration (2011). Draft Joint Technical Support Document: Proposed Rulemaking for 2017-2025 Light-Duty Vehicle Greenhouse

in these pollutants would be. And the damages associated with these pollutants would be more likely to occur in overburdened communities, so reducing them would generate benefits more focused in those communities.

Table 33: Value of damages from select criteria pollutants as reported in EPA rulemakings

Criteria Pollutant	Damages per MT in Current Dollars	Equivalent Mortality Risk (based on VSL)
$PM_{2.5}$	$1.74 – 1.92 million	16 – 18 percent or 1 in 6
Volatile Organic Compounds (VOCs)	$1,347 - 1,468	0.01 percent or 1 in 10,000
Nitrogen Oxides (NOx)	$5,624 – 6,111	0.005 percent or 1 in 2,000

While we cannot confidently estimate the degree to which emissions of these pollutants will be reduced under the adopted rule, we note that in the case of maximum offset credit use, rule requirements for direct environmental benefits to the state would further facilitate potential reductions in these other pollutant emissions specific to Washington.

4.3.6 Summary of benefits related to reduced GHG emissions

The adopted rule is likely to result in avoided climate change impacts of:

- $17.27 billion in present value avoided SCC
- Additional avoided (unquantified) social costs associated with:
    - Heath
    - Agriculture
    - Oceans
    - Forests
    - Wildfire
    - Ecosystems
    - Productivity and economic growth
    - Water
    - Transportation
    - Energy
    - Catastrophic impacts and tipping points
    - Inter- and intra-regional conflicts

Reductions in local costs associated with high heat events, wildfire, and flooding[94] (see previous sections for detail), to which Washington's geography and population are especially vulnerable, including:

- Wildfires impacting at least $1.6 billion in value each year, including potential losses of over 90 percent of the value of managed timber lands.
- Direct costs of fighting wildfires of over $12.5 million.

Gas Emission Standards and Corporate Average Fuel Economy Standards, EPA-420-D-11-901, November 2011.

[94] Note that reducing GHG emissions and reducing contribution to climate change is not likely to fully eliminate these costs, but contributes to a reduction in the incidence and size of these local impacts.

- $45 million in damages to utilities, state agencies, and other government infrastructure.
- Health impacts of high heat events:
    - $1.45 billion in lost lives.
    - Significant increases in emergency healthcare visits, costing over $12 thousand each.
- Agricultural losses to harvest and quality due to high heat events:
    - $60 million to $85 million in impacts to berries.
    - $50 million to cherries.
    - Significant reductions in the quality of wheat.
- Shellfish harvest losses and increased shellfish consumption-related human illness.
- Flood damage due to atmospheric rivers in western Washington (per county):
    - $10 million to $100 million per year increases in most Puget Sound-adjacent counties.
    - Over $100 million per year increases in Snohomish, King, and Lewis counties.
    - This is at least a doubling of annual flood damage costs in Western Washington, compared to costs in the 1990s.
- Flood damage due to atmospheric rivers in eastern Washington (per county)
    - $1 million per year increases in most eastern Washington counties, with some counties incurring up to $10 million more per year.
    - This is up to a doubling of annual costs for most eastern Washington counties.
    - For Pend Oreille, Spokane, Whitman, Columbia, and Asotin counties, this is between two and four times as flood damage costs in the 1990s.
- Environmental justice and disproportionate impacts of climate change:
    - Wildfire smoke exposure and illness.
    - Heat-related mortality.
    - Exposure to other pollutants, including fine particulate matter from wildfires and fuel combustion.

Chapter 5: Cost-Benefit Comparison and Conclusions

5.1 Summary of costs and benefits of the rule

5.1.1 Costs

We estimated annual and total present value costs of allowance purchases, emissions abatement, and offset credit purchases in Chapter 3. Here, we summarize total present value costs with and without offset credit use. Offset credits reduce the average compliance cost within each year, while creating more opportunity to purchase allowances to bank for future use.

Table 34: Total present value costs

Cost Category	Present Value through 2050, no offset credit use (billions of $)	Present Value through 2050, maximum credit offset use (billions of $)
Allowance purchases	$21.88	$21.88
Offset credit purchases	$0.00	$2.56
Emissions abatement	$11.11	$11.11
Total	$32.98	$35.54

In our model structure, the availability and use of offset credits does not change allowance market behavior. This is a result of the allowance market model excluding an interrelated offset credit market, due to limited resources and time to complete modeling of multiple allowance market scenarios, as well as the inherent complexity and high level of uncertainty about offset credit market attributes for Washington. Instead, in this model, use of offset credits allows for additional accumulation of banked allowances (to be used or sold at a later date), while reducing the average cost of compliance within each year. This results in a higher total present value cost estimate than in the scenario with no offsets, and is a highly conservative assumption, as purchases of offset credits in lieu of allowances would only serve to decrease total costs.

If covered and opt-in entities purchased offset credits in lieu of purchasing allowances, it would reduce market demand, putting downward pressure on allowance prices, counteracting upward pressure that would result from reductions in allowance supply corresponding to offset use. Absent a combined allowance-offset credit market model, we cannot estimate the size of these effects, but allowance prices would still reflect the marginal emissions abatement costs of remaining market participants, and could not fall below the auction floor price in a given year. Greenhouse gas emissions reductions would remain the same in either scenario.

Entities might choose to retain a surplus of banked allowances through 2050 as a precautionary measure in the face of uncertainty about future regulation, or as a source of potential revenue

if the market has been linked with ongoing programs in other jurisdictions. They might choose to sell any remaining banked allowances at the end of the program. Due to the allowance market model considering offset credit use as an factor external to allowance market decisions, combined with uncertainty in banking behavior at the end of the program, we could not make a confident assumption about the eventual disposition of surplus credits banked at the end of the program.

5.1.2 Benefits

5.1.2.1 Quantifiable benefits

We estimated annual and total present value benefits of emissions reductions, natural gas revenues, market revenues to the State, and sales of offset credits in Chapter 4. Here we summarize total quantifiable present value benefits, with and without offset credit use. Quantifiable benefits should be considered in conjunction with benefits discussed qualitatively or partially quantified, in Section 2.5.2.2.

Table 35: Total present value benefits

Cost Category	Present Value through 2050, no offset credit use (billions of $)	Present Value through 2050, maximum offset credit use (billions of $)
Revenues to Washington	$19.77	$19.77
Revenues to natural gas utilities	$2.11	$2.11
Avoided Social Cost of Carbon	$17.27	$17.27
Revenues to sellers of offset credits	$0.00	$2.56
Total	$39.14	$41.70

5.1.2.2 Qualitative and partially quantifiable benefits

Costs resulting from climate change not fully reflected in the SCC

Additional avoided impacts of climate change not included in the SCC:

- Health:
  - Respiratory illness
  - Lyme disease
  - Death, injuries, and illnesses from omitted natural disaster and migration
  - Water, food, sanitation, shelter
- Agriculture:
  - Weeds, pests, pathogens
  - Food price spikes
  - Heat and precipitation extremes
- Oceans:

    - Acidification, temperature, and extreme weather impacts on fisheries, extinction, reefs
    - Storm surge interaction with sea level rise
- Forests:
    - Pest infestations
    - Pathogens
    - Species invasion and migration
    - Flooding and soil erosion
- Wildfire:
    - Burned acreage
    - Public health
    - Property losses
    - Fire management costs
- Ecosystems:
    - Biodiversity
    - Habitat
    - Species extinction
    - Outdoor recreation and tourism
    - Ecosystem services
    - Rising value of ecosystems due to increased scarcity
    - Accelerated decline due to mass migration
- Productivity and economic growth:
    - Labor productivity and supply, public health
    - Infrastructure impacts from severe events
    - Diversion of resources to climate adaptation
- Water:
    - Availability and competing needs
    - Flooding
- Transportation:
    - Changes to land and ocean transportation
- Energy:
    - Energy supply disruptions
- Catastrophic impacts and tipping points:
    - Rapid sea level rise
    - Methane releases from permafrost
    - Damages at very high temperatures
    - Unknown catastrophic events
- Inter- and intra-regional conflict:
    - National security
    - Increased violent conflicts

Wildfires

- Based on a national average of comprehensive wildfire impacts, **wildfires cost Washingtonians at least $1.6 to $8 billion each year.**
- In 2020, Washington spent an estimated **$20 million on aviation readiness and support** for large fires.
- The WA Department of Natural Resources incurred **direct costs of over $12.5 million** responding to wildfire incidents in 2020, and estimated additional damages of:
    - **$20 million** to utilities.
    - **$15 million** to state agency infrastructure.
    - **$10 million** to other government infrastructure.
- During a severe wildfire season, which are forecast to increase due to climate change, **burned managed (working) forests can lose over 90 percent of the value of their timber,** even when salvage harvest is accounted for.
- Wildfires also cause **hazardous air quality** in broad regions, impacting rural as well as densely populated areas.

Heat impacts

- The 2021 heat dome event in the Pacific Northwest resulted in **at least $1.45 billion in lost lives.**
- **Extreme heat events are forecast to increase due to climate change,** corresponding to wildfire events as well.
- Even when extreme heat events do not result in death, they significantly increase burden on healthcare services. During the 2021 heat dome event, the **number of people needing emergency room services increased 70-fold.** Healthcare visits related to a high heat event **costs $12,544 per visit** on average.

Ongoing drought and the 2021 heat dome also affected harvests:

- At least **30 percent impact to raspberry harvests**: The aggregate Whatcom County raspberry harvest was 30 to 40 percent lower than the average harvest, with individual growers experiencing losses between 15 and 75 percent, due to the 2021 heat dome event. [95] In 2017, Washington produced nearly $200 million across all types of berry, of which 30 percent would be $60 million.
- At least **ten percent impact to cherry harvests**: The overall cherry harvest, largely in the Yakima Valley, was at least 10 percent lower than the average harvest, due to the 2021

[95] Bratt, C, 2021. June 'heat dome' cut raspberry volume 30%. Lynden Tribune. December 10, 2021.

heat dome event.[96] In 2021, Washington produced nearly $0.5 billion in fresh and processed cherries, of which 10 percent would be $50 million.

- **Over 40 percent impact to blueberry harvests and product quality**: Following the 2021 heat dome event, the Washington Blueberry Commission estimated $85 million in yield loss and quality impacts to the expected harvest that year.[97] In 2017, Washington produced nearly $200 million across all types of berry, of which $85 million would be 43 percent.
- Wheat harvests:
    - A **34-fold increase in the share of "poor" or "very poor" condition spring wheat**.[98]
    - A **6-fold increase in the share of "poor" or "very poor" condition winter wheat**.[99]
- Shellfish harvests:
    - **40 percent losses of seeded oysters**.
    - A **56 percent increase in vibriosis cases**.[100] Vibriosis is an illness in humans caused by shellfish contaminated with Vibrio bacteria, which are naturally occurring but present in high concentrations in warmer temperatures.[101]
    - **5 – 30 percent oyster mortality** in the Salish Sea.[102]
    - Higher losses among shellfish species in smaller, sheltered waters, and those that live nearer the surface, such as cockles.[103]

Flood damages

- Flood damage due to atmospheric rivers in western Washington (per county):
    - $10 million to $100 million per year increases in most Puget Sound-adjacent counties.

[96] Zhou, A, 2021. Western lawmakers seek more federal aid for farmers, ranchers hurt by extreme heat, drought. Seattle Times. July 27, 2021.
[97] Ibid.
[98] Ingwersen, J, 2021. 'Wither away and die:' US Pacific Northwest heat wave bakes wheat, fruit crops. Reuters. July 12, 2021.
[99] Ibid.
[100] Hagenbuch, B, 2021. In hot water: Heat dome recovery looks bleak for small-scale shellfish farms. National Fisherman. August 17, 2021.
[101] https://www.cdc.gov/vibrio/faq.html
[102] Royal, T, 2022. Heat dome found to be deadly for some shellfish species, but not for others. Northwest Treaty Tribes. January 10, 2022.
[103] Ibid.

    - Over $100 million per year increases in Snohomish, King, and Lewis counties.
    - This is at least a doubling of annual flood damage costs in Western Washington, compared to costs in the 1990s.
- Flood damage due to atmospheric rivers in eastern Washington (per county)
    - $1 million per year increases in most eastern Washington counties, with some counties incurring up to $10 million more per year.
    - This is up to a doubling of annual costs for most eastern Washington counties.
    - For Pend Oreille, Spokane, Whitman, Columbia, and Asotin counties, this is between two and four times as flood damage costs in the 1990s.

Environmental justice improvements

Wildfires account for *at least* 25 to 50 percent of fine particulate matter in Washington, compounding health and quality of life impacts for overburdened populations that are more likely to live or work outdoors near high-traffic roadways and/or in wildfire smoke prone areas.

Heat-related mortality is more likely to affect people who:

- Have lower incomes.
- Have less shade and more impervious or paved surfaces.
- Are unsheltered or had inadequate housing.
- Have less education.
- Live alone.
- Are elderly.
- Lack transportation.
- Lack recreational spaces.
- Experience more job or income insecurity.

Other pollutants

Table 36: Value of damages from select criteria pollutants as reported in EPA rulemakings[104]

Criteria Pollutant	Damages per MT in Current Dollars	Equivalent Mortality Risk (based on VSL)
$PM_{2.5}$	$1.74 – 1.92 million	16 – 18 percent or 1 in 6
Volatile Organic Compounds (VOCs)	$1,347 - 1,468	0.01 percent or 1 in 10,000
Nitrogen Oxides (NOx)	$5,624 – 6,111	0.005 percent or 1 in 2,000

While we cannot confidently estimate the degree to which emissions of these pollutants will be reduced under the adopted rule, we note that in the case of maximum offset credit use, rule requirements for direct environmental benefits to the state would further facilitate potential reductions in these other pollutant emissions specific to Washington.

5.2 Conclusion

We conclude, based on a reasonable understanding of the quantified and qualitative costs and benefits likely to arise from the adopted rule, as compared to the regulatory baseline, that the benefits of the adopted rule are greater than the costs.

[104] ICF International (2014). California's Low Carbon Fuel Standard: Compliance Outlook & Economic Impacts. In turn, this cites specifically:

- US Environmental Protection Agency (2010). Diesel Emissions Quantifier Health Benefits Methodology, EPA, EPA-420-B-10-034, August 2010.
- US Environmental Protection Agency and National Highway Traffic Safety Administration (2011). Draft Joint Technical Support Document: Proposed Rulemaking for 2017-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards, EPA-420-D-11-901, November 2011.

Chapter 6: Least-Burdensome Alternative Analysis

6.1 Introduction

RCW 34.05.328(1)(e) requires Ecology to "…[d]etermine, after considering alternative versions of the rule and the analysis required under (b), (c), and (d) of this subsection, that the rule being adopted is the least burdensome alternative for those required to comply with it that will achieve the general goals and specific objectives stated under (a) of this subsection." The referenced subsections provide the following:

> "(a) Clearly state in detail the general goals and specific objectives of the statute that the rule implements;
>
> (b) Determine that the rule is needed to achieve the general goals and specific objectives stated under (a) of this subsection, and analyze alternatives to rule making and the consequences of not adopting the rule;
>
> (c) Provide notification in the notice of proposed rulemaking under RCW 34.05.320 that a preliminary cost-benefit analysis is available. The preliminary cost-benefit analysis must fulfill the requirements of the cost-benefit analysis under (d) of this subsection. If the agency files a supplemental notice under RCW 34.05.340, the supplemental notice must include notification that a revised preliminary cost-benefit analysis is available. A final cost-benefit analysis must be available when the rule is adopted under RCW 34.05.360;
>
> (d) Determine that the probable benefits of the rule are greater than its probable costs, taking into account both the qualitative and quantitative benefits and costs and the specific directives of the statute being implemented."

In other words, to be able to adopt the rule, we are required to determine that the contents of the rule are the least burdensome set of requirements that achieve the goals and objectives of the authorizing statute(s).

We assessed alternatives for rule content, and determined whether they met the goals and objectives of the authorizing statute(s). Of those that would meet the goals and objectives, we determined whether those chosen for inclusion in the rule were the least burdensome to those required to comply with them.

6.2 Goals and objectives of the authorizing statute

The authorizing statute for this rule is Chapter 70A.65 RCW, Greenhouse Gas Emissions – Cap and Invest Program. Its goals and objectives are:

- Implementing a cap on greenhouse gas emissions from covered entities and a program to track, verify, and enforce compliance with the cap through the use of compliance instruments, in order to ensure the reduction of greenhouse gas emissions consistent with the limits established in RCW 70A.45.020.

- Establishing annual emission allowance budgets as necessary to achieve the proportionate share of reductions by covered entities necessary to achieve the 2030, 2040, and 2050 statewide emissions limits established in RCW 70A.45.020.
- Restoring the health of our forests.
- Positioning Washington's economy, technology centers, financial institutions, and manufacturers to benefit from national and international efforts that must occur to reduce greenhouse gases.
- Creating climate policy that minimizes leakage by recognizing the special nature of emissions-intensive, trade-exposed industries and increased life-cycle emissions associated with product imports.
- Encouraging energy-intensive and trade-exposed industries to continue to innovate, find new ways to be more energy efficient, use lower carbon products, and be positioned to be global leaders in a low carbon economy.
- Considering opportunities to implement the program in a manner that allows linking the state's program with those of other jurisdictions.
- Establishing a coordinated and strategic statewide approach to climate resilience.
- Building an equitable and inclusive clean energy economy.
- Establishing this program in a manner that contributes to a healthy environment for all of Washington's communities.

In 2020, the legislature updated the state's GHG emissions limits that are to be achieved by 2030, 2040, and 2050, based on current science and emissions trends, to support local and global efforts to avoid the most significant impacts from climate change. Achieving the GHG emissions reductions required by these limits will require coordinated, comprehensive, and multisectoral implementation of policies, programs, and laws, as other enacted policies are insufficient to meet the limits. Chapter 70A.65 includes a goal of ensuring that the government provides clear policy and requirements, financial tools, and other mechanisms to support achieving the GHG emissions limits.

6.3 Measures to reduce burden

Chapter 70A.65 RCW provides a detailed framework for the Cap and Invest Program, which in some cases limited Ecology's discretion in developing certain elements of the rule. However, to the extent Ecology had discretion to choose between alternatives in the rulemaking, Ecology took steps to minimize the burden on the regulated community, including small businesses. We included the following elements in the rule to minimize burden.[105]

[105] In this rulemaking, Ecology initially proposed that entities required to report emissions under Chapter 173-441 WAC, and emitting at least 25,000 MT CO2e, would be automatically registered in the Cap and Invest Program. The

- The rule includes provisions similar to those in the existing California-Quebec cap-and-trade program. The similarity of these provisions is intended to facilitate potential linkage with the California-Quebec program in the future, and will also make it simpler and reduce transaction costs for parties that already participate in the California-Quebec program by providing them with requirements they are already familiar with and have been working with for years. For example, Ecology is adopting the same compliance deadline (November 1, at 5 pm) as California and Quebec, as well as similar holding limits, corporate association disclosures, and auction processes, just to name a few. This not only supports the statutory objective of implementing the program in a manner that allows for linkage, but also supports a reduced burden that can result from such future linkage (RCW 70A.65.210) in the following ways:
    - Mutual use and recognition of allowances, and the potential for transferability of offset credits.
    - Broader GHG emission reduction opportunities, reducing compliance costs.
    - Broader offset project opportunities, reducing compliance costs.
    - Reduced compliance effort and administrative costs, including joint allowance auctions and a unified tracking system.
    - Enhanced market security.
    - Consistent requirements for covered entities whose operations span jurisdictional boundaries.
- Ecology adjusted the dates for allocating no cost allowances to EITE facilities such that they get current vintage allowances (rather than future vintage allowances) except for the minimal number of allowances required to reconcile their allowance allocation with their actual production. This allows EITE facilities more flexibility based on their needs, for immediate use of no cost allowances for compliance, if necessary, rather than needing to purchase current vintage allowances or otherwise reduce emissions.
- Ecology is putting five percent of the annual allowance budgets for 2023 through 2030 in the APCR immediately, which is an increase to the minimum of two percent per year required by statute. Ecology is also making the allowances placed in the APCR vintageless, which makes them eligible for use for compliance at any time. This will greatly increase the number of allowances available for auction from the APCR in the early years and have a moderating effect on allowance prices. It will also make more allowances available at the lower APCR prices, meaning covered entities will have less need to purchase price ceiling units at a higher price.

adopted rule does not include this provision, and instead requires affirmative registration by these covered entities after Ecology provides them notice of coverage. This change was based on consistency with current Western Climate Initiative (WCI) Compliance Instrument Tracking System Service (CITSS) procedures. This is a clarification of the CITSS and registration process that helps ensure smooth registration by covered entities, and does not change the amount of information or effort required of covered entities.

- Ecology will be holding an APCR auction each year after the 3rd quarter regular auction and before the November 1 compliance deadline, to enable covered entities to purchase allowances from the APCR before resorting to the purchase of price ceiling units at the higher price ceiling price.
- Ecology decided to exclude the number of allowances that are needed to meet a current compliance obligation from the holding limit requirements. This approach gives covered and opt-in entities more flexibility by allowing them to hold larger numbers of compliance instruments at any one time.
- Ecology is maximizing the number of allowances available for purchase at auction by including a mechanism for allowances that do not sell in a given auction to remain available for purchase at subsequent auctions for two years before being placed in the Emissions Containment Reserve.
- Ecology is exercising the option to suspend the emissions containment trigger price, which will have a moderating effect on allowance prices.

6.4 Alternatives considered and why they were excluded

We considered the following alternatives for rule content during the rule development process, and did not include those elements in the rule for the reasons discussed in each subsection below.

- Setting different price controls.
- Establishing a different total allowance budget trajectory.
- Adopting additional offset protocols for additional offset project categories.
- Adopting fewer offset protocols.
- Requiring separate bid guarantees for parallel auctions.
- Requiring all of the no cost allowances provided to EITE facilities to be from future vintage years.
- Putting a lower amount of the annual allowance budget into the APCR. (The minimum required under the regulatory baseline is 2 percent.)
- Not frontloading the APCR.
- Not including an annual APCR auction.
- Applying holding limits to all allowances in a compliance account, rather than exempting those allowances in a holding account needed for compliance at the next compliance deadline.
- Putting allowances not sold at a single auction directly into the ECR.
- Implementing the ECR trigger price.

6.4.1 Price controls

We considered multiple options for price controls (floor, ceiling, APCR tier prices), in conjunction with price trajectory modeling[106] results under various assumptions. Price trajectory modeling results indicated that in early compliance periods, the declining program budget and attributes of GHG emissions abatement options available and appropriate for Washington covered entities, would result in significant upward pressure on prices in the first two compliance periods. Modeling also indicated that high confidence in approaching linkage with another jurisdiction would alleviate a significant portion of that upward pressure, lowering prices and resulting compliance costs. We therefore chose Cap and Invest program attributes in line with California allowance market price controls, to increase the likelihood and confidence that linkage could be achieved early. Alternative sets of price controls, while potentially allowing for wider or narrower variation in prices, would not have met the statutory goal of program design that facilitates linkage with other jurisdictions. This, in turn, would have foregone the opportunity for lower allowance market prices than those used in this analysis.

6.4.2 Total allowance budget trajectory

We considered an alternative trajectory and path for reductions in the total allowance budget over time. The trajectory of the allowance budget needed to be designed to achieve statutory emissions reductions by the applicable deadlines while achieving the goals and objectives of the statute in an efficient way that does not create unnecessary burden and is aligned with GHG emissions regulations and market structures in potential future linked jurisdictions.

The adopted percentage reductions in different compliance periods reflect what Ecology believes are likely achievable emissions reductions, accounting for relatively straightforward abatement options and offset projects available in the short run, and the need for technology and efficiencies to develop in the medium run. In the long run, the percentage reductions strike a balance between the need to provide flexibility in achieving the most difficult final emissions reductions, and the potential for significant technological and infrastructural advancement that will allow for a higher reduction rate in the future.

The regulatory baseline establishes required emissions reduction goals and timeframes, leaving Ecology no discretion in setting a less aggressive *overall* allowance budget trajectory that would not achieve the limits in RCW 70A.45.020. In addition, RCW 70A.65.070(2) requires Ecology to "adopt annual allowance budgets for the program on a calendar year basis that provide for progressively equivalent reductions year over year." These statutory requirements left Ecology with the following options for the timing and size of reductions in the total allowance budget within each decade:

- **Higher early reductions and low later reductions, meeting the stepwise 2030, 2040, and 2050 emissions limits.** A budget trajectory that would require very high initial

[106] Vivid Economics, 2022. Washington State Climate Commitment Act, Summary of market modeling and analysis of the proposed Cap and Invest Program. September 2022.

reductions in GHG emissions in each decade would contribute to gaining environmental and human health benefits earlier, but would impose more burden on covered and opt-in entities by creating higher demand for emissions reductions before markets and technology have time to adapt. This would drive up short-run allowance prices – potentially to APCR or ceiling prices depending on the cost of available short-run emissions abatement options or offsets – resulting in inefficiencies in the market and a higher overall cost of achieving the statutory GHG emissions limits.

- **Lower early reductions and high later reductions, meeting stepwise 2030, 2040, and 2050 emissions limits.** A budget trajectory that would require low emissions reductions early in each decade, followed by very high reductions toward the end of the decade, would delay gaining environmental and human health benefits as well as delaying compliance costs for covered and opt-in entities. While this would seemingly reduce the present value of compliance burden by delaying costs, overall lower costs might not manifest due to risks of:
    - Reduced supply of emissions reduction options in later years due to:
        - Less market incentive for technologies to develop over time in Washington.
        - Insufficient quantity of affordable emissions reduction options to meet a sudden surge in demand.
    - Allowance prices rising to very high levels – potentially to APCR or ceiling prices – in later years of each decade:
        - Outweighing cost-savings of delaying compliance costs.
        - Risking market inefficiency or failure undermining the state's ability to meet the statutory emissions limits in 2030, 2040, and/or 2050.

6.4.4 Additional offset project protocols

The adopted rule's offset provisions are modeled after California's offset rules and protocols as a way to facilitate potential future linkage and to accelerate the use of offset credits in our program design from the beginning of the program, while providing the needed time to further develop an offset program that is more customized to Washington's unique needs. However, there are two California offset protocols that Ecology decided not to adopt by reference in the rule. Because the CCA requires that offset projects provide direct environmental benefits to the state, we determined that incorporating the Rice Cultivation and Mine Methane Capture offset protocols was not appropriate in light of the goals and objectives of the authorizing statutes, as these project types are not likely to meet the requirement of providing direct environmental benefits to Washington. (These types of offset projects are highly unlikely to be located here, based on current agricultural and mining resources.)

A number of other offset protocols or offset project categories were also suggested during rule development, however, none of these other protocols were found to be appropriate for immediate adoption in Washington. Offset protocols must meet the minimum criteria

established in RCW 70A.65.170. However, the adopted rule does not preclude the future adoption of additional offset protocols for other project categories, and Ecology will actively consider such future adoption as protocols develop and improve over time to meet our statutory standards.

6.4.5 Fewer offset protocols

Ecology initially considered including only three of the California offset protocols, and later added the Ozone Depleting Substances Protocol. The Ozone Depleting Substances Protocol generates offset credits by capturing and destroying certain potent greenhouse gases, such as Freon, that may be found in commercial and industrial equipment that was manufactured before the creation of these substances was prohibited. There are many potential sources of these substances in facilities in Washington, which may be captured and destroyed. Excluding this protocol would have given entities access to fewer types of offset, and the adopted rule language reduces potential compliance burden by making additional offset options available.

In addition, Ecology received public comment recommending against the proposed adoption of CARB's U.S. Forest Projects protocol. We decided to keep this protocol in the adopted rule in light of the requirement in RCW 70A.56.090 and .100. These policies include "to promote the removal of excess carbon from the atmosphere through voluntary and incentive-based sequestration activities in Washington" and "to support the participation of working forests in current and future carbon markets."

6.4.6 Separate bid guarantees for parallel auctions

Ecology initially considered requiring separate bid guarantees for parallel auctions of future vintage allowances and quarterly auctions of current-past vintage allowances. This would have imposed additional burden on allowance market participants. Instead, the rule requires just one bid guarantee to cover both auctions, making it simpler and reducing transaction costs for parties participating in these auctions.

6.4.7 Future vintage allowances for EITE facilities

Ecology initially considered basing the initial allocation of no-cost allowances to EITE facilities on each facility's previous year's production. This approach has the advantage of using more recent production data, but has the disadvantage that the previous year's production data will not be known and verified until late in the year following the facilities' emissions. Under this scenario, the initial no cost allowances allocated to EITE facilities would have to be from vintage years later than the year in which the compliance obligation accrued, and would not be eligible under the statute to meet compliance obligations for that vintage year.

Ecology modified its initial approach, such that under the adopted rule, the initial allocation of no cost allowances (distributed in October of the year prior to the vintage year of the allowances) would be based on production data from two years prior, and would be of allowances from the current vintage year and thus eligible to be used for the current year's

compliance obligation. Under the adopted rule, only the allowances provided in October of the next year to reconcile a facility's initial allocation with the facility's actual production would be future vintage allowances.

6.4.8 Number of allowances to the APCR

Price ceiling units sell for a higher price than APCR allowances. Price ceiling units are sold only after the APCR has been exhausted. Ecology initially considered placing into the APCR only the minimum two percent of the annual allowance budget required by statute. Instead, the adopted rule requires Ecology to place five percent of the annual allowance budget into the APCR. Increasing the number of allowances placed into the APCR will make more allowances available at the lower APCR prices, meaning covered entities will have less need to purchase price ceiling units at a higher price.

The adopted rule also places all of the allowances that are to go into the APCR between 2023 and 2030 into the APCR in 2023, and makes those allowances vintageless. This greatly increases the number of allowances available for auction from the APCR, and makes all those allowances eligible for use for compliance starting in 2023. These measures will help moderate allowance prices. We also considered other percentages of allowances to place into the APCR. Lower percentages would result in fewer allowances available at the lower APCR prices if settlement prices begin to approach the ceiling price. Higher percentages could drive up prices and increase burden regardless of the scenario, by reducing allowance supply.

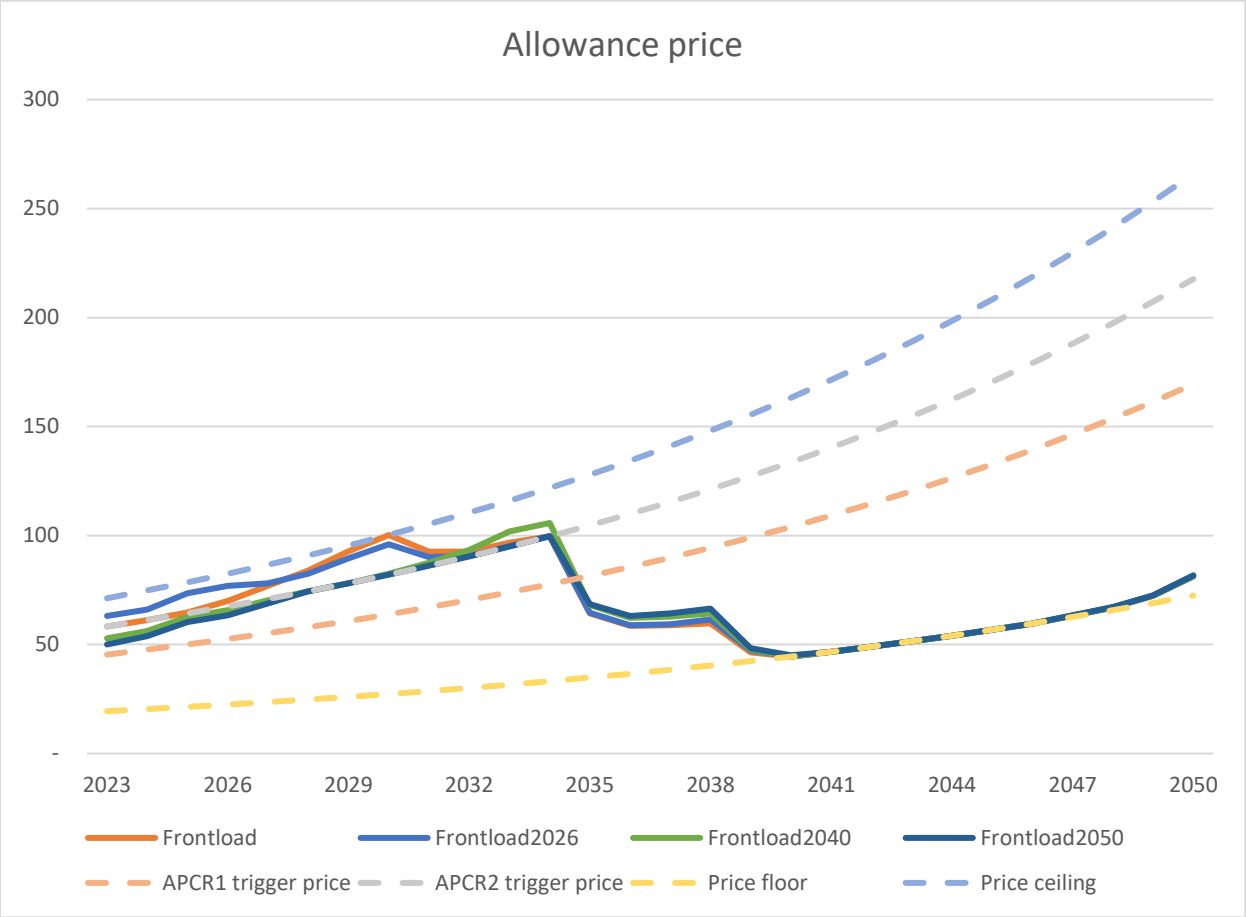
6.4.9 Vintage and vintageless APCR allowances and frontloading

Modeling performed by Vivid Economics[107] indicated that in early compliance periods, the declining program budget and attributes of GHG emissions abatement options available and appropriate for Washington covered entities, would result in significant upward pressure on prices in the first two compliance periods. To mitigate this pressure, the adopted rule brings vintageless APCR allowances forward from years through 2030, increasing short-run allowance supply while maintaining a total allowance budget trajectory that meets statutory emissions limits. This element of the design of the Cap and Invest program is also consistent with California's current approach, facilitating potential future linkage with other jurisdictions, as well as creating consistent structures across jurisdictions for entities subject to regulation in multiple jurisdictions.

We also considered other frontloading periods for vintageless APCR allowances – through 2026 (the end of the first compliance period), 2040, and 2050. As illustrated in the graph below, frontloading APCR allowances through 2026 would put upward pressure on allowance prices in early years, while frontloading beyond 2030 would put downward pressure on prices.

[107] Vivid Economics, 2022. Washington State Climate Commitment Act, Summary of market modeling and analysis of the proposed Cap and Invest Program. September 2022.

Figure 8: Modeled price trajectories under alternative frontloading scenarios



Frontloading beyond 2030, however, would also change emissions trajectories, increasing total emissions in each year through the 2040s. This would not have met the goals of the authorizing statute, particularly jeopardizing meeting the 2030 emissions limit.

6.4.9 Annual APCR auction

Ecology initially considered holding APCR auctions only when new covered or opt-in entities enter the program and when the settlement price at a quarterly auction of current vintage allowances approaches the ceiling price, which is the minimum statutory requirement. Instead, the adopted rule requires Ecology to offer an APCR auction once a year immediately preceding each compliance deadline. Making APCR allowances available for purchase at auction at this time provides an opportunity for covered and opt in entities that have not acquired sufficient compliance instruments to cover their compliance obligations to acquire allowances from an APCR auction before the compliance deadline.

Since price ceiling units are sold only after the APCR has been exhausted, the annual APCR auction provides a means of exhausting the APCR to make price ceiling units available. Holding less frequent APCR auctions would not provide this benefit in all years. Holding more frequent

APCR auctions would not be necessary to meet the goals of an efficient market facilitating compliance with statutory GHG emissions limits, since covered entities would not necessarily need or want to buy allowances at APCR prices while they had potential access to lower market prices.

6.4.10 Exception to holding limit

Ecology initially considered applying the holding limit to all allowances contained in a registered entity's holding account and compliance account. Instead, the adopted rule exempts from the holding limit those compliance instruments that are needed for compliance with the next compliance deadline. This approach gives registered entities more flexibility by allowing them to hold larger numbers of compliance instruments at any one time.

6.4.11 Providing allowances for re-auction

Ecology initially considered placing all allowances that have not been sold after one auction directly into the ECR. This would limit the number of allowances available at subsequent auctions, thus likely pushing prices higher. Instead, the rule follows California's lead and makes allowances that have not been sold after one auction available for purchase at subsequent auctions over the following two years. If after two years of auctions the allowances remain unsold, they will be placed in the ECR. This increases the number of allowances available at auction, which should have a dampening effect on allowance prices.

6.4.12 Suspending the ECR trigger price

As authorized in E2SSB 5842 (2022), Ecology has determined to suspend the ECR trigger price. The ECR trigger price is designed to raise auction prices; suspending the ECR trigger price will therefore help keep auction prices down.

6.5 Conclusion

After considering alternatives to the rule's contents, within the context of the goals and objectives of the authorizing statute, we determined that the rule represents the least-burdensome alternative of possible rule contents meeting the statutory goals and objectives.

Chapter 7: Regulatory Fairness Act Compliance

7.1 Introduction

The Regulatory Fairness Act (RFA; RCW 19.85.070) requires Ecology to perform a set of analyses and make certain determinations regarding the rule. This chapter presents the:

- Analysis of relative compliance cost burden.
- Consideration of lost sales or revenue.
- Cost-mitigating elements of the rule, if required.
- Small business and local government consultation.
- Industries likely impacted by the rule.
- Expected impact on jobs.

A small business is defined by the RFA as having 50 or fewer employees, at the highest ownership and operator level. Estimated compliance costs are determined as compared to the regulatory baseline (the regulatory environment in the absence of the rule, limited to existing federal and state requirements). Analyses under the RFA only apply to costs to "businesses in an industry" in Washington State. This means the impacts, for this part of our analyses, are not evaluated for government agencies.

7.2 Choice to develop Small Business Economic Impact Statement

The analyses required under the RFA, and their inclusion in a Small Business Economic Impact Statement, are based on whether the rule would impose compliance costs on small businesses. A rule is otherwise exempt from these analyses under RCW 19.85.025(4).

Based on available information, we did not identify any small businesses that we expect to be covered entities and therefore required to comply with the rule. The average business that is likely to be a covered entity under the rule employs 19,894 people. However, we do not have full information concerning all potential covered entities. For example, about half of the 50-60 electric power entities (EPEs) that are expected to start reporting under recent amendments to the GHG reporting rule[108] (Chapter 173-441 WAC), would also be covered entities. Based on the size of other covered entities, we do not expect these EPEs to be small businesses.

While it may be reasonable to assume that all EPEs are large businesses, we cannot be certain of all their attributes. This is particularly true for EPEs for which we have uncertainty about emissions levels. Due to uncertainty about the employment attributes of EPEs, we chose to

[108] WA Department of Ecology, 2022. Rulemaking for Chapter 173-441 WAC. Administrative Order #21-07.

complete a Small Business Economic Impact Statement and complete work required under the RFA, to fully understand potential disproportion in the impacts of the rule.

As the RFA requires analyses specifically related to employment impacts and price or output impacts (as they play into revenue and profits), we also determined this analysis would be the most appropriate space to discuss macroeconomic modeling we performed to fully understand the potential impacts of the rule.

7.3 Analysis of relative compliance cost burden

We calculated the estimated per-business costs to comply with the rule, based on the costs estimated in Chapter 3 of this document. In this section, we estimate compliance costs per employee.

Since there is uncertainty in the employment levels of potential small business EPEs, we chose to examine the full range of 1 – 50 employees that defines a small business in the RFA.

Table 37: Average annual present value compliance costs per employee, through 2050

Employment or average cost category	Low	High
Small business employment	1	50
Average employment at largest ten percent of businesses	133,098	133,098
Small business cost per employee	$181,232	$9,763,768
Largest business cost per employee	$68	$73

We conclude that, **if the rule does impose compliance costs on small businesses, it may disproportionately affect them**. Therefore in the eventuality that the rule does impact small businesses, Ecology would need to include elements in the rule to mitigate this potential disproportion, as far as is legal and feasible, which it has done (see Sections 6.3 and 7.4).

7.4 Loss of sales or revenue

Businesses that would incur costs under the Cap and Invest Program could experience reduced sales or revenues if the rule significantly affects the prices of the goods they sell. The degree to which this could happen is strongly related to each business's production and pricing model (whether additional lump-sum costs would significantly affect marginal costs), as well as the specific attributes of the markets in which they sell goods, including the degree of influence each firm has on market prices, as well as the relative responsiveness of market demand to price changes.

We used the REMI E3+ model for Washington State to estimate the impact of the rule on directly affected markets, accounting for dynamic adjustments throughout the economy. The model accounts for: inter-industry impacts; price, wage, and population changes; and dynamic adjustment of all economic and population variables over time. This provides information about how industries and consumers react to compliance costs. For this Final Regulatory Analyses, we used a more recent version of the REMI model – made available in late July to early August

2022 – to reflect updated economic circumstances.[109]

REMI model inputs

We used the compliance costs estimated in Chapter 3 as inputs to the REMI model, assigning costs proportionately to each sector's share of GHG emissions, less allocated no cost allowances. Proportions were based on the first year all sectors would be covered (2027, the beginning of the second compliance period).

We used the quantifiable benefits estimated in Chapter 4 as inputs as well, reflecting where the costs from Chapter 3 were spent. Compliance costs were modeled as production costs. Because avoided SCC is not a result of spending, we reflected this benefit as an input to amenity value in the REMI model. Amenity value reflects the perceived benefits of living in a region, which in turn attracts high-value labor migration into the state. Amenity value in the REMI model can be thought of as a *perceived* increase in real income spread across the state's population, which then affects population and demographics, labor force, market demand, and prices. We examined results that did or did not include the amenity value impact.

All cost and benefit inputs were year-specific, and assumed to be real values (growing in line with inflation). As use of offset credits to meet compliance obligations did not significantly affect cost or benefits estimates, we made the simplifying and conservative assumption that no offset credits were used in the REMI model. Appendix G discusses alternative assumptions about the flows of inputs to the REMI model.

Table 38: REMI E3+ model input categories, total compliance costs

REMI E3+ Industry Aggregation	REMI E3+ Industry Aggregation
Electric power generation, transmission and distribution	Dairy product manufacturing
Natural gas distribution	Animal slaughtering and processing
Water, sewage and other systems (utilities)	Pulp, paper, and paperboard mills
Glass and glass product manufacturing	Petroleum and coal products manufacturing
Cement and concrete product manufacturing	Basic chemical manufacturing
Lime, gypsum, and other nonmetallic mineral product manufacturing	Pesticide, fertilizer, and other agricultural chemical manufacturing
Iron and Steel Mills and Ferroalloy Manufacturing	Wholesale trade
Alumina and aluminum production and processing	Retail trade
Nonferrous Metal (except Aluminum) Smelting and Refining	Pipeline transportation
Semiconductor and other electronic component manufacturing	Waste management and remediation services
Aerospace product and parts manufacturing	Educational services
Fruit and vegetable preserving and specialty food manufacturing	

[109] REMI E3+ version 3.3.0. The Preliminary Regulatory Analyses for this rulemaking used the previous version 2.5.0.

Table 39: REMI E3+ model input categories, benefits

Benefit Category	REMI Input Variable
Abatement costs	Firm sales: Industrial machinery; Engine, turbine, and power transmission machinery; Engineering, architectural, and related services
State revenues	Detailed industry sales: Transportation infrastructure
Natural gas utility revenues	Fuel price offset: Natural gas
Avoided SCC	Amenity value: Statewide

Consumption price impacts

We ran the REMI model through 2050, assuming lagged market share response, and examined results for output and prices, both statewide and in the most affected industries. Impacts to output and prices are indicators of whether revenues and profits would be impacted. Price impacts are presented as percentages to facilitate consistent understanding of the real value of these impacts regardless of inflation. This means that the percentage impacts can be applied to a nominal baseline price for a given year, regardless of the degree of inflation assumed to occur by that year.

Table 40: Impacts to consumption price levels (direct+indirect+induced), no amenity value, percent

Year	Statewide Price Level	Motor vehicle fuels, lubricants, and fluids	Electricity	Natural Gas	Fuel Oil
2030	0.19%	0.99%	1.45%	-1.56%	0.95%
2040	0.06%	0.33%	0.54%	0.18%	0.31%
2050	0.04%	0.18%	0.33%	1.18%	0.17%

Percent difference from REMI reference scenario price levels.
Note: Statewide price level impacts reflect aggregate price increases and decreases across all industries and commodities in the state, and are not the sum of the individual commodity price impacts presented above.

Table 41: Impacts to consumption price levels (direct+indirect+induced), SCC amenity value, percent

Year	Statewide Price Level	Motor vehicle fuels, lubricants, and fluids	Electricity	Natural Gas	Fuel Oil
2030	0.19%	0.99%	1.45%	-1.56%	0.95%
2040	0.05%	0.32%	0.54%	0.18%	0.31%
2050	0.03%	0.17%	0.32%	1.18%	0.16%

Percent difference from REMI reference scenario price levels.
Note: Statewide price level impacts reflect aggregate price increases and decreases across all industries and commodities in the state, and are not the sum of the individual commodity price impacts presented above.

We note that potential consumption price impacts were significantly mitigated by the adopted rule's provisions enabling covered parties to use frontloaded APCR allowances and otherwise intertemporally optimize their behavior to smooth allowance price trajectories and lower overall compliance costs. They were also mitigated by the adopted rule's requirements to use consigned no cost allowance revenues to counteract impacts to consumers, and additional

allowance releases of APCR allowances when allowance prices reached the rule's APCR trigger prices.

We modeled impacts to consumer prices based on the compliance costs incurred under the adopted rule, as well as how those funds are spent as transfers to other industries and activities. Using this model, we can differentiate between producer costs or prices, and impacts to consumer prices. Note that these estimates are influenced by the elasticity (responsiveness of demand to prices; ability of producers to pass costs on to consumers) associated with the industries modeled. The results presented for our primary analysis reflect industry elasticities as defined by industry codes – significantly, the wholesale industry for transportation fuel suppliers. For alternative specifications and results, including more inelastic assumptions surrounding transportation fuels resulting in higher potential fuel price impacts, see Appendix G.

Finally, while the RFA focuses required analyses on relative compliance cost burden for small and large businesses, we note that indirect and induced impacts to price levels affect everyone in the state's economy, including small businesses. Small businesses, in turn, may also have more difficulty passing their costs on to consumers depending on the attributes of their industry including market share of larger businesses, or economies of scale in production and transportation of inputs or final products.

Output Impacts

We ran the REMI model through 2050, assuming lagged market share response, and examined results for output and prices, both statewide and in the most affected industries. Impacts to output and prices are indicators of whether revenues and profits would be impacted.

Table 42: Impacts to output, no amenity value, billions of $

Year	Statewide	Utilities	Retail	Wholesale (includes transportation fuels)	Transportation and Warehousing	Construction (infrastructure)	Manufacturing
2030	-$0.99	-$0.19	-$0.26	-$0.56	-$0.07	$0.74	-$0.58
2040	-$1.73	-$0.15	-$0.17	-$0.46	-$0.07	$0.23	-$0.70
2050	-$0.84	-$0.08	-$0.12	-$0.24	-$0.04	$0.00	-$0.19

Difference from REMI reference scenario output levels.
Note: Statewide output level impacts reflect aggregate output increases and decreases across all industries in the state, and are not the sum of impacts to the sectors presented above.

Table 43: Impacts to output, SCC amenity value, billions of $

Year	Statewide	Utilities	Retail	Wholesale (includes transportation fuels)	Transportation and Warehousing	Construction (infrastructure)	Manufacturing
2030	-$0.75	-$0.18	-$0.24	-$0.55	-$0.07	$0.77	-$0.56
2040	-$1.11	-$0.14	-$0.12	-$0.43	-$0.06	$0.28	-$0.63
2050	-$0.09	-$0.07	-$0.03	-$0.20	-$0.02	$0.03	-$0.10

Difference from REMI reference scenario output levels.
Note: Statewide output level impacts reflect aggregate output increases and decreases across all industries in the state, and are not the sum of impacts to the sectors presented above.

Impacts to prices and output do not reflect significant structural changes to the state economy, such as local development of new or expanded green industries over time. The REMI model is based on the state's economy in its present state, and forecasts based on known and expected growth trajectories and sectoral relationships. The inclusion of large structural changes such as local development of a new industry or sector, a significant change to electrification infrastructure, or greater local access to technological advances, would allow for greater flexibility in the economy. This would mitigate price increases and negative impacts to output and employment.

7.4 Action taken to reduce small business impacts

The RFA (19.85.030(2) RCW) states that:

"Based upon the extent of disproportionate impact on small business identified in the statement prepared under RCW 19.85.040, the agency shall, where legal and feasible in meeting the stated objectives of the statutes upon which the rule is based, reduce the costs imposed by the rule on small businesses. The agency must consider, without limitation, each of the following methods of reducing the impact of the proposed rule on small businesses:

a) Reducing, modifying, or eliminating substantive regulatory requirements;

b) Simplifying, reducing, or eliminating recordkeeping and reporting requirements;

c) Reducing the frequency of inspections;

d) Delaying compliance timetables;

e) Reducing or modifying fine schedules for noncompliance; or

f) Any other mitigation techniques including those suggested by small businesses or small business advocates."

We considered all of the above options, the goals and objectives of the authorizing statutes (see Chapter 6), and the scope of this rulemaking. We limited compliance cost-reduction methods to those that:

- Are legal and feasible.
- Meet the goals and objectives of the authorizing statute.
- Are within the scope of this rulemaking.

Though the requirements of the adopted rule are not analytically separable from the regulatory baseline for the purposes of this analysis, the authorizing statute does not allow Ecology to reduce, modify, or eliminate substantive requirements for any covered entities. The areas of the rule reflecting these statutory requirements include rule coverage, inspections or their equivalent in verification, emissions reduction goals, compliance timetables, and penalties. The areas in which Ecology exercised its discretion do not control substantive regulatory requirements or these other areas dictated in whole or in part by the statute.

Small businesses would also inherently have fewer or no corporate associations (direct or indirect), and require fewer personnel managing or observing market and compliance activities. The rule also allows electric utilities that purchase imported power from a federal power marketing administration that has voluntarily elected to comply with the Cap and Invest Program, to provide by agreement for the federal power marketing administration to assume the compliance obligation.

For generally more burdensome alternatives that Ecology considered but did not include in the rule, see Chapter 6.

7.5 Small business and government involvement

Ecology involved small businesses and local governments in its development of the rule, using:

- Four stakeholder meetings:
    - November 8, 2021
    - December 16, 2021 (morning).
    - December 16, 2021 (afternoon).
    - January 11, 2022.
- For each stakeholder meeting we sent notifications to two email distribution lists that include multiple business and local government contacts:
    - Climate Commitment Act listserv.
    - Greenhouse gas reporting listserv.
- Two Tribal rulemaking review sessions:
    - January 13, 2022.
    - January 18, 2022.
- An informal comment period from November 8, 2021 to January 26, 2022 (deadline extended from initial date of January 18 in response to stakeholder requests).

- The formal comment period for this rulemaking, from May 16, 2022 to July 15, 2022, held public hearings on June 21, June 22, June 27, and June 28, 2022. Ecology received a total of 1,401 comments from individuals, businesses, industry organizations, and governments.

7.6 North American Industry Classification System (NAICS) codes of impacted industries

The rule likely impacts the following industries, with associated NAICS codes. NAICS definitions and industry hierarchies are discussed at https://www.census.gov/naics/

Table 44: Potentially impacted NAICS codes

NAICS	NAICS Title	NAICS	NAICS Title
1121	Cattle Ranching and Farming	3274	Lime and Gypsum Product Manufacturing
2123	Nonmetallic Mineral Mining and Quarrying	3311	Iron and Steel Mills and Ferroalloy Manufacturing
2131	Support Activities for Mining	3313	Alumina and Aluminum Production and Processing
2211	Electric Power Generation, Transmission and Distribution	3314	Nonferrous Metal (except Aluminum) Production and Processing
2212	Natural Gas Distribution	3321	Forging and Stamping
2213	Water, Sewage and Other Systems	3344	Semiconductor and Other Electronic Component Manufacturing
3112	Grain and Oilseed Milling	3359	Other Electrical Equipment and Component Manufacturing
3114	Fruit and Vegetable Preserving and Specialty Food Manufacturing	3364	Aerospace Product and Parts Manufacturing
3115	Dairy Product Manufacturing	4247	Petroleum and Petroleum Products Merchant Wholesalers
3116	Animal Slaughtering and Processing	4251	Wholesale Electronic Markets and Agents and Brokers
3119	Other Food Manufacturing	4451	Grocery Stores
3211	Sawmills and Wood Preservation	4471	Gasoline Stations
3212	Veneer, Plywood, and Engineered Wood Product Manufacturing	4811	Scheduled Air Transportation
3219	Other Wood Product Manufacturing	4862	Pipeline Transportation of Natural Gas
3221	Pulp, Paper, and Paperboard Mills	4881	Support Activities for Air Transportation
3222	Converted Paper Product Manufacturing	4921	Couriers and Express Delivery Services
3241	Petroleum and Coal Products Manufacturing	4931	Warehousing and Storage
3251	Basic Chemical Manufacturing	5622	Waste Treatment and Disposal
3253	Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	6113	Colleges, Universities, and Professional Schools
3272	Glass and Glass Product Manufacturing	9241	Administration of Environmental Quality Programs
3273	Cement and Concrete Product Manufacturing	9281	National Security and International Affairs

7.7 Impact on jobs

We used the REMI E3+ model for Washington State to estimate the impact of the rule on jobs in the state, accounting for dynamic adjustments throughout the economy.

The adopted rule will result in transfers of money within and between industries and sectors, as compared to the regulatory baseline. The modeled impacts on employment are the result of multiple small increases and decreases in employment, prices, and other economic variables across all industries in the state. We used outputs from the same model run as described above in Section 7.5. Employment impacts are presented in thousands of full-time employee (FTE) equivalents in each year.

Table 45: Impacts to employment, no amenity value, thousands of FTEs

Year	Statewide	Utilities	Retail	Wholesale (includes transportation fuels)	Transportation and Warehousing	Construction (infrastructure)	Manufacturing
2030	2.67	-0.14	-1.10	-1.40	-0.48	4.63	1.242
2040	-2.47	-0.09	-0.55	-0.88	-0.40	1.24	0.24
2050	-1.17	-0.04	-0.27	-0.35	-0.19	-0.15	0.681

Difference from REMI reference scenario employment levels.
Note: Statewide employment impacts reflect aggregate employment increases and decreases across all industries in the state, and are not the sum of impacts to the sectors presented above.

Table 46: Impacts to employment, SCC amenity value, thousands of FTEs

Year	Statewide	Utilities	Retail	Wholesale (includes transportation fuels)	Transportation and Warehousing	Construction (infrastructure)	Manufacturing
2030	4.00	-0.13	-1.02	-1.37	-0.42	4.87	1.3
2040	0.46	-0.08	-0.34	-0.81	-0.26	1.54	0.404
2050	2.03	-0.04	-0.03	-0.27	-0.03	0.06	0.876

Difference from REMI reference scenario employment levels.
Note: Statewide employment impacts reflect aggregate employment increases and decreases across all industries in the state, and are not the sum of impacts to the sectors presented above.

Impacts to employment do not reflect significant structural changes to the state economy, such as local development of new or expanded green industries over time. The REMI model is based on the state's economy in its present state, and forecasts based on known and expected growth trajectories and sectoral relationships. The inclusion of large structural changes such as local development of a new industry or sector, a significant change to electrification infrastructure, or greater local access to technological advances, would allow for greater flexibility in the economy. This would mitigate price increases and negative impacts to output and employment.

References

Aldy, JE, MJ Kotchen, RN Stavins, and JH Stock, 2021. Keep climate policy focused on the social cost of carbon. Science, Vol. 373, Issue 6557. 20 August 2021.

Bratt, C, 2021. June 'heat dome' cut raspberry volume 30%. Lynden Tribune. December 10, 2021.

Bressler, RD, 2021. The mortality cost of carbon. Nat. Commun. 12, 4467 (2021).

Bressler, RD, FC Moore, K Rennert, and D Anthoff, 2021. Estimates of country level temperature-related mortality damage functions. Scientific Reports, Nature Portfolio 11:20282. https://doi.org/10.1038/s41598-021-99156-5.

Burke, M, A Driscoll, S Heft-Neal, J Xue, J Burney, and M Wara, 2020. The changing risk and burden of wildfire in the United States. PNAS 118(2). https://doi.org/10.1073/pnas.2011048118.

California Air Resources Board, 2022. Summary of Market Transfers Report. 2014 – 2021. https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/program-data/summary-market-transfers-report.

CarbonBrief, 2017. Q & A: The social cost of carbon. February 14, 2017. https://www.carbonbrief.org/qa-social-cost-carbon.

Carleton, T and M Greenstone, 2021. Updating the United States Government's Social Cost of Carbon. University of Chicago, Becker Friedman Institute for Economics Working Paper No. 2021-04. November 12, 2021. https://ssrn.com/abstract=3764255 or http://dx.doi.org/10.2139/ssrn.3764255.

Corringham, TW, J McCarchy, T Shulgina, A Gershunov, DR Cayan, and FM Ralph, 2022. Climate change contributions to future atmospheric river flood damages in the western United States. Nature Scientific Reports 12:13747. https://doi.org/10.1038/s41598-022-15474-2

Delaney, P, 2020. How Washington's Economy Benefits from Trade and Investment. Business Roundtable. https://s3.amazonaws.com/brt.org/BRT_General_Trade_WA_2020.pdf.

Engrossed Substitute Senate Bill 5689. 2022 Regular Session. https://lawfilesext.leg.wa.gov/biennium/2021-22/Pdf/Bills/Senate%20Passed%20Legislature/5689-S.PL.pdf.

Hagenbuch, B, 2021. In hot water: Heat dome recovery looks bleak for small-scale shellfish farms. National Fisherman. August 17, 2021.

Henderson, SB, KE McLean, MJ Lee, and T Kosatsky, 2022. Analysis of community deaths during the catastrophic 2021 heat dome. Environmental Epidemiology (2022) 6:e189. DOI: 10.1097/EE9.0000000000000189.

ICF International, 2014. California's Low Carbon Fuel Standard: Compliance Outlook & Economic Impacts.

In the Matter of the Further Investigation into Environmental and Socioeconomic Costs under Minnesota Statutes Section 216B.2422, Subdivision 3. State of Minnesota Office of Administrative Hearings. For the Public Utilities Commission. OAH 80-2500-31888. MPUC E-999/CI-14-643. https://mn.gov/oah/assets/2500-31888-environmental-socioeconomic-costs-carbon-report_tcm19-222628.pdf.

Ingwersen, J, 2021. 'Wither away and die:' US Pacific Northwest heat wave bakes wheat, fruit crops. Reuters. July 12, 2021.

Interagency Working Group on Social Cost of Carbon, 2010. Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866. February 2010. United States Government. http://www.whitehouse.gov/sites/default/files/omb/inforeg/for-agencies/Social-Cost-of-Carbon-for-RIA.pdf.

Interagency Working Group on Social Cost of Carbon, 2013. Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866. May 2013. United States Government.

Interagency Working Group on Social Cost of Carbon, 2015. Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866. May 2013. United States Government. May 2013, revised July 2015.

Interagency Working Group on Social Cost of Carbon, 2015. Response to Comments: Social Cost of Carbon for Regulatory Impact Analysis. July 2015. United States Government.

Interagency Working Group on Social Cost of Greenhouse Gases, 2021. Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990. United States Government. https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf.

King County, 2021. Results of heat mapping project show inequitable impact of hotter summers. https://kingcounty.gov/elected/executive/constantine/news/release/2021/June/23-heat-mapping-results.aspx. Results: https://www.arcgis.com/apps/webappviewer/index.html?id=84709c65c08a40bbb47d0723ef1c797a&extent=-13604644.7965%2C6019787.1095%2C-13561266.7829%2C6046616.5065%2C102100.

Knowlton, K, M Rotkin-Ellman, L Geballe, W Max, and GM Solomon, 2011. Six Climate Change-Related Events in the United States Accounted for About $14 Billion in Lost Lives and Health Costs. Health Affairs 30(11), pp. 2167-2176. DOI: 10.1377/hlthaff.2011.0229.

Louisiana v. Biden, Federal District Court for the District of Louisiana, Case No. 2:21-CV-01074. Memorandum Decision, 2/11/2022.

Louisiana v. Biden, United States Court of Appeals for the Fifth Circuit, Case No. 22-30087. Document: 00516220740. Filed: 03/01/2022.

Oregon Forest Resources Institute, 2021. Economic Impacts to Oregon's Forest Sector – 2020 Labor Day Fires. September 2021.

Rennert, K, F Errickson, BC Prest, L Rennels, RG Newell, W Pizer, C Kingdon, J Wingenroth, R Cooke, B Parthum, D Smith, K Cromar, D Diaz, FC Moore, UK Müller, RJ Plevin, AE Raftery, H Ševčíková, H Sheets, JH Stock, T Tan, M Watson, TE Wong, and D Anthoff, 2022. Comprehensive Evidence Implies a Higher Social Cost of CO2. Nature (2022). https://doi.org/10.1038/s41586-022-05224-9.

Royal, T, 2022. Heat dome found to be deadly for some shellfish species, but not for others. Northwest Treaty Tribes. January 10, 2022.

Schramm, PJ, A Vaidyanathan, L Radhakrishnan, A Gates, K Harnett, and P Breysse, 2021. Heat-Related Emergency Department Visits During the Northwestern Heat Wave — United States, June 2021. US Centers for Disease Control and Prevention. Weekly 70(90), pp. 1020-2021. July 23, 2021. https://www.cdc.gov/mmwr/volumes/70/wr/mm7029e1.htm.

Silva, RA, JJ West, JF Lamarque, DT Shindell, WJ Collins, G Faluvegi, GA Folberth, LW Horowitz, T Nagashima, V Naik, ST Rumbold, K Sudo, T Takemura, D Bergmann, P Cameron-Smith, RM Doherty, B Josse, IA MacKenzie, DS Stevenson, and G Zeng, 2017. Future global mortality from changes in air pollution attributable to climate change. Nat. Clim. Change, 7, no. 9, pp. 647-651. DOI: 10.1038/nclimate3354.

State of California and Sierra Club, et al. v. David Bernhardt, et al., Case No. 4:18-cv-05712-YGR, Consolidated case, Re: Dkt. Nos. 108, 109, 123, 125, 126, 127. US District Court, Northern District of California. Decided July 15, 2020.

United Nations Environment Programme, 2022. Spreading like Wildfire – The Rising Threat of Extraordinary Landscape Fires. A UNEP Rapid Response Assessment. Nairobi.

US Bureau of Economic Analysis, 2020. Activities of U.S. Affiliates of Foreign Multinational Enterprises, 2018. https://www.bea.gov/sites/default/files/2020-11/imne1120.pdf.

US Census Bureau, 2022. QuickFacts: Washington. https://www.census.gov/quickfacts/WA.

US Department of Agriculture, National Agricultural Statistics Service, 2018. 2017 Census of Agriculture – State Data, Washington.

US Department of Agriculture, National Agricultural Statistics Service, 2022. Apple Utilized Production in Oregon and Washington down 1 percent from 2020, Sweet Cherry Utilized Production in Oregon and Washington up 9 percent from 2020. Press release. May 5, 2022.

US Department of the Treasury, 2022. Series I Savings Bonds Rates & Terms: Calculating Interest Rates. https://www.treasurydirect.gov/indiv/research/indepth/ibonds/res_ibonds_iratesandterms.htm.

US Environmental Protection Agency, 2010. Diesel Emissions Quantifier Health Benefits Methodology, EPA, EPA-420-B-10-034, August 2010.

US Environmental Protection Agency, 2022. Mortality Risk Valuation. https://www.epa.gov/environmental-economics/mortality-risk-valuation.

US Environmental Protection Agency and National Highway Traffic Safety Administration, 2011. Draft Joint Technical Support Document: Proposed Rulemaking for 2017-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards, EPA-420-D-11-901, November 2011.

van den Bergh, J and W Botzen, 2014. A lower bound to the social cost of CO2 emissions. Nature Clim Change 4, 253–258 (2014). https://doi.org/10.1038/nclimate2135.

Vivid Economics, 2022. Washington State Climate Commitment Act, Summary of market modeling and analysis of the proposed Cap and Invest Program. September 2022. Ecology publication no. 22-02-038. https://apps.ecology.wa.gov/publications/SummaryPages/2202038.html

WA Department of Commerce, 2020. Fuel Mix Disclosure 2020 Utility Emissions Report. Available through https://www.commerce.wa.gov/growing-the-economy/energy/fuel-mix-disclosure/.

WA Department of Commerce, 2021. Carbon Tax Assessment Model (CTAM). Version 4.2. Jan 11, 2021. https://www.commerce.wa.gov/growing-the-economy/energy/washington-state-energy-office/carbon-tax/.

WA Department of Ecology, 2022. CCA Total Program Baseline calculation. "2022 08 25 – CCA Total Program Baseline.xlsx". August 25, 2022.

WA Department of Ecology, 2022. Rulemaking for Chapter 173-441 WAC. Administrative Order #21-07.

WA Department of Ecology, 2022a. GHG Reporting Program Publication dataset. https://data.wa.gov/Natural-Resources-Environment/GHG-Reporting-Program-Publication/idhm-59de/data.

WA Department of Health, 2021. Heat Wave 2021. https://doh.wa.gov/emergencies/be-prepared-be-safe/severe-weather-and-natural-disasters/hot-weather-safety/heat-wave-2021.

WA Department of Health, 2022. Traffic Air Pollution Data. https://doh.wa.gov/data-statistical-reports/washington-tracking-network-wtn/traffic-air-pollution.

WA Department of Health, 2022a. Washington Tracking Network, Environmental Health Disparities Map. https://fortress.wa.gov/doh/wtnibl/WTNIBL/.

WA Department of Natural Resources, 2020. Impacts and Costs of Wildfire Season 2020. Presentation to the Senate Agriculture, Water, Natural Resources, and Parks. December 2, 2020.

Zald, HSJ and C Dunn, 2018. Severe fire weather and intensive forest management increase fire severity in a multi-ownership landscape. Ecological Applications (2018). DOI: 10.1002/eap.1710.

Zero Zone, Inc., et al. v. United States Department of Energy, et al., Nos. 14-2147, 14-2159, & 14-2334. Argued September 30, 2015 — Decided August 8, 2016. http://media.ca7.uscourts.gov/cgi-bin/rssExec.pl?Submit=Display&Path=Y2016/D08-08/C:14-2159:J:Ripple:aut:T:fnOp:N:1807496:S:0.

Zhou, A, 2021. Western lawmakers seek more federal aid for farmers, ranchers hurt by extreme heat, drought. Seattle Times. July 27, 2021.

Appendix A: Administrative Procedure Act (RCW 34.05.328) Determinations

A. RCW 34.05.328(1)(a) – Clearly state in detail the general goals and specific objectives of the statute that this rule implements.

See Chapter 6.

B. RCW 34.05.328(1)(b) –

1. Determine that the rule is needed to achieve the general goals and specific objectives of the statute.

See Chapters 1 and 2.

2. Analyze alternatives to rulemaking and the consequences of not adopting this rule.

In 2020, the legislature updated the state's greenhouse gas emissions limits that Washington must achieve by 2030, 2040, and 2050, based on current science and emissions trends, to support local and global efforts to avoid the most significant impacts from climate change. The Climate Commitment Act statute establishes a new Cap and Invest Program to help Washington achieve the GHG emissions reductions needed to meet these limits, and directs Ecology to adopt rules to implement the provisions of the program (RCW 70A.65.220.) Ecology is further directed to start the program by January 1, 2023, and adopt annual allowance budgets for the first compliance period of the program by October 1, 2022 (RCW 70.65.070(1)(a)). Ecology would be in violation of the Climate Commitment Act statute if we did not pursue rulemaking on this topic. Without this rulemaking Ecology would be unable to meet its obligations under the Climate Commitment Act to implement a cap on greenhouse gas emissions from covered entities and a program to track, verify, and enforce compliance through the use of compliance instruments. Please see the Least Burdensome Alternative Analysis, Chapter 6 of this document, for discussion of alternative rule content considered.

C. RCW 34.05.328(1)(c) - A preliminary cost-benefit analysis was made available.

When filing the rule proposal (CR-102) under RCW 34.05.320, Ecology provided notice that a preliminary cost-benefit analysis was available. At adoption (CR-103 filing) under RCW 34.05.360, Ecology is providing notice of the availability of the final cost-benefit analysis.

D. RCW 34.05.328(1)(d) – Determine that probable benefits of this rule are greater than its probable costs, taking into account both the qualitative and quantitative benefits and costs and the specific directives of the statute being implemented.

See Chapters 1 – 5.

E. RCW 34.05.328 (1)(e) - Determine, after considering alternative versions of the analysis required under RCW 34.05.328 (b), (c) and (d) that the rule being adopted is the least

burdensome alternative for those required to comply with it that will achieve the general goals and specific objectives stated in Chapter 6.

Please see Chapter 6.

F. RCW 34.05.328(1)(f) - Determine that the rule does not require those to whom it applies to take an action that violates requirements of another federal or state law.

This adopted rule would not require covered parties to violate existing federal and state laws and rules. The requirements of this rule do not conflict with EPA reporting requirements for greenhouse gases and do not alter reporting requirements in other states.

G. RCW 34.05.328 (1)(g) - Determine that the rule does not impose more stringent performance requirements on private entities than on public entities unless required to do so by federal or state law.

The compliance obligations in this adopted rule apply to both private and public entities. WAC 173-446-230 establishes methods for allocation of no cost allowances to electric utilities. Investor-owned utilities and consumer-owned utilities have different requirements due to their inherently different organizational structure, but those differences do not impose any more stringent requirements on either type of utility.

RCW 70A.65.080(7) exempts emissions from certain activities from the program, including those from national security facilities, which are more likely to be public entities.

H. RCW 34.05.328 (1)(h) Determine if the rule differs from any federal regulation or statute applicable to the same activity or subject matter.

- ☒ No. There is no federal regulation or federal statute applicable to the same activity or subject matter.
- If **yes**, the difference is justified because of the following:

  ☐ (i) A state statute explicitly allows Ecology to differ from federal standards.

  ☐ (ii) Substantial evidence that the difference is necessary to achieve the general goals and specific objectives stated in Chapter 6.

I. RCW 34.05.328 (1)(i) – Coordinate the rule, to the maximum extent practicable, with other federal, state, and local laws applicable to the same subject matter.

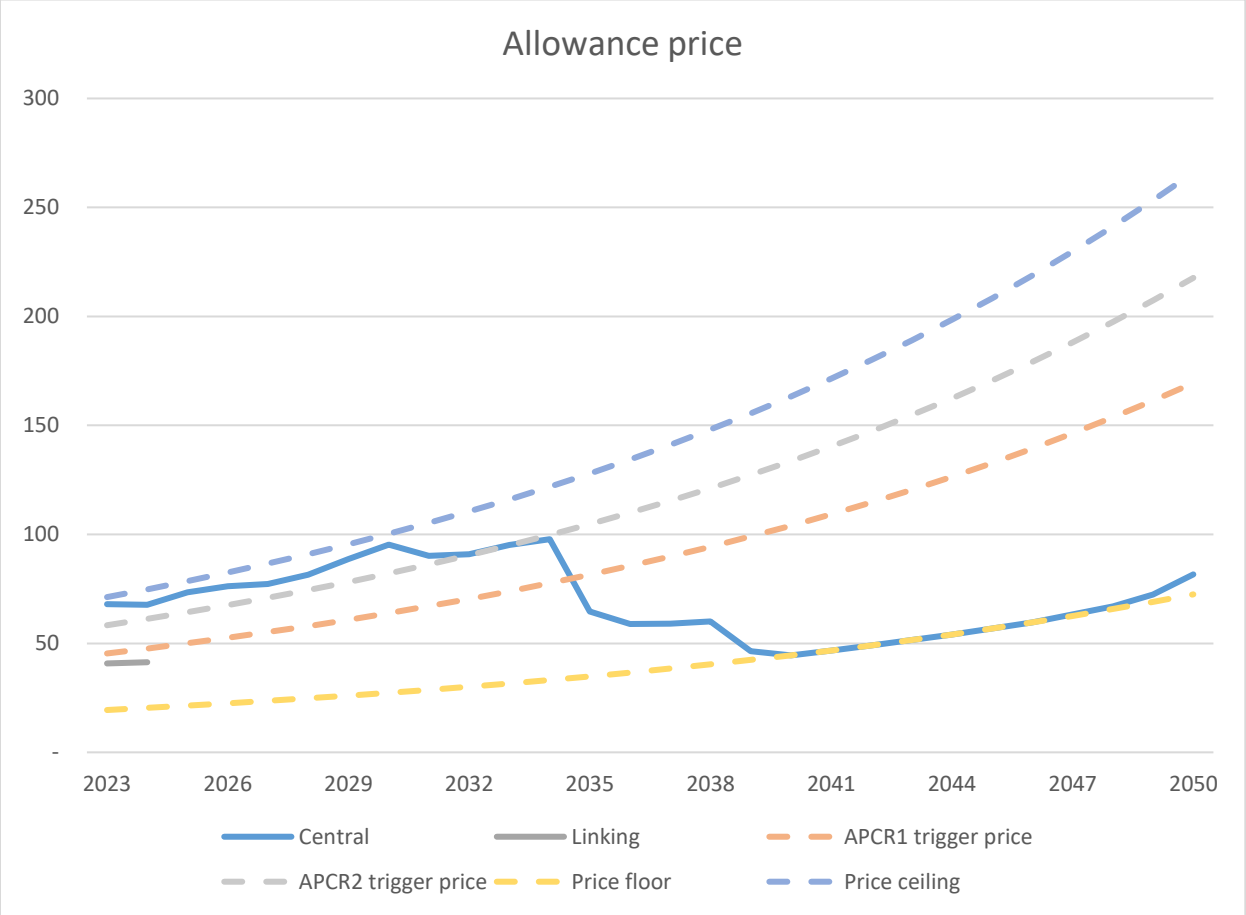
We are coordinating to the maximum extent practicable with rulemaking on the GHG Reporting Program (WAC 173-441) and on the Criteria for Emissions-Intensive, Trade-Exposed Industries (WAC 173-446A). There are overlaps in the stakeholders and Ecology staff working on these rules, which facilitates coordination. We are also coordinating this rulemaking with the requirements of RCW 19.405, the Clean Energy Transformation Act. Ecology is also working to make the rule consistent where possible with similar state law in California to facilitate potential program linkage, per RCW 70A.65.060(3).

Appendix B: Impacts of Expected Linkage

Based on an alternative scenario modeled by Vivid Economics[110], we examined the potential impact of linkage expectations on the Washington Cap and Invest Program allowance market. In this scenario, market participants would behave as though they had complete certainty that Washington would link with the California allowance market in 2025, and other attributes of the rule and central assumptions were included.

The main result of this model is a significant drop in initial Washington allowance prices, from $58.31 to $40.74 – a drop of 30 percent, or $17.57 per allowance (compared to our primary analysis). Low prices would persist in 2024, with an allowance price of $41.28 (32.6 percent lower than in our primary scenario). Overall compliance costs in these years would fall by similar percentages.

Figure 9: Allowance prices under the central and expected linkage scenarios



[110] Vivid Economics, 2022. Washington State Climate Commitment Act, Summary of market modeling and analysis of the proposed Cap and Invest Program. September 2022.

Prices were not modeled beyond 2024 for this analysis, as this model does not include full attributes of the California allowance market. Due to the relative size of the two markets, however, allowance prices are expected to track California prices in 2025 and beyond.

Appendix C: Impacts of Complementary Policies

We examined the impacts of including complementary policies on allowance price trajectories. Vivid Economics[111] modeled the allowance market for an alternative scenario that accounted for the:

- Clean Fuels Program rule (implementing a clean fuel standard), Chapter 173-455 WAC.
- Clean Vehicles Program rule (implementing zero emission vehicle requirements), Chapter 173-423 WAC.

This model did not make any additional assumptions about the Criteria for Emissions-Intensive, Trade-Exposed Industries rule (Chapter 173-446A WAC) since it does not impact the allowance market.

Finally, this model differs from our primary analysis in its exclusion of frontloading APCR allowances through 2030. Despite this difference from the rule, this alternative scenario illustrates the overall slight downward pressure on prices through resulting from the complementary policies. This impact is likely based in the Clean Vehicles Program requirement that 100 percent of passenger and light-duty vehicles sold be zero emissions vehicles starting in 2035.

[111] Vivid Economics, 2022. Washington State Climate Commitment Act, Summary of market modeling and analysis of the proposed Cap and Invest Program. September 2022.

Figure 10: Relative impact of complementary policies

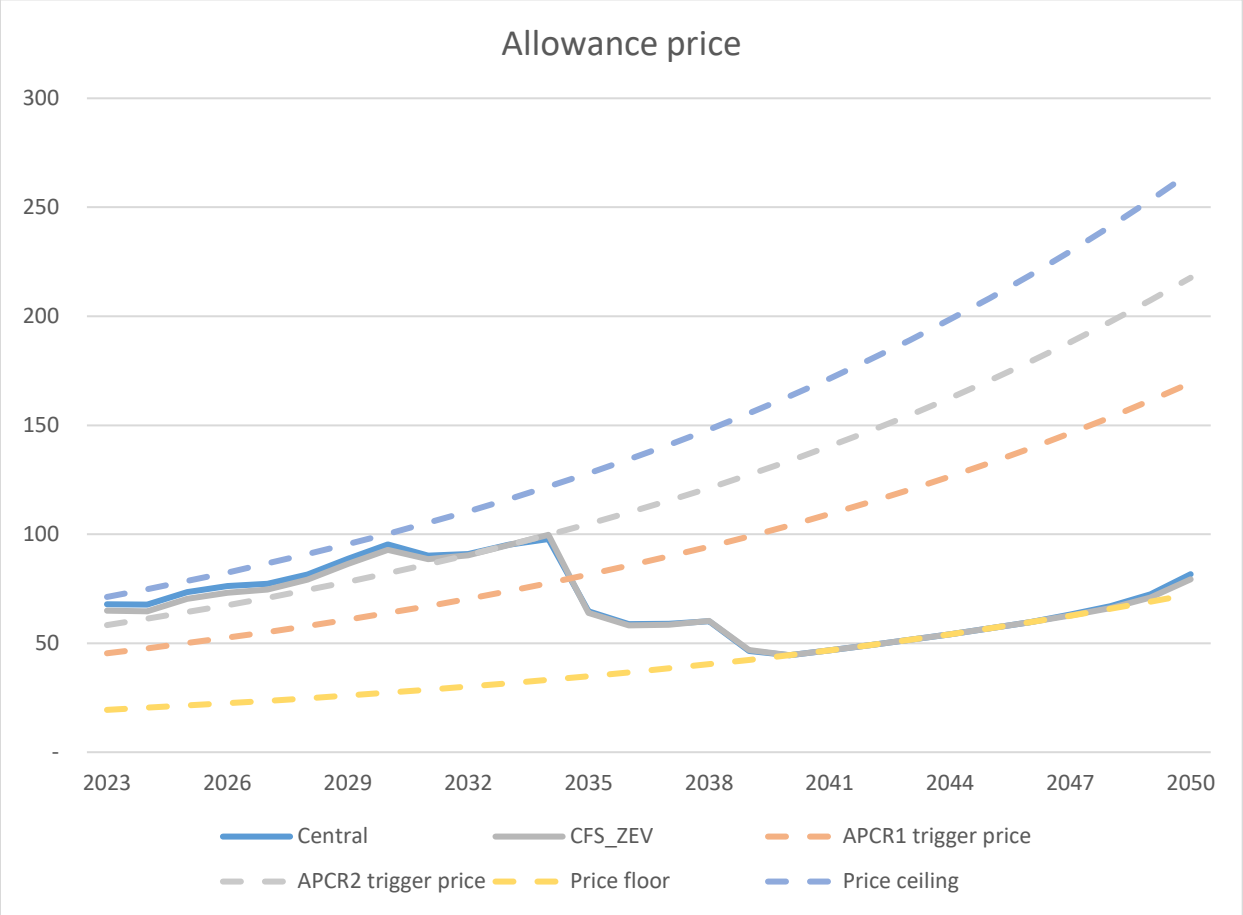


Table 47: Reduction in allowance prices due to complementary policies

Year	Difference in Allowance Price
2023	-$2.93
2024	-$3.00
2025	-$3.09
2026	-$3.00
2027	-$2.59
2028	-$2.32
2029	-$2.36
2030	-$2.49
2031	-$1.63
2032	-$0.55
2033	-$0.23
2034	$1.94
2035	-$0.62
2036	-$0.70
2037	-$0.53
2038	$0.20

Year	Difference in Allowance Price
2039	$0.38
2040	-
2041	-
2042	-
2043	-
2044	-
2045	-
2046	-
2047	-$0.51
2048	-$0.94
2049	-$1.44
2050	-$2.27

Appendix D: Sensitivity Analysis of Linkage Expectations

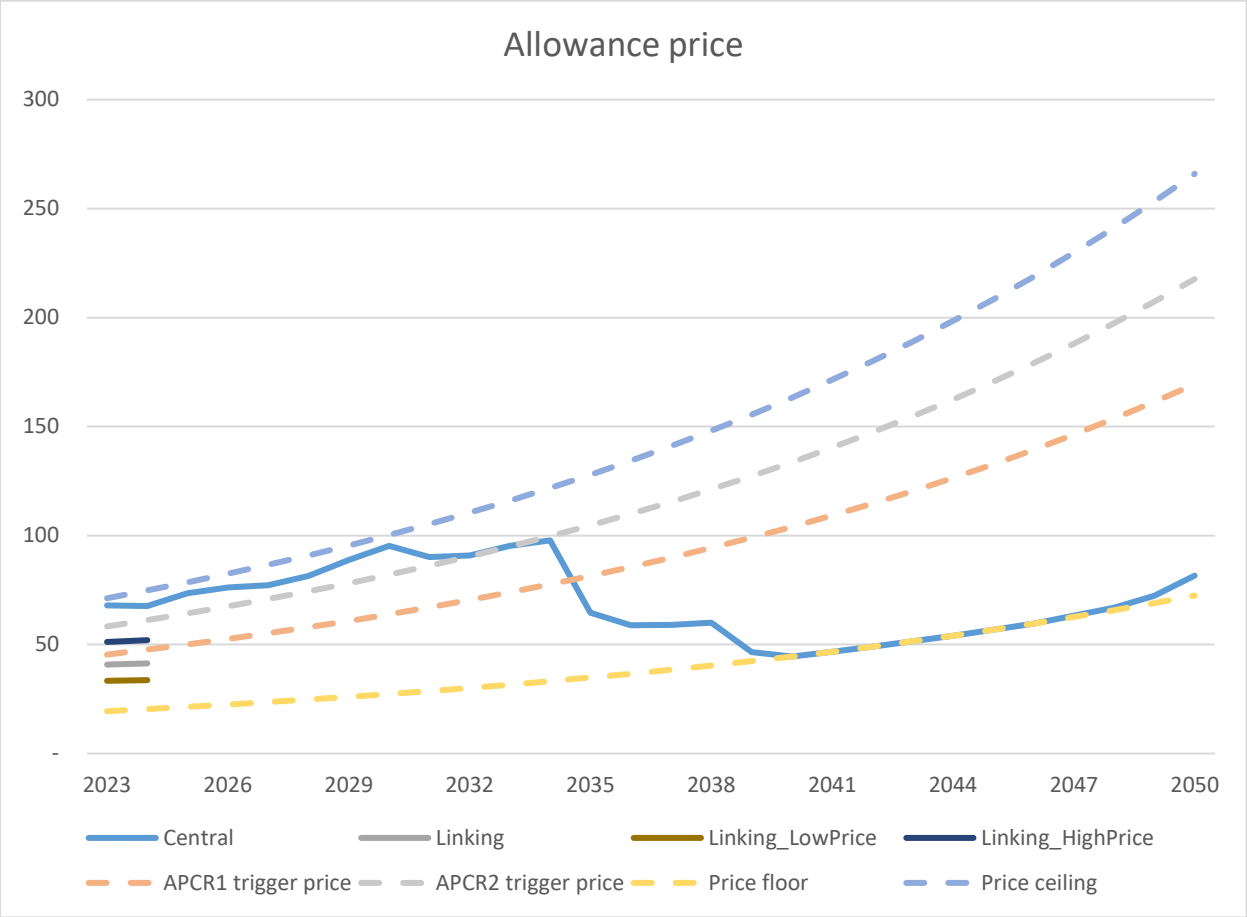
In our primary analysis, we did not include any expectation of linkage with GHG emissions allowance programs in other states. In Appendix B, we considered the impacts of market participants expecting market linkage in 2025. We also examined the impacts of later expected linkage years, based on scenarios developed by Vivid Economics[112] reflecting:

- Expected linkage in 2025 with lower California prices.
- Expected linkage in 2025 with higher California prices.
- Expected linkage in 2027.
- Expected linkage in 2030.

While the central scenario modeled for these comparisons differs from our primary analysis in that it does not include frontloading of APCR allowances through 2030, the general differences are informative to our analysis in their consistent illustration that linkage expectations reduce allowance prices, and the expected linked price levels and timing of linkage affect the magnitude of the allowance price decrease.

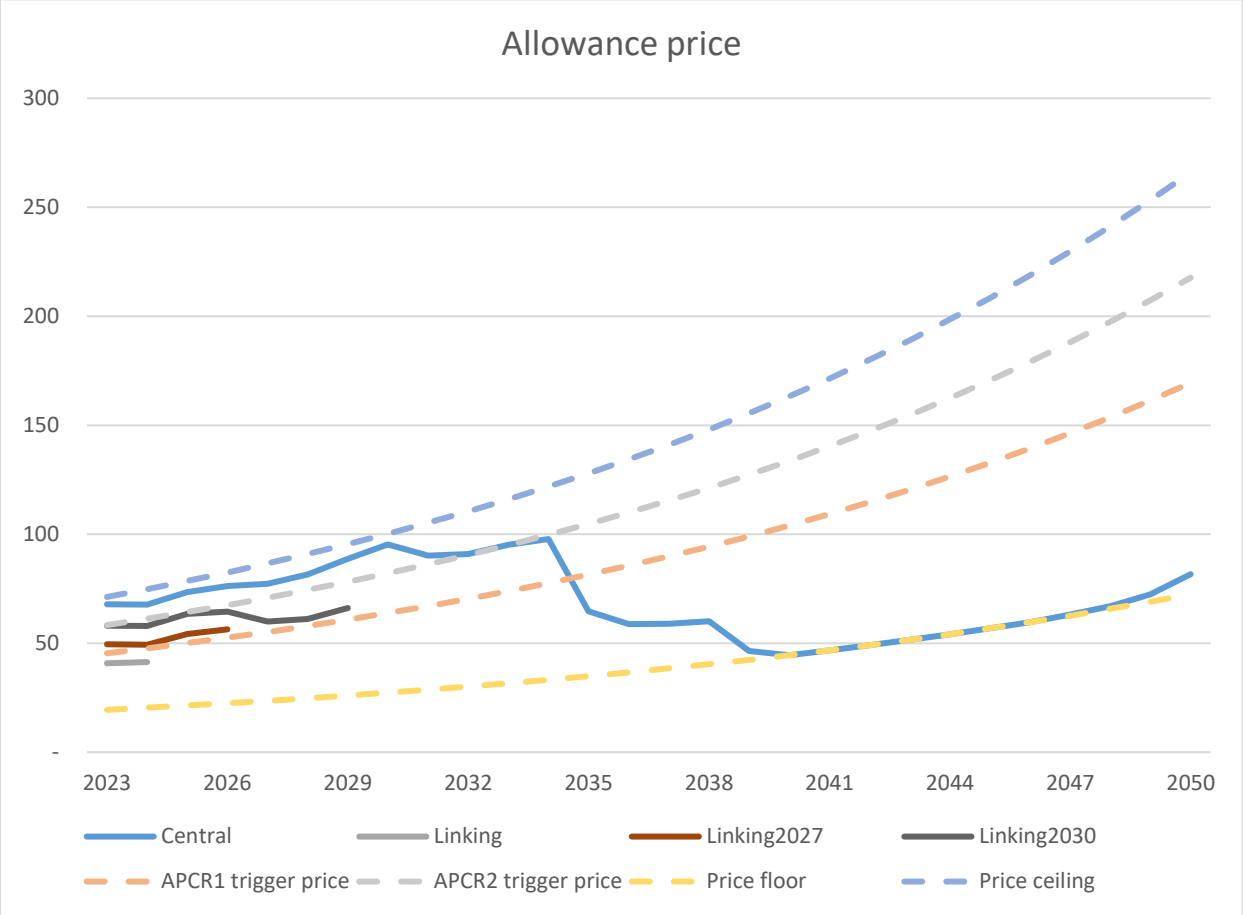
[112] Vivid Economics, 2022. Washington State Climate Commitment Act, Summary of market modeling and analysis of the proposed Cap and Invest Program. September 2022.

Figure 11: Allowance price differences at three levels of expected linkage prices



Higher expected prices following linkage would still reduce prices relative to the central scenario (our primary scenario without frontloading), but not by as much as expectations of average or lower prices. Similarly, lower expected prices would reduce allowance prices in the Washington market by more than the average expectation.

Figure 12: Allowance price differences at three different expected linkage years



The expected timing of linkage would also affect the degree of downward pressure on prices in the Washington allowance market. The sooner Washington is expected to link, the stronger the downward pressure on allowance prices.

Appendix E: Sensitivity Analysis of Market Behaviors

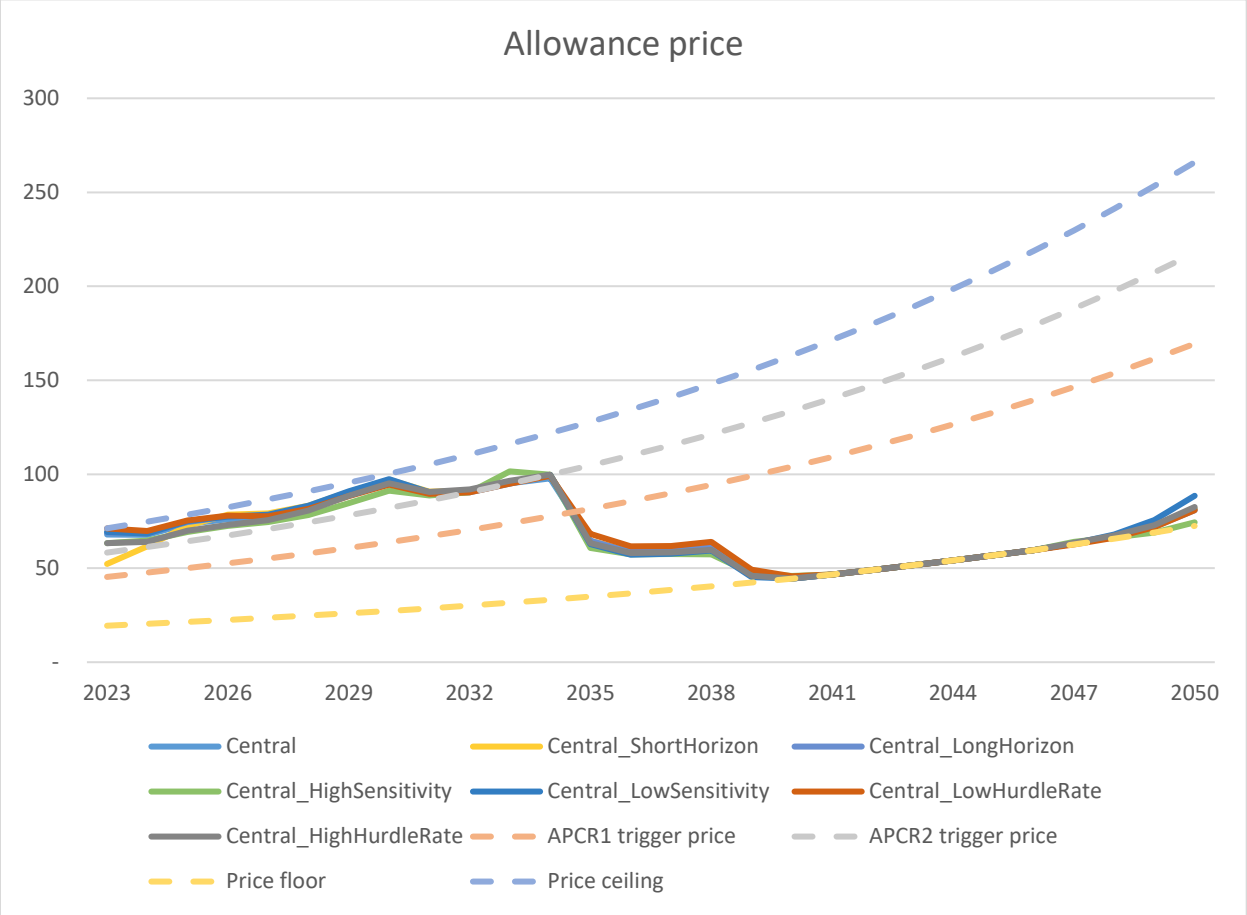
Based on a set of alternative scenarios modeled by Vivid Economics[113], we examined the potential impact of varying assumptions about the behavior of allowance market participants. These scenarios include:

- Limited foresight in the first compliance period. This reflects a period of adaptation and learning in early years of the program.
- Longer foresight across the model.
- High sensitivity to allowance prices among financial participants.
- Lower sensitivity to allowance prices among financial participants.
- A lower hurdle rate (minimum acceptable rate of return) for financial participants.
- A higher hurdle rate for financial participants.

In all sensitivity scenarios, inclusion of amenity value mitigates negative impacts.

[113] Vivid Economics, 2022. Washington State Climate Commitment Act, Summary of market modeling and analysis of the proposed Cap and Invest Program. September 2022.

Figure 13: Allowance prices under behavioral sensitivity scenarios



Qualitatively, the graph above shows that there are minor differences across different behavioral scenarios, which generally track one another. Differences of note are consistent with expectations, and include:

- Lower prices in the first compliance period if market participants have limited foresight in the first compliance period.
- Smoother price trajectories with a lower hurdle rate or lower sensitivity to prices.
- More variable price trajectories with a higher hurdle rate or higher sensitivity to prices.

Using the same methodology as in our primary analysis, we estimated the following for the sensitivity scenarios above. Recall that these scenarios do not include frontloading of APCR allowances through 2030, and so do not reflect the additional price smoothing and downward pressure on prices in early years that results from frontloading.

The impacts presented below further inform likely ranges of impacts around the results of our primary analysis.

- Present value costs and benefits each reflect a range of approximately $1.5 billion through 2050, and a range of up to approximately $200 million around present value net benefits.

- Statewide employment impacts, output impacts, and price impacts are generally similar.

Table 48: Present value costs and benefits through 2050, billions of $

Sensitivity	Costs	Benefits	Net Benefit
Short Horizon	$33.41	$39.56	$6.15
Long Horizon	$34.08	$40.25	$6.16
High Sensitivity	$32.74	$39.06	$6.33
Low Sensitivity	$34.32	$40.49	$6.17
Low Hurdle Rate	$34.21	$40.23	$6.02
High Hurdle Rate	$33.45	$39.69	$6.23

Table 49: Employment impacts, no amenity value, thousands of FTE

Sensitivity	2030	2040	2050
Short Horizon	2.60	-2.43	-1.22
Long Horizon	2.20	-2.42	-1.26
High Sensitivity	2.08	-2.04	-1.32
Low Sensitivity	2.42	-2.74	-1.11
Low Hurdle Rate	1.99	-2.32	-1.28
High Hurdle Rate	2.57	-2.30	-1.15

Table 50: Employment impacts, SCC amenity value, thousands of FTE

Sensitivity	2030	2040	2050
Short Horizon	3.95	0.49	1.98
Long Horizon	3.55	0.51	1.94
High Sensitivity	3.36	0.83	1.87
Low Sensitivity	3.79	0.21	2.10
Low Hurdle Rate	3.33	0.58	1.87
High Hurdle Rate	3.89	0.61	2.05

Table 51: Output impacts, no amenity value, billions of $

Sensitivity	2030	2040	2050
Short Horizon	-$1.09	-$1.73	-$0.86
Long Horizon	-$1.18	-$1.73	-$0.87
High Sensitivity	-$1.10	-$1.63	-$0.88
Low Sensitivity	-$1.17	-$1.77	-$0.85
Low Hurdle Rate	-$1.22	-$1.73	-$0.88
High Hurdle Rate	-$1.08	-$1.71	-$0.84

Table 52: Output impacts, SCC amenity value, billions of $

Sensitivity	2030	2040	2050
Short Horizon	-$0.84	-$1.11	-$0.11
Long Horizon	-$0.93	-$1.12	-$0.12
High Sensitivity	-$0.86	-$1.03	-$0.13
Low Sensitivity	-$0.91	-$1.15	-$0.09
Low Hurdle Rate	-$0.97	-$1.12	-$0.14
High Hurdle Rate	-$0.83	-$1.09	-$0.09

Table 53: Motor vehicle fuel price impacts, no amenity value, percent

Sensitivity	2030	2040	2050
Short Horizon	1.02%	0.33%	0.18%
Long Horizon	1.00%	0.34%	0.18%
High Sensitivity	0.93%	0.35%	0.16%
Low Sensitivity	1.03%	0.31%	0.19%
Low Hurdle Rate	0.98%	0.35%	0.17%
High Hurdle Rate	1.00%	0.34%	0.18%

Table 54: Motor vehicle fuel price impacts, SCC amenity value, percent

Sensitivity	2030	2040	2050
Short Horizon	1.01%	0.33%	0.17%
Long Horizon	1.00%	0.33%	0.17%
High Sensitivity	0.93%	0.35%	0.16%
Low Sensitivity	1.03%	0.31%	0.19%
Low Hurdle Rate	0.98%	0.35%	0.17%
High Hurdle Rate	1.00%	0.34%	0.18%

Table 55: Electricity price impacts, no amenity value, percent

Sensitivity	2030	2040	2050
Short Horizon	1.49%	0.55%	0.33%
Long Horizon	1.47%	0.55%	0.33%
High Sensitivity	1.37%	0.57%	0.31%
Low Sensitivity	1.51%	0.51%	0.36%
Low Hurdle Rate	1.45%	0.57%	0.32%
High Hurdle Rate	1.47%	0.56%	0.33%

Table 56: Electricity price impacts, SCC amenity value, percent

Sensitivity	2030	2040	2050
Short Horizon	1.49%	0.55%	0.33%
Long Horizon	1.47%	0.55%	0.33%
High Sensitivity	1.37%	0.57%	0.31%
Low Sensitivity	1.51%	0.51%	0.35%
Low Hurdle Rate	1.45%	0.57%	0.32%
High Hurdle Rate	1.47%	0.56%	0.33%

Table 57: Natural gas price impacts, no amenity value, percent

Sensitivity	2030	2040	2050
Short Horizon	-1.89%	0.15%	1.18%
Long Horizon	-1.85%	0.14%	1.18%
High Sensitivity	-1.79%	0.09%	1.11%
Low Sensitivity	-1.89%	0.29%	1.29%
Low Hurdle Rate	-1.83%	0.11%	1.15%

Sensitivity	2030	2040	2050
High Hurdle Rate	-1.92%	0.10%	1.21%

Table 58: Natural gas price impacts, SCC amenity value, percent

Sensitivity	2030	2040	2050
Short Horizon	-1.89%	0.15%	1.18%
Long Horizon	-1.85%	0.14%	1.18%
High Sensitivity	-1.79%	0.09%	1.11%
Low Sensitivity	-1.89%	0.29%	1.29%
Low Hurdle Rate	-1.83%	0.11%	1.15%
High Hurdle Rate	-1.92%	0.10%	1.21%

Appendix F: Sensitivity Analysis of Technology Assumptions

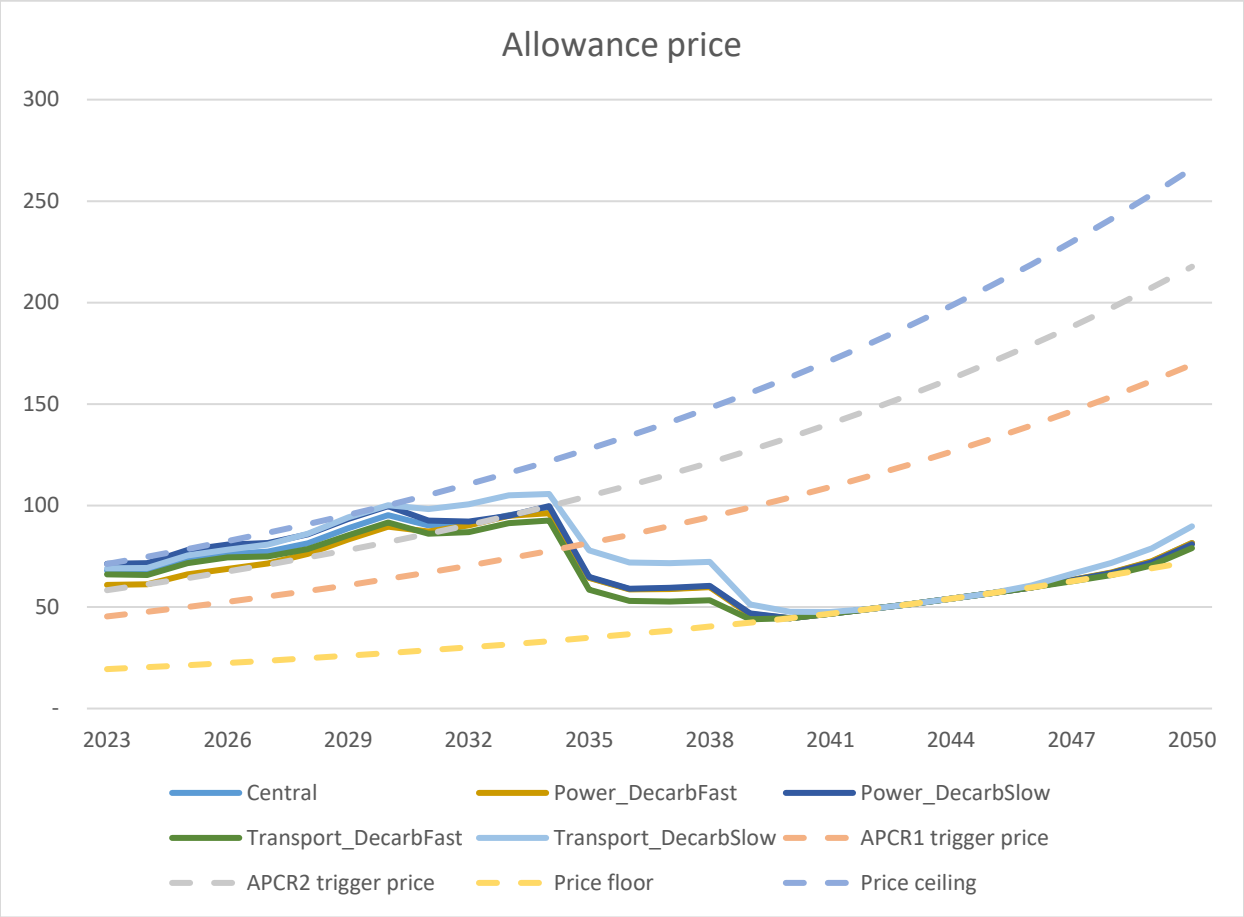
Based on a set of alternative scenarios modeled by Vivid Economics[114], we examined the potential impact of varying technology assumptions affecting decarbonization rates of the energy and transportation sectors. These scenarios include:

- 10 percent faster decarbonization in the power sector.
- 10 percent slower decarbonization in the power sector.
- Less transportation sector inertia (resistance to change) leading to faster decarbonization.
- More transportation sector inertia leading to slower decarbonization.

In all sensitivity scenarios, inclusion of amenity value mitigates negative impacts.

[114] Vivid Economics, 2022. Washington State Climate Commitment Act, Summary of market modeling and analysis of the proposed Cap and Invest Program. September 2022.

Figure 14: Allowance prices under technology sensitivity scenarios



Qualitatively, the graph above shows that there are potentially significant differences across different technology scenarios, although their price trajectories generally track one another. Differences of note are consistent with expectations, and include:

- Faster decarbonization in the power or transportation sector puts downward pressure on allowance prices. Faster decarbonization in the power sector reduces prices more than faster decarbonization in the transportation sector through 2031, after which faster transportation decarbonization reduces prices more until the 2040s.
- Slower decarbonization in the power or transportation sector puts upward pressure on allowance prices, more so for the power sector through 2028. After 2028, slower decarbonization in the transportation sector puts significant upward pressure on prices relative to other scenarios until the 2040s.

Using the same methodology as in our primary analysis, we estimated the following for the sensitivity scenarios above. Recall that these scenarios do not include frontloading of APCR allowances through 2030, and so do not reflect the additional price smoothing and downward pressure on prices in early years that results from frontloading.

The impacts presented below further inform likely ranges of impacts around the results of our primary analysis.

- Present value costs reflect a range of between $2 billion and $5 billion through 2050 across paired sensitivities.
- Present value benefits reflect a range of between $2 billion and $4 billion through 2050 across paired sensitivities.
- Net present value benefits reflect a range of approximately $0.5 billion around our primary estimates across paired sensitivities.
- Statewide employment impacts reflect up to 500 fewer FTEs across paired sensitivities.
- Statewide output and price impacts are generally similar to our primary estimates.

Table 59: Present value costs and benefits through 2050, billions of $

Sensitivity	Costs	Benefits	Net Benefit
Power decarbonizes faster	$32.05	$38.36	$6.31
Power decarbonizes slower	$35.11	$41.23	$6.12
Transportation decarbonizes faster	$31.16	$37.26	$6.10
Transportation decarbonizes slower	$38.04	$43.89	$5.85

Table 60: Employment impacts, no amenity value, thousands of FTE

Sensitivity	2030	2040	2050
Power decarbonizes faster	2.22	-2.30	-1.18
Power decarbonizes slower	2.33	-2.56	-1.29
Transportation decarbonizes faster	1.90	-2.40	-1.12
Transportation decarbonizes slower	2.71	-2.97	-1.26

Table 61: Employment impacts, SCC amenity value, thousands of FTE

Sensitivity	2030	2040	2050
Power decarbonizes faster	3.46	0.51	1.95
Power decarbonizes slower	3.76	0.46	1.97
Transportation decarbonizes faster	3.18	0.27	1.82
Transportation decarbonizes slower	4.13	0.19	2.34

Table 62: Output impacts, no amenity value, billions of $

Sensitivity	2030	2040	2050
Power decarbonizes faster	-$1.05	-$1.66	-$0.85
Power decarbonizes slower	-$1.22	-$1.78	-$0.89
Transportation decarbonizes faster	-$1.15	-$1.56	-$0.78
Transportation decarbonizes slower	-$1.17	-$2.05	-$0.99

Table 63: Output impacts, SCC amenity value, billions of $

Sensitivity	2030	2040	2050
Power decarbonizes faster	-$0.82	-$1.07	-$0.11

Sensitivity	2030	2040	2050
Power decarbonizes slower	-$0.95	-$1.14	-$0.12
Transportation decarbonizes faster	-$0.91	-$0.99	-$0.09
Transportation decarbonizes slower	-$0.90	-$1.38	-$0.15

Table 64: Motor vehicle fuel price impacts, no amenity value, percent

Sensitivity	2030	2040	2050
Power decarbonizes faster	0.92%	0.33%	0.18%
Power decarbonizes slower	1.05%	0.33%	0.18%
Transportation decarbonizes faster	0.93%	0.28%	0.16%
Transportation decarbonizes slower	1.08%	0.38%	0.23%

Table 65: Motor vehicle fuel price impacts, SCC amenity value, percent

Sensitivity	2030	2040	2050
Power decarbonizes faster	0.92%	0.32%	0.17%
Power decarbonizes slower	1.05%	0.33%	0.17%
Transportation decarbonizes faster	0.93%	0.27%	0.16%
Transportation decarbonizes slower	1.08%	0.38%	0.23%

Table 66: Electricity price impacts, no amenity value, percent

Sensitivity	2030	2040	2050
Power decarbonizes faster	1.36%	0.53%	0.32%
Power decarbonizes slower	1.55%	0.55%	0.33%
Transportation decarbonizes faster	1.37%	0.46%	0.30%
Transportation decarbonizes slower	1.59%	0.63%	0.42%

Table 67: Electricity price impacts, SCC amenity value, percent

Sensitivity	2030	2040	2050
Power decarbonizes faster	1.36%	0.53%	0.32%
Power decarbonizes slower	1.55%	0.55%	0.33%
Transportation decarbonizes faster	1.37%	0.46%	0.30%
Transportation decarbonizes slower	1.59%	0.63%	0.42%

Table 68: Natural gas price impacts, no amenity value, percent

Sensitivity	2030	2040	2050
Power decarbonizes faster	-1.90%	0.16%	1.18%
Power decarbonizes slower	-1.76%	0.19%	1.19%
Transportation decarbonizes faster	-1.77%	0.29%	1.07%
Transportation decarbonizes slower	-1.94%	0.20%	1.55%

Table 69: Natural gas price impacts, SCC amenity value, percent

Sensitivity	2030	2040	2050
Power decarbonizes faster	-1.90%	0.15%	1.18%

Sensitivity	2030	2040	2050
Power decarbonizes slower	-1.76%	0.19%	1.19%
Transportation decarbonizes faster	-1.77%	0.29%	1.07%
Transportation decarbonizes slower	-1.94%	0.20%	1.55%

Appendix G: Sensitivity Analysis of REMI Assumptions

In our primary analysis, we made a set of assumptions about inputs for the REMI model (see Chapter 7). The present value costs and benefits of the rule are the same regardless of REMI input assumptions, as the different assumptions only affect REMI results. For reference, tables below present the results of our primary REMI analysis.

Table 70: Primary REMI Model Results, No Amenity Value

Impact	2030	2040	2050
Employment impacts (thousands of FTE)	2.67	-2.47	-1.17
Output impacts (billions of $)	-$0.99	-$1.73	-$0.84
Motor vehicle fuel price (percent)	0.99%	0.33%	0.18%
Electricity price (percent)	1.45%	0.54%	0.33%
Natural gas price (percent)	-1.56%	0.18%	1.18%

Table 71: Primary REMI Model Results, SCC Amenity Value

Impact	2030	2040	2050
Employment impacts (thousands of FTE)	4.00	0.46	2.03
Output impacts (billions of $)	-$0.75	-$1.11	-$0.09
Motor vehicle fuel price (percent)	0.99%	0.32%	0.17%
Electricity price (percent)	1.45%	0.54%	0.32%
Natural gas price (percent)	-1.56%	0.18%	1.18%

We also examined alternative sets of assumptions about how costs are incurred or funds are spent, for our primary analysis reflecting the rule:

- Alternative 1, with assumptions consistent with our primary analysis except:
    - Costs to wholesale transportation fuel suppliers are incurred by the petroleum industry instead of the wholesale industry group.
    - Market revenues to the State are spent in line with general state government spending instead of a focus on transportation. Note that this assumption includes the sub-variable of whether spending on state government services increases amenity value.
    - Natural gas revenues are treated as a negative production cost rather than directly affecting natural gas prices.
- Alternative 2, with assumptions consistent with our primary analysis except:
    - Costs to wholesale transportation fuel suppliers are incurred by the petroleum industry instead of the wholesale industry group.
    - Natural gas revenues are treated as a negative production cost rather than directly affecting natural gas prices.
- Alternative 3, with assumptions consistent with our primary analysis except:

- Costs to wholesale transportation fuel suppliers are incurred by the petroleum industry instead of the wholesale industry group.

Employment impacts

Table 72: Employment impacts, no amenity value, thousands of FTE

Sensitivity	2030	2040	2050
REMI alternative 1	27.09	4.18	0.75
REMI alternative 2	9.33	-0.50	0.15
REMI alternative 3	10.71	-0.57	-0.16

Table 73: Employment impacts, government services amenity value, thousands of FTE

Sensitivity	2030	2040	2050
REMI alternative 1	30.69	7.41	2.56
REMI alternative 2	9.33	-0.50	0.15
REMI alternative 3	10.71	-0.57	-0.16

Table 74: Employment impacts, services and SCC amenity value, thousands of FTE

Sensitivity	2030	2040	2050
REMI alternative 1	32.06	10.34	5.78
REMI alternative 2	10.62	2.43	3.34
REMI alternative 3	12.01	2.36	3.01

Output impacts

Table 75: Output impacts, no amenity value, billions of $

Sensitivity	2030	2040	2050
REMI alternative 1	$1.49	-$1.88	-$1.14
REMI alternative 2	-$1.56	-$2.77	-$1.26
REMI alternative 3	-$1.29	-$2.71	-$1.26

Table 76: Output impacts, government services amenity value, billions of $

Sensitivity	2030	2040	2050
REMI alternative 1	$2.17	-$1.21	-$0.74
REMI alternative 2	-$1.56	-$2.77	-$1.26
REMI alternative 3	-$1.29	-$2.71	-$1.26

Table 77: Output impacts, services and SCC amenity value, billions of $

Sensitivity	2030	2040	2050
REMI alternative 1	$2.42	-$0.60	$0.02
REMI alternative 2	-$1.31	-$2.15	-$0.51
REMI alternative 3	-$1.04	-$2.09	-$0.52

Price impacts

Table 78: Motor vehicle fuel price impacts, no amenity value, percent

Sensitivity	2030	2040	2050
REMI alternative 1	3.15%	1.15%	0.67%
REMI alternative 2	3.12%	1.15%	0.67%
REMI alternative 3	3.13%	1.15%	0.67%

Table 79: Motor vehicle fuel price impacts, government services amenity value, percent

Sensitivity	2030	2040	2050
REMI alternative 1	3.15%	1.15%	0.67%
REMI alternative 2	3.12%	1.15%	0.67%
REMI alternative 3	3.13%	1.15%	0.67%

Table 80: Motor vehicle fuel price impacts, services and SCC amenity value, percent

Sensitivity	2030	2040	2050
REMI alternative 1	3.15%	1.14%	0.66%
REMI alternative 2	3.12%	1.14%	0.66%
REMI alternative 3	3.13%	1.14%	0.66%

Table 81: Electricity price impacts, no amenity value, percent

Sensitivity	2030	2040	2050
REMI alternative 1	1.52%	0.56%	0.34%
REMI alternative 2	1.49%	0.55%	0.34%
REMI alternative 3	1.49%	0.55%	0.34%

Table 82: Electricity price impacts, government services amenity value, percent

Sensitivity	2030	2040	2050
REMI alternative 1	1.52%	0.56%	0.34%
REMI alternative 2	1.49%	0.55%	0.34%
REMI alternative 3	1.49%	0.55%	0.34%

Table 83: Electricity price impacts, services and SCC amenity value, percent

Sensitivity	2030	2040	2050
REMI alternative 1	1.52%	0.56%	0.34%
REMI alternative 2	1.49%	0.55%	0.34%
REMI alternative 3	1.49%	0.55%	0.34%

Table 84: Natural gas price impacts, no amenity value, percent

Sensitivity	2030	2040	2050
REMI alternative 1	0.95%	0.65%	1.13%
REMI alternative 2	0.88%	0.64%	1.13%
REMI alternative 3	-1.56%	0.17%	1.18%

Table 85: Natural gas price impacts, government services amenity value, percent

Sensitivity	2030	2040	2050
REMI alternative 1	0.95%	0.65%	1.13%
REMI alternative 2	0.88%	0.64%	1.13%
REMI alternative 3	-1.56%	0.17%	1.18%

Table 86: Natural gas price impacts, services and SCC amenity value, percent

Sensitivity	2030	2040	2050
REMI alternative 1	0.95%	0.65%	1.13%
REMI alternative 2	0.88%	0.64%	1.13%
REMI alternative 3	-1.56%	0.17%	1.18%

Discussion

All three alternative REMI model input specifications result in significantly higher employment levels than in our primary scenario. This is largely a result of lower labor intensity in the petroleum sector than the wholesale sector, as well as higher labor intensity of government services, and the ability of the natural gas sector to distribute negative production costs across price, employment, and other internal business decisions.

Alternative REMI specifications 1 and 3 reduce negative output impacts, compared to our primary scenario. This is a result of lower demand elasticity (relative responsiveness of demand to price changes) in the petroleum sector than in the wholesale sector as a whole, allowing petroleum producers to pass more costs through to their direct consumers while maintaining output levels. The wholesale industry has generally higher demand elasticity. In alternative specification 1, this effect is bolstered by increased output across multiple sectors resulting from general state government spending patterns. Alternative REMI specification 2 has a difference similar to alternative specification 1 underlying the results, but lacks the output bolstering effect of state spending, while less natural gas price mitigation puts downward pressure on output across industries.

Similarly, all three alternative specifications result in higher increases in motor vehicle fuel prices, due to the lower demand elasticity faced by the petroleum sector compared to the wholesale sector. Less direct mitigation of natural gas price impact results in less decrease in price levels, bolstered in alternative specification 1 by broader government spending increasing economic activity and associated demand for fuels. In alternative specification 3, natural gas price increases are directly mitigated by allowance market revenues, but higher motor vehicle fuel prices result in substitution to natural gas and electricity. Electricity price impacts are similar across our primary scenario and alternative REMI specifications, with slight upward pressure exerted by substitution from motor vehicle fuels, and downward pressure exerted by substitution to natural gas.

Appendix H: Full Allowance Market Model Data Tables

Modeling performed by Vivid Economics[115] provided the following allowance price trajectories by scenario. These were the basis of our primary analysis and sensitivity analyses, and informed the rule.

H.1 Primary analysis: The adopted rule (including frontloading of APCR allowances through 2030)

Table 87: Primary analysis prices by year

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2023	58.31	45.37	58.31	19.41	71.23
2024	61.21	47.65	61.21	20.39	74.79
2025	64.76	50.03	64.28	21.40	78.54
2026	69.96	52.53	67.49	22.47	82.46
2027	76.91	55.15	70.87	23.60	86.59
2028	84.01	57.91	74.41	24.77	90.92
2029	92.76	60.81	78.13	26.02	95.46
2030	100.23	63.85	82.04	27.32	100.23
2031	92.57	67.04	86.15	28.69	105.24
2032	92.63	70.40	90.45	30.11	110.50
2033	96.74	73.91	94.98	31.62	116.03
2034	99.73	77.61	99.73	33.20	121.83
2035	64.35	81.49	104.71	34.86	127.92
2036	58.58	85.57	109.95	36.60	134.32
2037	58.79	89.84	115.44	38.43	141.04
2038	59.72	94.33	121.21	40.35	148.08
2039	46.39	99.05	127.27	42.38	155.49
2040	44.49	104.00	133.63	44.49	163.27
2041	46.72	109.20	140.32	46.72	171.43

[115] Vivid Economics, 2022. Washington State Climate Commitment Act, Summary of market modeling and analysis of the proposed Cap and Invest Program. September 2022.

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2042	49.05	114.66	147.34	49.05	180.00
2043	51.50	120.39	154.70	51.50	189.00
2044	54.08	126.42	162.43	54.08	198.46
2045	56.78	132.74	170.56	56.78	208.37
2046	59.62	139.38	179.09	59.62	218.80
2047	63.20	146.34	188.04	62.61	229.73
2048	66.91	153.66	197.44	65.74	241.22
2049	72.30	161.35	207.31	69.03	253.28
2050	81.47	169.41	217.68	72.48	265.95

Table 88: Primary analysis volumes by year

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2023	56,944,519	12,225,474	10,972,931	8,423,494	25,322,621	27,770,514	58,354,932	58,501,299	9,299,594	1,043,573	-
2024	52,905,144	11,260,997	9,094,768	8,224,713	24,324,667	24,313,109	55,248,639	54,097,976	-	693,049	-
2025	48,306,209	10,622,797	6,959,114	7,943,011	22,781,288	20,911,727	51,877,213	49,694,652	-	7,562,971	-
2026	44,062,212	9,993,411	5,353,109	7,145,714	21,569,978	17,863,091	48,633,872	45,291,328	-	-	-
2027	41,441,506	9,331,932	5,292,773	6,541,876	20,274,925	16,472,860	47,114,812	40,888,005	-	-	-
2028	38,893,574	8,634,916	5,379,086	5,954,099	18,925,473	15,549,870	45,684,197	36,484,681	-	-	-
2029	36,491,645	7,936,620	5,569,488	5,419,721	17,565,816	14,775,690	44,333,454	32,081,358	-	-	-
2030	33,801,018	7,230,163	5,256,464	5,100,676	16,213,716	13,379,075	42,546,031	27,678,034	-	-	-
2031	31,231,324	6,592,729	4,932,744	4,760,226	14,945,625	12,301,798	40,737,212	26,482,846	714,440	714,034	-
2032	28,841,787	6,000,788	4,622,529	4,450,556	13,767,914	11,291,038	38,876,018	25,287,658	682,196	682,602	-
2033	26,668,227	5,454,999	4,307,624	4,183,143	12,722,462	10,339,180	37,125,878	24,092,471	649,953	649,831	-
2034	24,523,838	4,941,580	3,987,465	3,897,834	11,696,959	9,414,141	35,292,279	22,897,283	617,710	269,465	-
2035	22,625,592	4,494,104	3,662,372	3,676,915	10,792,201	8,571,184	33,548,365	21,702,095	-	-	-
2036	20,461,573	4,161,655	3,316,312	3,276,765	9,706,842	7,802,783	31,495,134	20,506,907	-	-	-
2037	18,366,041	3,935,011	2,969,775	2,851,889	8,609,366	7,147,518	29,391,857	19,311,719	-	-	-
2038	16,267,008	3,714,143	2,617,608	2,421,068	7,514,189	6,491,767	27,150,918	18,116,531	-	-	-
2039	14,487,824	3,551,699	2,259,910	2,161,719	6,514,496	5,901,589	24,950,546	16,921,344	-	-	-
2040	12,799,423	3,398,850	1,896,681	1,920,519	5,583,374	5,318,133	22,709,819	15,726,156	-	-	-815,017
2041	11,267,576	3,239,314	1,527,591	1,754,576	4,746,096	4,739,229	20,802,497	14,530,968	-	-	-2,617,093
2042	9,776,759	3,074,447	1,153,276	1,577,985	3,971,051	4,156,872	19,072,717	13,335,780	-	-	-2,527,650
2043	8,380,972	2,922,101	773,906	1,407,469	3,277,496	3,589,647	17,461,103	11,763,164	-	-	-4,611,811
2044	7,078,296	2,780,871	389,463	1,231,213	2,676,750	3,035,493	15,917,890	10,190,549	-	-	-3,553,613
2045	5,874,851	2,650,586	-	1,059,046	2,165,219	2,494,728	14,442,484	8,617,933	-	-	-2,352,850
2046	5,146,143	2,535,787	-	870,178	1,740,178	2,383,640	13,409,501	7,045,318	-	-	-3,028,763
2047	4,488,553	2,433,252	-	700,336	1,354,965	2,287,257	12,371,031	5,472,702	-	-	-
2048	3,923,159	2,337,644	-	560,440	1,025,075	2,197,385	11,357,658	3,900,087	-	-	-

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2049	3,461,055	2,246,945	-	436,474	777,636	2,112,128	10,470,058	2,327,471	-	-	-
2050	3,097,227	2,166,721	-	333,554	596,952	2,036,717	9,721,375	754,855	-	-	-

H.2 Primary scenario with 2025 linkage expectation

Table 89: Primary scenario with 2025 linkage prices by year

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2023	40.74	45.37	58.31	19.41	71.23
2024	41.28	47.65	61.21	20.39	74.79

Table 90: Primary scenario with 2025 linkage volumes by year

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2023	**57,508,136**	**12,370,517**	**10,972,931**	**8,532,699**	**25,631,990**	**27,986,151**	**58,354,932**	**58,501,299**	**-**	**-**	**-**
2024	**54,036,766**	**11,803,144**	**9,094,768**	**8,354,694**	**24,784,160**	**24,930,248**	**55,248,639**	**54,097,976**	**-**	**-**	**-**

H.3 Central scenario (no frontloading of APCR allowances)

Table 91: Central scenario prices by year

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2023	67.93	45.37	58.31	19.41	71.23
2024	67.68	47.65	61.21	20.39	74.79
2025	73.47	50.03	64.28	21.40	78.54
2026	76.18	52.53	67.49	22.47	82.46
2027	77.22	55.15	70.87	23.60	86.59
2028	81.47	57.91	74.41	24.77	90.92
2029	88.75	60.81	78.13	26.02	95.46

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2030	95.25	63.85	82.04	27.32	100.23
2031	90.17	67.04	86.15	28.69	105.24
2032	90.87	70.40	90.45	30.11	110.50
2033	95.21	73.91	94.98	31.62	116.03
2034	97.79	77.61	99.73	33.20	121.83
2035	64.56	81.49	104.71	34.86	127.92
2036	58.82	85.57	109.95	36.60	134.32
2037	58.96	89.84	115.44	38.43	141.04
2038	60.06	94.33	121.21	40.35	148.08
2039	46.48	99.05	127.27	42.38	155.49
2040	44.49	104.00	133.63	44.49	163.27
2041	46.72	109.20	140.32	46.72	171.43
2042	49.05	114.66	147.34	49.05	180.00
2043	51.50	120.39	154.70	51.50	189.00
2044	54.08	126.42	162.43	54.08	198.46
2045	56.78	132.74	170.56	56.78	208.37
2046	59.62	139.38	179.09	59.62	218.80
2047	63.23	146.34	188.04	62.61	229.73
2048	66.97	153.66	197.44	65.74	241.22
2049	72.39	161.35	207.31	69.03	253.28
2050	81.60	169.41	217.68	72.48	265.95

Table 92: Central scenario volumes by year

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2023	56,768,478	12,176,502	10,972,931	8,388,668	25,230,379	27,699,117	58,354,932	58,501,299	1,578,216	1,578,216	-
2024	52,737,798	11,211,105	9,094,768	8,195,928	24,235,997	24,246,651	55,248,639	54,097,976	1,459,425	1,457,955	-
2025	48,032,558	10,563,281	6,959,114	7,904,473	22,605,690	20,832,711	51,877,213	49,694,652	1,340,635	1,340,576	-
2026	43,817,922	9,930,670	5,353,109	7,100,677	21,433,466	17,780,630	48,633,872	45,291,328	1,221,844	1,222,871	-
2027	41,258,124	9,280,700	5,292,773	6,517,117	20,167,534	16,412,845	47,114,812	40,888,005	1,103,054	1,102,282	-
2028	38,812,690	8,610,423	5,379,086	5,952,727	18,870,454	15,525,534	45,684,197	36,484,681	984,264	985,538	-
2029	36,520,907	7,942,788	5,569,488	5,437,585	17,571,046	14,788,055	44,333,454	32,081,358	865,473	865,280	-
2030	33,905,743	7,261,265	5,256,464	5,134,243	16,253,771	13,418,498	42,546,031	27,678,034	746,683	746,875	-

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2031	31,365,142	6,637,375	4,932,744	4,801,945	14,993,078	12,353,931	40,737,212	26,482,846	714,440	714,101	-
2032	28,981,658	6,047,991	4,622,529	4,493,902	13,817,236	11,344,785	38,876,018	25,287,658	682,196	682,535	-
2033	26,793,635	5,500,540	4,307,624	4,225,889	12,759,583	10,390,404	37,125,878	24,092,471	649,953	649,953	-
2034	24,637,756	4,983,527	3,987,465	3,938,606	11,728,158	9,460,928	35,292,279	22,897,283	617,710	-	-
2035	22,719,745	4,530,915	3,662,372	3,712,502	10,813,957	8,611,642	33,548,365	21,702,095	-	-	-
2036	20,536,734	4,194,310	3,316,312	3,305,101	9,721,011	7,838,093	31,495,134	20,506,907	-	-	-
2037	18,422,931	3,963,592	2,969,775	2,873,270	8,616,293	7,178,011	29,391,857	19,311,719	-	-	-
2038	16,305,113	3,731,243	2,617,608	2,437,905	7,518,357	6,510,579	27,150,918	18,116,531	-	-	-
2039	14,506,034	3,551,946	2,259,910	2,176,553	6,517,625	5,903,916	24,950,546	16,921,344	-	-	-
2040	12,815,352	3,399,056	1,896,681	1,933,556	5,586,059	5,319,865	22,709,819	15,726,156	-	-	-742,930
2041	11,282,224	3,239,483	1,527,591	1,766,189	4,748,961	4,740,492	20,802,497	14,530,968	-	-	-2,590,649
2042	9,789,480	3,074,584	1,153,276	1,588,147	3,973,473	4,157,731	19,072,717	13,335,780	-	-	-2,503,670
2043	8,391,689	2,922,199	773,906	1,416,212	3,279,371	3,590,168	17,461,103	11,763,164	-	-	-4,601,305
2044	7,087,132	2,780,921	389,463	1,238,581	2,678,168	3,035,732	15,917,890	10,190,549	-	-	-3,545,962
2045	5,881,950	2,650,576	-	1,065,122	2,166,253	2,494,737	14,442,484	8,617,933	-	-	-2,342,603
2046	5,151,299	2,535,706	-	874,682	1,740,910	2,383,564	13,409,501	7,045,318	-	-	-661,545
2047	4,492,155	2,433,093	-	703,635	1,355,426	2,287,108	12,371,031	5,472,702	-	-	-
2048	3,925,541	2,337,409	-	562,815	1,025,316	2,197,164	11,357,658	3,900,087	-	-	-
2049	3,462,539	2,246,651	-	438,152	777,736	2,111,852	10,470,058	2,327,471	-	-	-
2050	3,098,033	2,166,385	-	334,675	596,974	2,036,402	9,721,375	754,855	-	-	-

H.4 Central scenario with frontloading of APCR allowances through 2026

Table 93: Central scenario with 2026 frontloading prices by year

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2023	63.12	45.37	58.31	19.41	71.23
2024	66.10	47.65	61.21	20.39	74.79
2025	73.54	50.03	64.28	21.40	78.54
2026	76.95	52.53	67.49	22.47	82.46
2027	78.08	55.15	70.87	23.60	86.59
2028	82.48	57.91	74.41	24.77	90.92
2029	89.60	60.81	78.13	26.02	95.46
2030	95.96	63.85	82.04	27.32	100.23
2031	90.11	67.04	86.15	28.69	105.24
2032	90.62	70.40	90.45	30.11	110.50

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2033	95.06	73.91	94.98	31.62	116.03
2034	99.73	77.61	99.73	33.20	121.83
2035	64.57	81.49	104.71	34.86	127.92
2036	58.82	85.57	109.95	36.60	134.32
2037	59.34	89.84	115.44	38.43	141.04
2038	61.46	94.33	121.21	40.35	148.08
2039	47.23	99.05	127.27	42.38	155.49
2040	44.49	104.00	133.63	44.49	163.27
2041	46.72	109.20	140.32	46.72	171.43
2042	49.05	114.66	147.34	49.05	180.00
2043	51.50	120.39	154.70	51.50	189.00
2044	54.08	126.42	162.43	54.08	198.46
2045	56.78	132.74	170.56	56.78	208.37
2046	59.62	139.38	179.09	59.62	218.80
2047	63.29	146.34	188.04	62.61	229.73
2048	67.11	153.66	197.44	65.74	241.22
2049	72.58	161.35	207.31	69.03	253.28
2050	81.70	169.41	217.68	72.48	265.95

Table 94: Central scenario with 2026 frontloading volumes by year

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2023	56,836,175	12,192,150	10,972,931	8,404,007	25,267,088	27,724,630	58,354,932	58,501,299	5,600,120	5,600,120	1,916.67
2024	52,781,955	11,227,208	9,094,768	8,203,283	24,256,696	24,266,988	55,248,639	54,097,976	-	-	-
2025	48,098,347	10,579,477	6,959,114	7,907,664	22,652,092	20,850,535	51,877,213	49,694,652	-	-	-
2026	43,846,259	9,944,554	5,353,109	7,099,291	21,449,304	17,793,917	48,633,872	45,291,328	-	-	-
2027	41,266,040	9,291,610	5,292,773	6,512,360	20,169,296	16,421,458	47,114,812	40,888,005	1,103,054	1,103,054	-
2028	38,808,044	8,619,589	5,379,086	5,946,092	18,863,278	15,531,825	45,684,197	36,484,681	984,264	983,398	-
2029	36,515,562	7,951,309	5,569,488	5,430,406	17,564,360	14,793,681	44,333,454	32,081,358	865,473	866,339	-
2030	33,900,756	7,270,239	5,256,464	5,126,862	16,247,191	13,424,459	42,546,031	27,678,034	746,683	746,569	-
2031	31,365,008	6,648,313	4,932,744	4,795,927	14,988,023	12,362,345	40,737,212	26,482,846	714,440	714,554	-
2032	28,987,584	6,061,532	4,622,529	4,489,123	13,814,400	11,356,048	38,876,018	25,287,658	682,196	682,196	-
2033	26,805,717	5,517,157	4,307,624	4,222,547	12,758,389	10,404,889	37,125,878	24,092,471	649,953	649,765	-
2034	24,650,267	5,002,947	3,987,465	3,934,993	11,724,862	9,477,903	35,292,279	22,897,283	617,710	62,556	-

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2035	22,746,071	4,553,516	3,662,372	3,712,358	10,817,825	8,632,333	33,548,365	21,702,095	-	-	-
2036	20,567,851	4,217,175	3,316,312	3,306,744	9,727,619	7,859,298	31,495,134	20,506,907	-	-	-
2037	18,455,508	3,987,778	2,969,775	2,875,314	8,622,640	7,200,614	29,391,857	19,311,719	-	-	-
2038	16,338,721	3,758,246	2,617,608	2,438,691	7,524,176	6,535,887	27,150,918	18,116,531	-	-	-
2039	14,514,676	3,552,091	2,259,910	2,177,281	6,525,393	5,904,122	24,950,546	16,921,344	-	-	-
2040	12,825,606	3,399,238	1,896,681	1,934,633	5,595,054	5,320,162	22,709,819	15,726,156	-	-	-372,487
2041	11,292,074	3,239,750	1,527,591	1,767,374	4,757,359	4,740,855	20,802,497	14,530,968	-	-	-2,608,554
2042	9,799,033	3,075,067	1,153,276	1,589,575	3,981,116	4,158,288	19,072,717	13,335,780	-	-	-2,521,261
2043	8,401,742	2,923,135	773,906	1,417,973	3,286,727	3,591,134	17,461,103	11,763,164	-	-	-4,596,011
2044	7,097,958	2,782,675	389,463	1,240,730	2,685,091	3,037,436	15,917,890	10,190,549	-	-	-3,550,824
2045	5,893,877	2,653,643	-	1,067,667	2,172,567	2,497,627	14,442,484	8,617,933	-	-	-2,344,008
2046	5,164,718	2,540,669	-	877,578	1,746,472	2,388,229	13,409,501	7,045,318	-	-	-654,909
2047	4,507,341	2,440,505	-	706,734	1,360,101	2,294,075	12,371,031	5,472,702	-	-	-
2048	3,942,708	2,347,615	-	565,971	1,029,122	2,206,759	11,357,658	3,900,087	-	-	-
2049	3,481,600	2,259,574	-	441,222	780,804	2,124,000	10,470,058	2,327,471	-	-	-
2050	3,118,467	2,181,532	-	337,493	599,442	2,050,640	9,721,375	754,855	-	-	-

H.5 Central scenario with frontloading of APCR allowances through 2040

Table 95: Central scenario with 2040 frontloading prices by year

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2023	52.85	45.37	58.31	19.41	71.23
2024	56.26	47.65	61.21	20.39	74.79
2025	62.64	50.03	64.28	21.40	78.54
2026	65.79	52.53	67.49	22.47	82.46
2027	70.29	55.15	70.87	23.60	86.59
2028	74.41	57.91	74.41	24.77	90.92
2029	78.13	60.81	78.13	26.02	95.46
2030	82.56	63.85	82.04	27.32	100.23
2031	87.43	67.04	86.15	28.69	105.24
2032	93.31	70.40	90.45	30.11	110.50
2033	101.84	73.91	94.98	31.62	116.03
2034	105.77	77.61	99.73	33.20	121.83
2035	68.12	81.49	104.71	34.86	127.92

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2036	62.25	85.57	109.95	36.60	134.32
2037	62.81	89.84	115.44	38.43	141.04
2038	64.27	94.33	121.21	40.35	148.08
2039	47.76	99.05	127.27	42.38	155.49
2040	44.49	104.00	133.63	44.49	163.27
2041	46.72	109.20	140.32	46.72	171.43
2042	49.05	114.66	147.34	49.05	180.00
2043	51.50	120.39	154.70	51.50	189.00
2044	54.08	126.42	162.43	54.08	198.46
2045	56.78	132.74	170.56	56.78	208.37
2046	59.62	139.38	179.09	59.62	218.80
2047	63.29	146.34	188.04	62.61	229.73
2048	67.02	153.66	197.44	65.74	241.22
2049	72.33	161.35	207.31	69.03	253.28
2050	81.20	169.41	217.68	72.48	265.95

Table 96: Central scenario with 2040 frontloading volumes by year

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2023	57,124,272	12,298,254	10,972,931	8,453,029	25,400,058	27,862,371	58,354,932	58,501,299	14,993,049	-	-
2024	53,232,172	11,444,121	9,094,768	8,257,086	24,436,197	24,514,911	55,248,639	54,097,976	-	-	-
2025	48,594,009	10,699,351	6,959,114	7,980,362	22,955,182	21,007,293	51,877,213	49,694,652	-	-	-
2026	44,491,487	10,098,210	5,353,109	7,252,800	21,787,367	18,014,943	48,633,872	45,291,328	-	-	-
2027	41,994,182	9,476,630	5,292,773	6,706,393	20,518,386	16,681,722	47,114,812	40,888,005	-	-	-
2028	39,587,140	8,825,059	5,379,086	6,162,528	19,220,467	15,816,292	45,684,197	36,484,681	-	3,030,261	-
2029	37,303,071	8,166,746	5,569,488	5,660,436	17,906,401	15,087,655	44,333,454	32,081,358	-	6,425,503	-
2030	34,673,833	7,479,659	5,256,464	5,357,553	16,580,157	13,700,282	42,546,031	27,678,034	-	5,531,049	-
2031	32,026,402	6,829,465	4,932,744	4,996,477	15,267,716	12,597,010	40,737,212	26,482,846	-	-	-
2032	29,506,066	6,192,780	4,622,529	4,651,495	14,039,262	11,530,568	38,876,018	25,287,658	-	-	-
2033	27,139,791	5,598,529	4,307,624	4,349,133	12,884,505	10,521,687	37,125,878	24,092,471	-	-	-
2034	24,866,623	5,044,438	3,987,465	4,034,833	11,799,887	9,549,297	35,292,279	22,897,283	-	-	-
2035	22,887,942	4,563,504	3,662,372	3,795,865	10,866,201	8,668,874	33,548,365	21,702,095	-	-	-
2036	20,661,212	4,216,452	3,316,312	3,373,492	9,754,956	7,879,967	31,495,134	20,506,907	-	-	-
2037	18,524,313	3,973,545	2,969,775	2,939,600	8,641,392	7,203,953	29,391,857	19,311,719	-	-	-
2038	16,383,577	3,726,319	2,617,608	2,506,764	7,532,886	6,518,594	27,150,918	18,116,531	-	-	-

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2039	14,585,583	3,551,783	2,259,910	2,245,027	6,528,863	5,913,604	24,950,546	16,921,344	-	-	-
2040	12,885,394	3,398,760	1,896,681	1,995,431	5,594,522	5,326,899	22,709,819	15,726,156	-	-	-5,448.11
2041	11,346,024	3,238,959	1,527,591	1,821,920	4,757,554	4,745,293	20,802,497	14,530,968	-	-	-2,463,391
2042	9,843,913	3,073,558	1,153,276	1,637,218	3,979,861	4,160,300	19,072,717	13,335,780	-	-	-2,387,620
2043	8,436,060	2,920,165	773,906	1,458,451	3,283,537	3,590,326	17,461,103	11,763,164	-	-	-4,571,425
2044	7,121,136	2,777,109	389,463	1,273,887	2,680,678	3,033,066	15,917,890	10,190,549	-	-	-3,513,931
2045	5,905,283	2,643,962	-	1,093,668	2,167,654	2,488,605	14,442,484	8,617,933	-	-	-2,309,624
2046	5,162,148	2,525,147	-	895,279	1,741,722	2,373,639	13,409,501	7,045,318	-	-	-639,705
2047	4,491,078	2,417,602	-	717,877	1,355,599	2,272,546	12,371,031	5,472,702	-	-	-
2048	3,913,622	2,316,541	-	572,100	1,024,982	2,177,549	11,357,658	3,900,087	-	-	-
2049	3,441,659	2,220,886	-	443,679	777,093	2,087,633	10,470,058	2,327,471	-	-	-
2050	3,070,783	2,136,933	-	337,655	596,195	2,008,717	9,721,375	754,855	-	-	-

H.6 Central scenario with frontloading through 2050

Table 97: Central scenario with 2050 frontloading prices by year

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2023	50.03	45.37	58.31	19.41	71.23
2024	53.90	47.65	61.21	20.39	74.79
2025	60.37	50.03	64.28	21.40	78.54
2026	63.38	52.53	67.49	22.47	82.46
2027	68.82	55.15	70.87	23.60	86.59
2028	74.41	57.91	74.41	24.77	90.92
2029	78.13	60.81	78.13	26.02	95.46
2030	82.04	63.85	82.04	27.32	100.23
2031	86.15	67.04	86.15	28.69	105.24
2032	90.45	70.40	90.45	30.11	110.50
2033	94.98	73.91	94.98	31.62	116.03
2034	99.73	77.61	99.73	33.20	121.83
2035	68.62	81.49	104.71	34.86	127.92
2036	63.08	85.57	109.95	36.60	134.32
2037	64.32	89.84	115.44	38.43	141.04
2038	66.47	94.33	121.21	40.35	148.08

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2039	48.32	99.05	127.27	42.38	155.49
2040	45.08	104.00	133.63	44.49	163.27
2041	46.72	109.20	140.32	46.72	171.43
2042	49.05	114.66	147.34	49.05	180.00
2043	51.50	120.39	154.70	51.50	189.00
2044	54.08	126.42	162.43	54.08	198.46
2045	56.78	132.74	170.56	56.78	208.37
2046	59.62	139.38	179.09	59.62	218.80
2047	63.34	146.34	188.04	62.61	229.73
2048	67.16	153.66	197.44	65.74	241.22
2049	72.59	161.35	207.31	69.03	253.28
2050	81.56	169.41	217.68	72.48	265.95

Table 98: Central scenario with 2050 frontloading volumes by year

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2023	57,189,144	12,318,737	10,972,931	8,465,862	25,431,615	27,891,133	58,354,932	58,501,299	17,094,969	-	-
2024	53,377,825	11,539,965	9,094,768	8,270,029	24,473,064	24,618,215	55,248,639	54,097,976	-	-	-
2025	48,692,095	10,714,994	6,959,114	7,998,927	23,019,059	21,032,364	51,877,213	49,694,652	-	-	-
2026	44,621,159	10,120,344	5,353,109	7,291,127	21,856,579	18,053,904	48,633,872	45,291,328	-	-	-
2027	42,147,318	9,507,633	5,292,773	6,755,706	20,591,205	16,732,337	47,114,812	40,888,005	-	-	-
2028	39,756,288	8,866,493	5,379,086	6,216,910	19,293,799	15,877,909	45,684,197	36,484,681	-	1,400,495	-
2029	37,489,486	8,219,680	5,569,488	5,719,754	17,980,564	15,160,946	44,333,454	32,081,358	-	5,643,064	-
2030	34,878,737	7,546,427	5,256,464	5,423,105	16,652,741	13,785,132	42,546,031	27,678,034	-	5,710,894	-
2031	32,264,430	6,912,019	4,932,744	5,072,481	15,347,186	12,696,675	40,737,212	26,482,846	-	135,230	-
2032	29,777,136	6,290,096	4,622,529	4,735,714	14,128,797	11,643,568	38,876,018	25,287,658	-	766,520	-
2033	27,445,976	5,706,908	4,307,624	4,442,706	12,988,739	10,644,960	37,125,878	24,092,471	-	1,590,408	-
2034	25,175,286	5,157,546	3,987,465	4,127,563	11,902,712	9,674,529	35,292,279	22,897,283	-	472,815	-
2035	23,168,256	4,674,020	3,662,372	3,878,696	10,953,168	8,787,953	33,548,365	21,702,095	-	-	-
2036	20,899,931	4,317,700	3,316,312	3,440,559	9,825,360	7,987,147	31,495,134	20,506,907	-	-	-
2037	18,710,661	4,067,829	2,969,775	2,992,150	8,680,906	7,301,965	29,391,857	19,311,719	-	-	-
2038	16,546,085	3,816,082	2,617,608	2,550,028	7,562,367	6,610,085	27,150,918	18,116,531	-	-	-
2039	14,654,625	3,554,341	2,259,910	2,284,351	6,556,022	5,921,566	24,950,546	16,921,344	-	-	-
2040	12,944,647	3,399,312	1,896,681	2,030,347	5,618,307	5,331,538	22,709,819	15,726,156	-	-	-
2041	11,403,025	3,239,654	1,527,591	1,853,902	4,781,878	4,748,985	20,802,497	14,530,968	-	-	-2,009,728
2042	9,896,827	3,074,704	1,153,276	1,666,153	4,002,694	4,163,461	19,072,717	13,335,780	-	-	-2,303,706

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2043	8,485,074	2,922,277	773,906	1,484,567	3,304,323	3,593,591	17,461,103	11,763,164	-	-	-4,527,783
2044	7,167,193	2,780,939	389,463	1,297,358	2,699,433	3,037,277	15,917,890	10,190,549	-	-	-3,483,145
2045	5,949,442	2,650,501	-	1,114,675	2,184,267	2,494,815	14,442,484	8,617,933	-	-	-2,283,773
2046	5,204,717	2,535,496	-	913,119	1,756,102	2,383,366	13,409,501	7,045,318	-	-	-617,149
2047	4,533,235	2,432,706	-	733,073	1,367,456	2,286,744	12,371,031	5,472,702	-	-	-
2048	3,956,103	2,336,813	-	584,997	1,034,293	2,196,604	11,357,658	3,900,087	-	-	-
2049	3,484,712	2,245,843	-	454,530	784,339	2,111,092	10,470,058	2,327,471	-	-	-
2050	3,113,714	2,165,364	-	346,540	601,810	2,035,442	9,721,375	754,855	-	-	-

H.7 Central scenario with 2027 expected linkage

Table 99: Central scenario with 2027 linkage prices by year

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2023	49.46	45.37	58.31	19.41	71.23
2024	49.31	47.65	61.21	20.39	74.79
2025	54.14	50.03	64.28	21.40	78.54
2026	56.36	52.53	67.49	22.47	82.46

Table 100: Central scenario with 2027 linkage volumes by year

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2023	57,346,411	12,352,977	10,972,931	8,499,476	25,521,027	27,947,210	58,354,932	58,501,299	1,576,891	-	-
2024	53,748,933	11,678,525	9,094,768	8,322,327	24,653,313	24,787,016	55,248,639	54,097,976	1,460,750	-	-
2025	49,283,209	10,896,255	6,959,114	8,125,583	23,302,257	21,278,109	51,877,213	49,694,652	1,340,635	-	-
2026	45,360,418	10,149,112	5,353,109	7,572,652	22,285,545	18,206,434	48,633,872	45,291,328	1,221,844	-	-

H.8 Central scenario with 2030 expected linkage

Table 101. Central scenario with 2030 linkage prices by year

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2023	58.00	45.37	58.31	19.41	71.23
2024	57.91	47.65	61.21	20.39	74.79
2025	63.49	50.03	64.28	21.40	78.54
2026	64.43	52.53	67.49	22.47	82.46
2027	59.87	55.15	70.87	23.60	86.59
2028	61.17	57.91	74.41	24.77	90.92
2029	66.14	60.81	78.13	26.02	95.46

Table 102: Central scenario with 2030 linkage volumes by year

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2023	57,130,944	12,294,917	10,972,931	8,461,365	25,401,731	27,864,567	58,354,932	58,501,299	1,578,216	-	-
2024	53,231,501	11,363,203	9,094,768	8,281,442	24,492,089	24,448,152	55,248,639	54,097,976	1,459,165	-	-
2025	48,747,741	10,695,966	6,959,114	8,056,974	23,035,687	21,042,995	51,877,213	49,694,652	1,340,895	-	-
2026	44,905,255	10,097,836	5,353,109	7,460,738	21,993,572	18,106,041	48,633,872	45,291,328	1,220,662	-	-
2027	42,704,326	9,482,872	5,292,773	7,044,232	20,884,450	16,828,501	47,114,812	40,888,005	1,103,793	-	-
2028	40,549,323	8,841,183	5,379,086	6,598,139	19,730,916	16,003,376	45,684,197	36,484,681	984,012	-	-
2029	38,469,396	8,180,902	5,569,488	6,158,307	18,560,699	15,285,599	44,333,454	32,081,358	865,317	-	-

H.9 Central scenario with lower prices expected after 2025 linkage

Table 103: Central scenario with lower expected 2025 linkage prices, prices by year

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2023	33.36	45.37	58.31	19.41	71.23
2024	33.67	47.65	61.21	20.39	74.79

Table 104: Central scenario with lower expected 2025 linkage prices, volumes by year

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2023	57,696,369	12,388,820	10,972,931	8,574,838	25,759,780	28,031,683	58,354,932	58,501,299	-	-	-
2024	54,479,626	12,019,095	9,094,768	8,405,926	24,959,837	25,175,762	55,248,639	54,097,976	-	-	-

H.10 Central scenario with higher prices expected after 2025 linkage

Table 105: Central scenario with higher expected 2025 linkage prices, prices by year

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2023	51.19	45.37	58.31	19.41	71.23
2024	52.00	47.65	61.21	20.39	74.79

Table 106: Central scenario with higher expected 2025 linkage prices, volumes by year

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2023	56,366,677	11,499,139	10,972,931	8,455,993	25,438,614	27,065,147	58,354,932	58,501,299	1,576,148	-	-
2024	52,786,074	10,926,942	9,094,768	8,260,454	24,503,911	23,999,600	55,248,639	54,097,976	1,460,218	-	-

H.11 Central scenario (no frontloading of APCR allowances) without price ceiling

Table 107: Central scenario without price ceiling, prices by year

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)
2023	67.99	45.37	58.31	19.41
2024	67.87	47.65	61.21	20.39
2025	73.73	50.03	64.28	21.40
2026	76.29	52.53	67.49	22.47
2027	77.21	55.15	70.87	23.60
2028	81.48	57.91	74.41	24.77
2029	88.65	60.81	78.13	26.02

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)
2030	95.15	63.85	82.04	27.32
2031	89.96	67.04	86.15	28.69
2032	90.45	70.40	90.45	30.11
2033	94.98	73.91	94.98	31.62
2034	97.56	77.61	99.73	33.20
2035	64.46	81.49	104.71	34.86
2036	58.69	85.57	109.95	36.60
2037	58.77	89.84	115.44	38.43
2038	59.76	94.33	121.21	40.35
2039	46.35	99.05	127.27	42.38
2040	44.49	104.00	133.63	44.49
2041	46.72	109.20	140.32	46.72
2042	49.05	114.66	147.34	49.05
2043	51.50	120.39	154.70	51.50
2044	54.08	126.42	162.43	54.08
2045	56.78	132.74	170.56	56.78
2046	59.62	139.38	179.09	59.62
2047	63.18	146.34	188.04	62.61
2048	66.91	153.66	197.44	65.74
2049	72.30	161.35	207.31	69.03
2050	81.46	169.41	217.68	72.48

Table 108: Central scenario without price ceiling, volumes by year

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2023	56,767,211	12,175,759	10,972,931	8,388,487	25,230,035	27,698,259	58,354,932	58,501,299	1,578,216	1,577,750	-
2024	52,735,591	11,210,560	9,094,768	8,195,402	24,234,861	24,245,805	55,248,639	54,097,976	1,459,425	1,457,875	-
2025	48,030,227	10,562,346	6,959,114	7,903,706	22,605,063	20,831,389	51,877,213	49,694,652	1,340,635	1,341,965	-
2026	43,814,750	9,929,055	5,353,109	7,099,366	21,433,220	17,778,440	48,633,872	45,291,328	1,221,844	1,222,360	-
2027	41,252,565	9,278,099	5,292,773	6,515,081	20,166,612	16,409,473	47,114,812	40,888,005	1,103,054	1,103,224	-
2028	38,803,787	8,606,803	5,379,086	5,949,917	18,867,980	15,520,916	45,684,197	36,484,681	984,264	983,798	-
2029	36,510,418	7,938,419	5,569,488	5,434,586	17,567,925	14,782,709	44,333,454	32,081,358	865,473	865,939	-
2030	33,894,760	7,256,285	5,256,464	5,130,957	16,251,054	13,412,719	42,546,031	27,678,034	746,683	746,683	-
2031	31,353,644	6,632,115	4,932,744	4,798,555	14,990,229	12,347,995	40,737,212	26,482,846	714,440	714,440	-

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2032	28,971,180	6,042,664	4,622,529	4,490,666	13,815,322	11,338,936	38,876,018	25,287,658	682,196	681,963	-
2033	26,782,465	5,495,275	4,307,624	4,222,423	12,757,143	10,384,635	37,125,878	24,092,471	649,953	585,890	-
2034	24,626,911	4,978,416	3,987,465	3,935,192	11,725,838	9,455,395	35,292,279	22,897,283	617,710	-	-
2035	22,708,891	4,525,918	3,662,372	3,708,972	10,811,630	8,606,268	33,548,365	21,702,095	-	-	-
2036	20,526,382	4,189,532	3,316,312	3,301,628	9,718,910	7,833,015	31,495,134	20,506,907	-	-	-
2037	18,413,103	3,959,011	2,969,775	2,870,148	8,614,169	7,173,211	29,391,857	19,311,719	-	-	-
2038	16,296,466	3,726,813	2,617,608	2,435,338	7,516,706	6,506,022	27,150,918	18,116,531	-	-	-
2039	14,501,999	3,551,922	2,259,910	2,174,220	6,515,947	5,903,568	24,950,546	16,921,344	-	-	-
2040	12,811,613	3,399,032	1,896,681	1,931,450	5,584,450	5,319,595	22,709,819	15,726,156	-	-	-812,705
2041	11,278,944	3,239,457	1,527,591	1,764,301	4,747,595	4,740,288	20,802,497	14,530,968	-	-	-2,593,765
2042	9,786,577	3,074,546	1,153,276	1,586,471	3,972,283	4,157,575	19,072,717	13,335,780	-	-	-2,506,597
2043	8,389,106	2,922,135	773,906	1,414,737	3,278,327	3,590,035	17,461,103	11,763,164	-	-	-4,592,756
2044	7,084,826	2,780,808	389,463	1,237,297	2,677,259	3,035,592	15,917,890	10,190,549	-	-	-3,546,017
2045	5,879,877	2,650,383	-	1,064,015	2,165,479	2,494,552	14,442,484	8,617,933	-	-	-2,344,107
2046	5,149,447	2,535,397	-	873,790	1,740,260	2,383,273	13,409,501	7,045,318	-	-	-666,346
2047	4,490,483	2,432,635	-	702,922	1,354,926	2,286,677	12,371,031	5,472,702	-	-	-
2048	3,923,979	2,336,782	-	562,243	1,024,955	2,196,575	11,357,658	3,900,087	-	-	-
2049	3,461,070	2,245,885	-	437,712	777,474	2,111,131	10,470,058	2,327,471	-	-	-
2050	3,096,701	2,165,514	-	334,376	596,812	2,035,583	9,721,375	754,855	-	-	-

H.12 Central scenario (no frontloading of APCR allowances) without price floor

Table 109: Central scenario without price floor, prices by year

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price ceiling ($)
2023	70.89	45.37	58.31	71.23
2024	70.75	47.65	61.21	74.79
2025	76.88	50.03	64.28	78.54
2026	79.49	52.53	67.49	82.46
2027	80.54	55.15	70.87	86.59
2028	84.98	57.91	74.41	90.92
2029	92.41	60.81	78.13	95.46
2030	99.17	63.85	82.04	100.23
2031	94.24	67.04	86.15	105.24
2032	95.20	70.40	90.45	110.50
2033	101.52	73.91	94.98	116.03

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price ceiling ($)
2034	104.63	77.61	99.73	121.83
2035	67.34	81.49	104.71	127.92
2036	62.15	85.57	109.95	134.32
2037	67.15	89.84	115.44	141.04
2038	70.22	94.33	121.21	148.08
2039	31.94	99.05	127.27	155.49
2040	28.37	104.00	133.63	163.27
2041	28.06	109.20	140.32	171.43
2042	28.86	114.66	147.34	180.00
2043	27.49	120.39	154.70	189.00
2044	28.19	126.42	162.43	198.46
2045	29.99	132.74	170.56	208.37
2046	33.14	139.38	179.09	218.80
2047	38.56	146.34	188.04	229.73
2048	43.79	153.66	197.44	241.22
2049	50.14	161.35	207.31	253.28
2050	59.12	169.41	217.68	265.95

Table 110: Central scenario without price floor, volumes by year

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2023	56,742,953	12,215,843	10,972,931	8,368,773	25,185,406	27,725,593	58,354,932	58,501,299	1,578,216	1,578,216	-
2024	52,708,284	11,263,659	9,094,768	8,177,769	24,172,089	24,288,734	55,248,639	54,097,976	1,459,425	1,459,425	-
2025	47,977,290	10,639,202	6,959,114	7,878,560	22,500,414	20,895,477	51,877,213	49,694,652	1,340,635	1,340,635	-
2026	43,717,192	10,038,285	5,353,109	7,018,882	21,306,916	17,852,307	48,633,872	45,291,328	1,221,844	1,221,844	-
2027	41,144,282	9,430,976	5,292,773	6,401,217	20,019,315	16,510,332	47,114,812	40,888,005	1,103,054	1,102,962	-
2028	38,716,221	8,813,309	5,379,086	5,818,954	18,704,873	15,669,679	45,684,197	36,484,681	984,264	983,563	-
2029	36,471,973	8,207,976	5,569,488	5,298,744	17,395,765	14,993,959	44,333,454	32,081,358	865,473	866,266	-
2030	33,928,641	7,591,657	5,256,464	5,001,038	16,079,482	13,682,951	42,546,031	27,678,034	746,683	746,487	-
2031	31,493,723	7,044,728	4,932,744	4,687,874	14,828,377	12,697,658	40,737,212	26,482,846	714,440	714,527	-
2032	29,234,526	6,532,806	4,622,529	4,407,443	13,671,748	11,768,978	38,876,018	25,287,658	682,196	682,305	-
2033	27,148,266	6,024,998	4,307,624	4,173,710	12,641,935	10,859,176	37,125,878	24,092,471	649,953	649,802	-
2034	25,132,213	5,551,109	3,987,465	3,930,271	11,663,368	9,978,183	35,292,279	22,897,283	617,710	617,861	-
2035	23,367,945	5,119,106	3,662,372	3,760,418	10,826,049	9,156,364	33,548,365	21,702,095	-	-	-
2036	21,317,346	4,736,355	3,316,312	3,445,171	9,819,508	8,348,060	31,495,134	20,506,907	-	-	-
2037	19,344,380	4,469,053	2,969,775	3,088,459	8,817,094	7,660,852	29,391,857	19,311,719	-	-	-

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2038	17,317,421	4,238,595	2,617,608	2,645,107	7,816,110	7,001,653	27,150,918	18,116,531	-	-	-
2039	15,601,243	4,033,698	2,259,910	2,367,734	6,939,900	6,377,954	24,950,546	16,921,344	-	-	-
2040	13,963,795	3,845,972	1,896,681	2,139,781	6,081,361	5,763,528	22,709,819	15,726,156	-	-	-
2041	12,527,085	3,649,915	1,527,591	2,017,076	5,332,503	5,150,094	20,802,497	14,530,968	-	-	-
2042	11,054,154	3,442,483	1,153,276	1,883,525	4,574,869	4,524,823	19,072,717	13,335,780	-	-	-
2043	9,630,020	3,235,257	773,906	1,748,278	3,872,578	3,900,714	17,461,103	11,763,164	-	-	-
2044	8,229,605	3,008,687	389,463	1,595,350	3,236,105	3,259,108	15,917,890	10,190,549	-	-	-
2045	6,844,546	2,741,374	-	1,432,010	2,671,162	2,581,187	14,442,484	8,617,933	-	-	-
2046	5,988,504	2,583,137	-	1,226,941	2,178,426	2,428,149	13,409,501	7,045,318	-	-	-
2047	5,247,931	2,504,400	-	1,026,995	1,716,537	2,354,136	12,371,031	5,472,702	-	-	-
2048	4,593,199	2,438,738	-	847,693	1,306,767	2,292,414	11,357,658	3,900,087	-	-	-
2049	4,051,150	2,381,323	-	679,632	990,195	2,238,443	10,470,058	2,327,471	-	-	-
2050	3,624,191	2,334,238	-	536,782	753,171	2,194,183	9,721,375	754,855	-	-	-

H.13 Central scenario (no frontloading of APCR allowances) with no price controls

Table 111: Central scenario without price controls, prices by year

Year	Allowance price ($)
2023	72.51
2024	72.49
2025	79.08
2026	81.94
2027	83.52
2028	88.51
2029	96.68
2030	103.43
2031	97.61
2032	99.03
2033	104.38
2034	107.88
2035	52.94
2036	46.14
2037	45.19
2038	48.16

Year	Allowance price ($)
2039	23.42
2040	20.88
2041	20.71
2042	21.45
2043	20.88
2044	21.80
2045	23.63
2046	26.46
2047	31.89
2048	37.06
2049	43.06
2050	50.53

Table 112: Central scenario without price controls, volumes by year

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)
2023	56,742,915	12,254,838	10,972,931	8,356,939	25,158,208	27,756,931	58,354,932	61,657,731
2024	52,717,064	11,320,621	9,094,768	8,169,621	24,132,054	24,341,005	55,248,639	57,016,826
2025	47,933,048	10,673,390	6,959,114	7,868,446	22,432,099	20,924,545	51,877,213	52,375,922
2026	43,663,368	10,083,709	5,353,109	6,998,959	21,227,590	17,889,003	48,633,872	47,735,017
2027	41,088,195	9,489,642	5,292,773	6,379,437	19,926,342	16,558,200	47,114,812	43,094,113
2028	38,665,338	8,886,010	5,379,086	5,801,360	18,598,882	15,733,315	45,684,197	38,453,208
2029	36,443,500	8,294,595	5,569,488	5,289,466	17,289,952	15,074,454	44,333,454	33,812,304
2030	33,998,024	7,746,809	5,256,464	5,007,069	15,987,682	13,829,417	42,546,031	29,171,399
2031	31,690,603	7,271,960	4,932,744	4,722,171	14,763,728	12,916,459	40,737,212	27,911,725
2032	29,537,684	6,808,576	4,622,529	4,466,548	13,640,032	12,036,625	38,876,018	26,652,051
2033	27,560,312	6,334,521	4,307,624	4,260,989	12,657,179	11,161,922	37,125,878	25,392,377
2034	25,616,818	5,863,428	3,987,465	4,044,053	11,721,872	10,285,832	35,292,279	24,132,703
2035	23,963,291	5,407,642	3,662,372	3,921,650	10,971,627	9,447,394	33,548,365	22,873,029
2036	21,998,642	4,981,542	3,316,312	3,669,339	10,031,448	8,600,756	31,495,134	21,613,355
2037	20,142,283	4,646,451	2,969,775	3,373,764	9,152,293	7,851,530	29,391,857	20,353,681
2038	18,065,377	4,355,450	2,617,608	2,914,922	8,177,397	7,134,589	27,150,918	19,094,007
2039	16,240,438	4,114,431	2,259,910	2,570,009	7,296,087	6,474,527	24,950,546	17,834,333
2040	14,551,078	3,912,532	1,896,681	2,303,040	6,438,826	5,843,972	22,709,819	16,574,659
2041	13,087,158	3,710,369	1,527,591	2,179,033	5,670,164	5,222,208	20,802,497	15,314,985
2042	11,606,529	3,503,987	1,153,276	2,052,710	4,896,555	4,594,817	19,072,717	14,055,311
2043	10,182,059	3,312,667	773,906	1,923,569	4,171,917	3,982,068	17,461,103	12,397,845
2044	8,797,396	3,125,346	389,463	1,774,260	3,508,328	3,373,418	15,917,890	10,740,379
2045	7,444,927	2,921,803	-	1,611,264	2,911,859	2,751,329	14,442,484	9,082,913

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)
2046	6,467,403	2,682,659	-	1,398,783	2,385,962	2,521,699	13,409,501	7,425,447
2047	5,584,481	2,509,310	-	1,186,644	1,888,526	2,358,751	12,371,031	5,767,981
2048	4,880,787	2,446,607	-	991,268	1,442,911	2,299,811	11,357,658	4,110,515
2049	4,293,402	2,394,251	-	804,434	1,094,716	2,250,596	10,470,058	2,453,049
2050	3,829,401	2,354,590	-	643,507	831,304	2,213,315	9,721,375	795,584

H.14 Central scenario (no frontloading of APCR allowances) with complementary policies

Table 113: Central scenario with complementary policies, prices by year

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2023	65.00	45.37	58.31	19.41	71.23
2024	64.68	47.65	61.21	20.39	74.79
2025	70.38	50.03	64.28	21.40	78.54
2026	73.18	52.53	67.49	22.47	82.46
2027	74.64	55.15	70.87	23.60	86.59
2028	79.15	57.91	74.41	24.77	90.92
2029	86.39	60.81	78.13	26.02	95.46
2030	92.76	63.85	82.04	27.32	100.23
2031	88.54	67.04	86.15	28.69	105.24
2032	90.32	70.40	90.45	30.11	110.50
2033	94.98	73.91	94.98	31.62	116.03
2034	99.73	77.61	99.73	33.20	121.83
2035	63.94	81.49	104.71	34.86	127.92
2036	58.12	85.57	109.95	36.60	134.32
2037	58.43	89.84	115.44	38.43	141.04
2038	60.26	94.33	121.21	40.35	148.08
2039	46.86	99.05	127.27	42.38	155.49
2040	44.49	104.00	133.63	44.49	163.27
2041	46.72	109.20	140.32	46.72	171.43
2042	49.05	114.66	147.34	49.05	180.00

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2043	51.50	120.39	154.70	51.50	189.00
2044	54.08	126.42	162.43	54.08	198.46
2045	56.78	132.74	170.56	56.78	208.37
2046	59.62	139.38	179.09	59.62	218.80
2047	62.72	146.34	188.04	62.61	229.73
2048	66.04	153.66	197.44	65.74	241.22
2049	70.95	161.35	207.31	69.03	253.28
2050	79.33	169.41	217.68	72.48	265.95

Table 114: Central scenario with complementary policies, volumes by year

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2023	56,602,836	12,234,805	10,972,931	8,403,883	24,991,217	27,767,246	58,070,370	58,501,299	1,578,216	1,577,437	-
2024	52,581,533	11,264,999	9,094,768	8,213,733	24,008,034	24,310,812	54,960,517	54,097,976	1,459,425	1,459,571	-
2025	47,946,468	10,635,286	6,959,114	7,928,888	22,423,180	20,917,113	51,542,849	49,694,652	1,340,635	1,340,237	-
2026	43,761,966	10,022,402	5,353,109	7,157,632	21,228,823	17,897,376	48,225,745	45,291,328	1,221,844	1,222,691	-
2027	41,231,082	9,392,390	5,292,773	6,594,366	19,951,553	16,553,359	46,634,532	40,888,005	1,103,054	1,103,238	-
2028	38,808,235	8,739,973	5,379,086	6,042,246	18,646,929	15,686,435	45,127,437	36,484,681	984,264	984,264	-
2029	36,473,346	8,087,031	5,569,488	5,534,267	17,282,560	14,963,680	43,625,501	32,081,358	865,473	865,473	-
2030	33,869,453	7,414,635	5,256,464	5,235,445	15,962,909	13,596,863	41,735,916	27,678,034	746,683	746,236	-
2031	31,327,345	6,793,998	4,932,744	4,906,962	14,693,641	12,532,670	39,816,792	26,482,846	714,440	714,886	-
2032	28,913,321	6,201,583	4,622,529	4,597,275	13,491,934	11,517,180	37,820,254	25,287,658	682,196	-	-
2033	26,684,559	5,648,068	4,307,624	4,327,988	12,400,880	10,554,150	35,925,610	24,092,471	649,953	165,791	-
2034	24,528,670	5,124,017	3,987,465	4,036,708	11,380,480	9,614,594	33,984,128	22,897,283	617,710	-	-
2035	22,642,606	4,665,962	3,662,372	3,813,512	10,500,760	8,758,500	31,947,475	21,702,095	-	-	-
2036	20,484,668	4,319,421	3,316,312	3,403,484	9,445,451	7,972,886	29,764,041	20,506,907	-	-	-
2037	18,386,359	4,079,152	2,969,775	2,964,636	8,372,796	7,301,326	27,645,536	19,311,719	-	-	-
2038	16,290,089	3,836,280	2,617,608	2,516,457	7,319,744	6,621,316	25,407,928	18,116,531	-	-	-
2039	14,451,406	3,577,992	2,259,910	2,246,269	6,367,234	5,938,087	23,232,020	16,921,344	-	-	-
2040	12,774,029	3,399,490	1,896,681	1,996,303	5,481,555	5,327,669	20,944,630	15,726,156	-	-	-622,477
2041	11,275,577	3,239,708	1,527,591	1,824,419	4,683,860	4,746,234	18,967,834	14,530,968	-	-	-2,664,589
2042	9,804,654	3,074,481	1,153,276	1,641,400	3,935,497	4,161,469	17,171,366	13,335,780	-	-	-2,559,094
2043	8,417,005	2,921,493	773,906	1,464,160	3,257,446	3,591,854	15,508,958	11,763,164	-	-	-4,650,669
2044	7,106,207	2,779,149	389,463	1,280,908	2,656,687	3,035,166	13,931,999	10,190,549	-	-	-3,650,989
2045	5,878,554	2,647,098	-	1,101,701	2,129,755	2,491,577	12,439,884	8,617,933	-	-	-2,474,814
2046	5,111,286	2,529,781	-	903,989	1,677,517	2,377,994	11,415,740	7,045,318	-	-	-830,932
2047	4,407,657	2,424,036	-	726,779	1,256,842	2,278,593	10,484,993	5,472,702	-	-	-
2048	3,800,756	2,324,836	-	580,687	895,233	2,185,346	9,660,581	3,900,087	-	-	-

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2049	3,316,396	2,230,641	-	451,523	634,231	2,096,803	8,922,023	2,327,471	-	-	-
2050	2,991,134	2,147,485	-	344,795	498,854	2,018,636	8,298,265	754,855	-	-	-

H.15 Central scenario (no frontloading of APCR allowances) with shorter foresight in the first compliance period

Table 115: Central scenario with shorter foresight, prices by year

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2023	52.29	45.37	58.31	19.41	71.23
2024	61.55	47.65	61.21	20.39	74.79
2025	72.54	50.03	64.28	21.40	78.54
2026	78.56	52.53	67.49	22.47	82.46
2027	79.16	55.15	70.87	23.60	86.59
2028	83.32	57.91	74.41	24.77	90.92
2029	90.61	60.81	78.13	26.02	95.46
2030	97.06	63.85	82.04	27.32	100.23
2031	90.78	67.04	86.15	28.69	105.24
2032	91.22	70.40	90.45	30.11	110.50
2033	96.02	73.91	94.98	31.62	116.03
2034	99.73	77.61	99.73	33.20	121.83
2035	64.59	81.49	104.71	34.86	127.92
2036	58.78	85.57	109.95	36.60	134.32
2037	58.92	89.84	115.44	38.43	141.04
2038	60.68	94.33	121.21	40.35	148.08
2039	46.92	99.05	127.27	42.38	155.49
2040	44.49	104.00	133.63	44.49	163.27
2041	46.72	109.20	140.32	46.72	171.43
2042	49.05	114.66	147.34	49.05	180.00
2043	51.50	120.39	154.70	51.50	189.00

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2044	54.08	126.42	162.43	54.08	198.46
2045	56.78	132.74	170.56	56.78	208.37
2046	59.62	139.38	179.09	59.62	218.80
2047	63.23	146.34	188.04	62.61	229.73
2048	66.96	153.66	197.44	65.74	241.22
2049	72.36	161.35	207.31	69.03	253.28
2050	81.55	169.41	217.68	72.48	265.95

Table 116: Central scenario with shorter foresight, volumes by year

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2023	56,977,046	12,217,850	10,972,931	8,438,095	25,348,171	27,772,248	58,354,932	58,501,299	1,578,216	-	-
2024	52,876,112	11,253,257	9,094,768	8,221,627	24,306,460	24,303,586	55,248,639	54,097,976	1,459,425	3,037,345	-
2025	48,234,952	10,604,428	6,959,114	7,916,632	22,754,778	20,880,043	51,877,213	49,694,652	1,340,635	1,339,046	-
2026	43,892,427	9,961,709	5,353,109	7,093,613	21,483,996	17,808,598	48,633,872	45,291,328	1,221,844	1,223,268	-
2027	41,265,049	9,297,572	5,292,773	6,499,094	20,175,610	16,421,725	47,114,812	40,888,005	1,103,054	1,103,220	-
2028	38,774,413	8,616,001	5,379,086	5,928,684	18,850,641	15,521,499	45,684,197	36,484,681	984,264	983,332	-
2029	36,469,465	7,939,692	5,569,488	5,410,589	17,549,695	14,775,114	44,333,454	32,081,358	865,473	865,776	-
2030	33,846,802	7,252,458	5,256,464	5,106,053	16,231,828	13,400,752	42,546,031	27,678,034	746,683	747,311	-
2031	31,309,314	6,626,277	4,932,744	4,775,314	14,974,979	12,335,425	40,737,212	26,482,846	714,440	714,440	-
2032	28,931,781	6,037,467	4,622,529	4,469,807	13,801,978	11,328,047	38,876,018	25,287,658	682,196	682,033	-
2033	26,752,642	5,491,488	4,307,624	4,204,092	12,749,438	10,375,984	37,125,878	24,092,471	649,953	649,971	-
2034	24,602,496	4,975,984	3,987,465	3,918,976	11,720,071	9,448,728	35,292,279	22,897,283	617,710	102,821	-
2035	22,698,978	4,524,983	3,662,372	3,697,496	10,814,128	8,602,216	33,548,365	21,702,095	-	-	-
2036	20,524,311	4,188,931	3,316,312	3,294,320	9,724,748	7,830,112	31,495,134	20,506,907	-	-	-
2037	18,415,418	3,958,376	2,969,775	2,864,598	8,622,668	7,170,893	29,391,857	19,311,719	-	-	-
2038	16,296,139	3,725,559	2,617,608	2,429,160	7,523,812	6,503,564	27,150,918	18,116,531	-	-	-
2039	14,503,252	3,551,843	2,259,910	2,168,349	6,523,150	5,902,623	24,950,546	16,921,344	-	-	-
2040	12,813,798	3,398,932	1,896,681	1,926,572	5,591,614	5,318,923	22,709,819	15,726,156	-	-	-543,789
2041	11,279,482	3,239,297	1,527,591	1,760,022	4,752,572	4,739,731	20,802,497	14,530,968	-	-	-2,622,260
2042	9,785,668	3,074,240	1,153,276	1,582,721	3,975,431	4,157,018	19,072,717	13,335,780	-	-	-2,534,090
2043	8,387,264	2,921,526	773,906	1,411,415	3,280,417	3,589,300	17,461,103	11,763,164	-	-	-4,613,296
2044	7,081,936	2,779,657	389,463	1,234,312	2,678,505	3,034,432	15,917,890	10,190,549	-	-	-3,567,103
2045	5,875,754	2,648,367	-	1,061,288	2,166,099	2,492,649	14,442,484	8,617,933	-	-	-2,362,591
2046	5,144,131	2,532,147	-	871,494	1,740,490	2,380,218	13,409,501	7,045,318	-	-	-669,756
2047	4,483,603	2,427,815	-	700,897	1,354,891	2,282,146	12,371,031	5,472,702	-	-	-
2048	3,915,394	2,330,212	-	560,422	1,024,760	2,190,399	11,357,658	3,900,087	-	-	-
2049	3,450,857	2,237,629	-	436,038	777,190	2,103,371	10,470,058	2,327,471	-	-	-

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2050	3,085,161	2,155,879	-	332,832	596,450	2,026,526	9,721,375	754,855	-	-	-

H.16 Central scenario (no frontloading of APRC allowances) with longer foresight

Table 117: Central scenario with longer foresight, prices by year

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2023	68.94	45.37	58.31	19.41	71.23
2024	68.58	47.65	61.21	20.39	74.79
2025	74.62	50.03	64.28	21.40	78.54
2026	77.46	52.53	67.49	22.47	82.46
2027	77.94	55.15	70.87	23.60	86.59
2028	82.06	57.91	74.41	24.77	90.92
2029	89.31	60.81	78.13	26.02	95.46
2030	95.60	63.85	82.04	27.32	100.23
2031	89.77	67.04	86.15	28.69	105.24
2032	90.45	70.40	90.45	30.11	110.50
2033	94.98	73.91	94.98	31.62	116.03
2034	99.73	77.61	99.73	33.20	121.83
2035	64.53	81.49	104.71	34.86	127.92
2036	58.78	85.57	109.95	36.60	134.32
2037	59.25	89.84	115.44	38.43	141.04
2038	61.20	94.33	121.21	40.35	148.08
2039	47.16	99.05	127.27	42.38	155.49
2040	44.49	104.00	133.63	44.49	163.27
2041	46.72	109.20	140.32	46.72	171.43
2042	49.05	114.66	147.34	49.05	180.00
2043	51.50	120.39	154.70	51.50	189.00
2044	54.08	126.42	162.43	54.08	198.46
2045	56.78	132.74	170.56	56.78	208.37
2046	59.62	139.38	179.09	59.62	218.80

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2047	63.18	146.34	188.04	62.61	229.73
2048	66.84	153.66	197.44	65.74	241.22
2049	72.09	161.35	207.31	69.03	253.28
2050	80.85	169.41	217.68	72.48	265.95

Table 118: Central scenario with longer foresight, volumes by year

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2023	56,741,916	12,167,134	10,972,931	8,384,072	25,217,779	27,686,785	58,354,932	58,501,299	1,578,216	1,577,252	-
2024	52,707,247	11,200,986	9,094,768	8,191,106	24,220,388	24,233,753	55,248,639	54,097,976	1,459,425	1,459,625	-
2025	47,985,110	10,551,160	6,959,114	7,897,967	22,576,869	20,817,292	51,877,213	49,694,652	1,340,635	1,340,753	-
2026	43,765,329	9,918,269	5,353,109	7,090,332	21,403,619	17,763,698	48,633,872	45,291,328	1,221,844	1,222,490	-
2027	41,210,962	9,269,262	5,292,773	6,507,317	20,141,609	16,397,675	47,114,812	40,888,005	1,103,054	1,102,490	-
2028	38,772,723	8,601,718	5,379,086	5,944,814	18,847,105	15,513,980	45,684,197	36,484,681	984,264	984,270	-
2029	36,494,078	7,937,232	5,569,488	5,431,814	17,555,544	14,780,514	44,333,454	32,081,358	865,473	865,178	-
2030	33,889,999	7,258,463	5,256,464	5,131,118	16,243,954	13,414,604	42,546,031	27,678,034	746,683	747,086	-
2031	31,361,387	6,636,578	4,932,744	4,802,796	14,989,269	12,352,853	40,737,212	26,482,846	714,440	714,889	-
2032	28,984,635	6,048,326	4,622,529	4,497,041	13,816,738	11,345,163	38,876,018	25,287,658	682,196	437,432	-
2033	26,801,549	5,501,383	4,307,624	4,231,012	12,761,530	10,391,520	37,125,878	24,092,471	649,953	405,989	-
2034	24,642,742	4,984,370	3,987,465	3,943,745	11,727,161	9,461,783	35,292,279	22,897,283	617,710	31,752	-
2035	22,736,478	4,531,759	3,662,372	3,721,584	10,820,764	8,613,154	33,548,365	21,702,095	-	-	-
2036	20,557,884	4,193,734	3,316,312	3,315,359	9,732,479	7,838,369	31,495,134	20,506,907	-	-	-
2037	18,439,382	3,960,965	2,969,775	2,882,537	8,626,106	7,176,363	29,391,857	19,311,719	-	-	-
2038	16,313,934	3,725,080	2,617,608	2,444,314	7,526,931	6,505,510	27,150,918	18,116,531	-	-	-
2039	14,520,147	3,551,954	2,259,910	2,181,899	6,526,384	5,904,626	24,950,546	16,921,344	-	-	-
2040	12,828,637	3,398,977	1,896,681	1,938,755	5,594,224	5,320,402	22,709,819	15,726,156	-	-	-393,997
2041	11,292,763	3,239,230	1,527,591	1,771,313	4,754,630	4,740,740	20,802,497	14,530,968	-	-	-2,596,748
2042	9,796,808	3,073,944	1,153,276	1,592,942	3,976,646	4,157,476	19,072,717	13,335,780	-	-	-2,509,968
2043	8,395,983	2,920,783	773,906	1,420,434	3,280,861	3,589,043	17,461,103	11,763,164	-	-	-4,598,217
2044	7,087,964	2,778,128	389,463	1,242,021	2,678,353	3,033,195	15,917,890	10,190,549	-	-	-3,558,030
2045	5,878,775	2,645,601	-	1,067,643	2,165,531	2,490,068	14,442,484	8,617,933	-	-	-2,359,956
2046	5,143,457	2,527,640	-	876,108	1,739,709	2,375,982	13,409,501	7,045,318	-	-	-688,339
2047	4,479,360	2,421,129	-	704,103	1,354,128	2,275,862	12,371,031	5,472,702	-	-	-
2048	3,907,903	2,321,150	-	562,502	1,024,252	2,181,881	11,357,658	3,900,087	-	-	-
2049	3,440,472	2,226,397	-	437,246	776,829	2,092,814	10,470,058	2,327,471	-	-	-
2050	3,072,775	2,142,998	-	333,563	596,213	2,014,419	9,721,375	754,855	-	-	-

H.17 Central scenario (no frontloading of APCR allowances) with high financial sector sensitivity to prices

Table 119: Central scenario with high price sensitivity, prices by year

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2023	63.27	45.37	58.31	19.41	71.23
2024	64.66	47.65	61.21	20.39	74.79
2025	69.29	50.03	64.28	21.40	78.54
2026	72.60	52.53	67.49	22.47	82.46
2027	74.63	55.15	70.87	23.60	86.59
2028	78.38	57.91	74.41	24.77	90.92
2029	84.64	60.81	78.13	26.02	95.46
2030	91.27	63.85	82.04	27.32	100.23
2031	88.63	67.04	86.15	28.69	105.24
2032	90.45	70.40	90.45	30.11	110.50
2033	101.52	73.91	94.98	31.62	116.03
2034	99.73	77.61	99.73	33.20	121.83
2035	60.83	81.49	104.71	34.86	127.92
2036	57.38	85.57	109.95	36.60	134.32
2037	57.54	89.84	115.44	38.43	141.04
2038	57.43	94.33	121.21	40.35	148.08
2039	47.21	99.05	127.27	42.38	155.49
2040	45.88	104.00	133.63	44.49	163.27
2041	46.72	109.20	140.32	46.72	171.43
2042	49.05	114.66	147.34	49.05	180.00
2043	51.50	120.39	154.70	51.50	189.00
2044	54.08	126.42	162.43	54.08	198.46
2045	56.78	132.74	170.56	56.78	208.37
2046	59.62	139.38	179.09	59.62	218.80
2047	64.06	146.34	188.04	62.61	229.73
2048	66.32	153.66	197.44	65.74	241.22
2049	69.03	161.35	207.31	69.03	253.28

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2050	74.40	169.41	217.68	72.48	265.95

Table 120: Central scenario with high price sensitivity, volumes by year

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2023	56,905,294	12,237,018	10,972,931	8,409,909	25,285,437	27,773,337	58,354,932	58,501,299	1,578,216	1,574,880	-
2024	52,882,721	11,272,558	9,094,768	8,215,640	24,299,755	24,319,477	55,248,639	54,097,976	1,459,425	1,462,761	-
2025	48,263,133	10,645,201	6,959,114	7,934,070	22,724,749	20,929,651	51,877,213	49,694,652	1,340,635	1,340,635	-
2026	44,106,413	10,035,252	5,353,109	7,164,453	21,553,599	17,913,218	48,633,872	45,291,328	1,221,844	1,220,663	-
2027	41,598,558	9,405,076	5,292,773	6,599,609	20,301,100	16,567,850	47,114,812	40,888,005	1,103,054	1,102,350	-
2028	39,178,642	8,748,492	5,379,086	6,047,695	19,003,368	15,696,834	45,684,197	36,484,681	984,264	986,148	-
2029	36,900,386	8,087,109	5,569,488	5,540,309	17,703,479	14,965,985	44,333,454	32,081,358	865,473	863,907	-
2030	34,282,076	7,400,395	5,256,464	5,239,152	16,386,064	13,584,905	42,546,031	27,678,034	746,683	748,249	-
2031	31,709,908	6,758,871	4,932,744	4,903,184	15,115,109	12,499,372	40,737,212	26,482,846	714,440	713,889	-
2032	29,277,636	6,141,723	4,622,529	4,586,805	13,926,579	11,459,596	38,876,018	25,287,658	682,196	547,515	-
2033	27,001,077	5,561,217	4,307,624	4,303,114	12,829,123	10,468,343	37,125,878	24,092,471	649,953	785,166	-
2034	24,803,509	5,010,953	3,987,465	4,011,474	11,793,617	9,505,306	35,292,279	22,897,283	617,710	291,958	-
2035	22,857,246	4,530,794	3,662,372	3,786,602	10,877,478	8,628,811	33,548,365	21,702,095	-	-	-
2036	20,651,023	4,179,067	3,316,312	3,379,634	9,776,010	7,838,459	31,495,134	20,506,907	-	-	-
2037	18,528,607	3,920,259	2,969,775	2,944,901	8,693,672	7,149,730	29,391,857	19,311,719	-	-	-
2038	16,415,551	3,714,303	2,617,608	2,502,924	7,580,715	6,504,889	27,150,918	18,116,531	-	-	-
2039	14,607,074	3,551,158	2,259,910	2,234,300	6,561,706	5,911,224	24,950,546	16,921,344	-	-	-
2040	12,896,212	3,397,109	1,896,681	1,986,847	5,615,575	5,324,315	22,709,819	15,726,156	-	-	-
2041	11,347,770	3,235,020	1,527,591	1,818,690	4,766,469	4,741,284	20,802,497	14,530,968	-	-	-455,821
2042	9,835,927	3,064,836	1,153,276	1,637,993	3,979,822	4,152,157	19,072,717	13,335,780	-	-	-2,170,664
2043	8,416,810	2,902,564	773,906	1,461,340	3,279,000	3,573,922	17,461,103	11,763,164	-	-	-4,265,690
2044	7,083,346	2,745,155	389,463	1,277,108	2,671,620	3,003,113	15,917,890	10,190,549	-	-	-3,516,045
2045	5,843,575	2,591,674	-	1,095,739	2,156,162	2,439,460	14,442,484	8,617,933	-	-	-2,714,821
2046	5,073,321	2,447,852	-	895,228	1,730,241	2,300,981	13,409,501	7,045,318	-	-	-1,256,201
2047	4,375,847	2,314,311	-	715,151	1,346,386	2,175,452	12,371,031	5,472,702	-	-	-
2048	3,778,167	2,191,678	-	567,034	1,019,454	2,060,178	11,357,658	3,900,087	-	-	-
2049	3,294,074	2,083,513	-	436,909	773,652	1,958,502	10,470,058	2,327,471	-	-	-534,096
2050	2,919,486	1,993,871	-	331,348	594,268	1,874,239	9,721,375	754,855	-	-	-

H.18 Central scenario (no frontloading of APCR allowances) with low financial sector sensitivity to prices

Table 121: Central scenario with low price sensitivity, prices by year

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2023	69.29	45.37	58.31	19.41	71.23
2024	68.36	47.65	61.21	20.39	74.79
2025	75.13	50.03	64.28	21.40	78.54
2026	77.54	52.53	67.49	22.47	82.46
2027	78.44	55.15	70.87	23.60	86.59
2028	83.18	57.91	74.41	24.77	90.92
2029	90.85	60.81	78.13	26.02	95.46
2030	97.35	63.85	82.04	27.32	100.23
2031	90.37	67.04	86.15	28.69	105.24
2032	91.01	70.40	90.45	30.11	110.50
2033	95.36	73.91	94.98	31.62	116.03
2034	99.67	77.61	99.73	33.20	121.83
2035	62.78	81.49	104.71	34.86	127.92
2036	57.14	85.57	109.95	36.60	134.32
2037	57.77	89.84	115.44	38.43	141.04
2038	59.42	94.33	121.21	40.35	148.08
2039	45.33	99.05	127.27	42.38	155.49
2040	44.49	104.00	133.63	44.49	163.27
2041	46.72	109.20	140.32	46.72	171.43
2042	49.05	114.66	147.34	49.05	180.00
2043	51.50	120.39	154.70	51.50	189.00
2044	54.08	126.42	162.43	54.08	198.46
2045	56.78	132.74	170.56	56.78	208.37
2046	59.62	139.38	179.09	59.62	218.80
2047	63.18	146.34	188.04	62.61	229.73
2048	68.00	153.66	197.44	65.74	241.22
2049	75.67	161.35	207.31	69.03	253.28

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2050	88.52	169.41	217.68	72.48	265.95

Table 122: Central scenario with low price sensitivity, volumes by year

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2023	56,728,693	12,160,710	10,972,931	8,381,833	25,213,220	27,678,913	58,354,932	58,501,299	1,578,216	1,578,216	-
2024	52,684,693	11,183,508	9,094,768	8,190,020	24,216,397	24,215,641	55,248,639	54,097,976	1,459,425	1,459,425	-
2025	47,942,427	10,525,363	6,959,114	7,894,262	22,563,689	20,789,614	51,877,213	49,694,652	1,340,635	1,339,723	-
2026	43,708,060	9,878,957	5,353,109	7,081,901	21,394,093	17,720,677	48,633,872	45,291,328	1,221,844	1,222,756	-
2027	41,122,735	9,215,401	5,292,773	6,493,218	20,121,343	16,339,557	47,114,812	40,888,005	1,103,054	1,103,054	-
2028	38,656,974	8,532,787	5,379,086	5,925,094	18,820,007	15,439,364	45,684,197	36,484,681	984,264	984,264	-
2029	36,351,647	7,854,510	5,569,488	5,408,167	17,519,482	14,691,565	44,333,454	32,081,358	865,473	865,473	-
2030	33,730,807	7,166,676	5,256,464	5,105,488	16,202,179	13,319,708	42,546,031	27,678,034	746,683	746,683	-
2031	31,204,446	6,542,286	4,932,744	4,779,314	14,950,103	12,256,948	40,737,212	26,482,846	714,440	714,021	-
2032	28,839,566	5,957,122	4,622,529	4,476,801	13,783,114	11,253,361	38,876,018	25,287,658	682,196	682,383	-
2033	26,676,067	5,415,618	4,307,624	4,214,742	12,738,084	10,305,999	37,125,878	24,092,471	649,953	650,185	-
2034	24,534,531	4,905,765	3,987,465	3,932,528	11,708,773	9,384,221	35,292,279	22,897,283	617,710	-	-
2035	22,647,089	4,458,523	3,662,372	3,716,604	10,809,591	8,541,888	33,548,365	21,702,095	-	-	-
2036	20,485,822	4,129,777	3,316,312	3,317,128	9,722,606	7,776,804	31,495,134	20,506,907	-	-	-
2037	18,381,049	3,905,257	2,969,775	2,883,517	8,622,500	7,123,032	29,391,857	19,311,719	-	-	-
2038	16,292,953	3,713,979	2,617,608	2,440,885	7,520,480	6,494,292	27,150,918	18,116,531	-	-	-
2039	14,502,969	3,551,521	2,259,910	2,175,466	6,516,071	5,903,328	24,950,546	16,921,344	-	-	-
2040	12,802,392	3,398,646	1,896,681	1,928,524	5,578,541	5,318,889	22,709,819	15,726,156	-	-	-1,999,853
2041	11,259,349	3,239,063	1,527,591	1,755,792	4,736,902	4,739,109	20,802,497	14,530,968	-	-	-2,766,875
2042	9,756,644	3,074,137	1,153,276	1,573,051	3,956,180	4,156,224	19,072,717	13,335,780	-	-	-2,663,240
2043	8,354,091	2,921,748	773,906	1,397,302	3,261,134	3,588,818	17,461,103	11,763,164	-	-	-4,668,868
2044	7,046,611	2,780,571	389,463	1,216,853	2,659,725	3,034,837	15,917,890	10,190,549	-	-	-3,549,320
2045	5,840,477	2,650,527	-	1,041,666	2,148,284	2,494,621	14,442,484	8,617,933	-	-	-2,238,448
2046	5,111,278	2,536,264	-	851,274	1,723,740	2,384,088	13,409,501	7,045,318	-	-	-442,243
2047	4,454,631	2,434,633	-	681,317	1,338,680	2,288,555	12,371,031	5,472,702	-	-	-
2048	3,891,193	2,340,296	-	542,313	1,008,584	2,199,878	11,357,658	3,900,087	-	-	-
2049	3,433,444	2,251,090	-	419,987	762,366	2,116,025	10,470,058	2,327,471	-	-	-
2050	3,073,699	2,172,581	-	317,745	583,373	2,042,226	9,721,375	754,855	-	-	-

H.19 Central scenario (no frontloading of APCR allowances) with low financial sector hurdle rate

Table 123: Central scenario with low hurdle rate, prices by year

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2023	71.23	45.37	58.31	19.41	71.23
2024	69.86	47.65	61.21	20.39	74.79
2025	75.48	50.03	64.28	21.40	78.54
2026	77.95	52.53	67.49	22.47	82.46
2027	77.64	55.15	70.87	23.60	86.59
2028	81.47	57.91	74.41	24.77	90.92
2029	88.40	60.81	78.13	26.02	95.46
2030	94.54	63.85	82.04	27.32	100.23
2031	89.50	67.04	86.15	28.69	105.24
2032	90.45	70.40	90.45	30.11	110.50
2033	94.98	73.91	94.98	31.62	116.03
2034	99.12	77.61	99.73	33.20	121.83
2035	68.21	81.49	104.71	34.86	127.92
2036	61.65	85.57	109.95	36.60	134.32
2037	61.80	89.84	115.44	38.43	141.04
2038	63.96	94.33	121.21	40.35	148.08
2039	49.28	99.05	127.27	42.38	155.49
2040	45.69	104.00	133.63	44.49	163.27
2041	46.72	109.20	140.32	46.72	171.43
2042	49.05	114.66	147.34	49.05	180.00
2043	51.50	120.39	154.70	51.50	189.00
2044	54.08	126.42	162.43	54.08	198.46
2045	56.78	132.74	170.56	56.78	208.37
2046	59.62	139.38	179.09	59.62	218.80
2047	62.66	146.34	188.04	62.61	229.73
2048	66.28	153.66	197.44	65.74	241.22
2049	71.92	161.35	207.31	69.03	253.28

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2050	80.92	169.41	217.68	72.48	265.95

Table 124: Central scenario with low hurdle rate, volumes by year

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2023	56,711,860	12,159,542	10,972,931	8,377,667	25,201,720	27,675,081	58,354,932	58,501,299	1,578,216	1,578,216	-
2024	52,688,978	11,196,475	9,094,768	8,187,327	24,210,407	24,227,077	55,248,639	54,097,976	1,459,425	1,458,409	-
2025	47,959,834	10,548,098	6,959,114	7,895,687	22,556,935	20,813,083	51,877,213	49,694,652	1,340,635	1,341,651	-
2026	43,762,721	9,918,510	5,353,109	7,091,975	21,399,127	17,764,669	48,633,872	45,291,328	1,221,844	1,221,547	-
2027	41,231,750	9,277,198	5,292,773	6,513,690	20,148,088	16,408,026	47,114,812	40,888,005	1,103,054	1,103,351	-
2028	38,817,338	8,621,747	5,379,086	5,954,451	18,862,053	15,537,198	45,684,197	36,484,681	984,264	983,351	-
2029	36,564,363	7,973,077	5,569,488	5,443,549	17,578,249	14,819,607	44,333,454	32,081,358	865,473	865,567	-
2030	33,980,841	7,312,385	5,256,464	5,143,659	16,268,333	13,469,538	42,546,031	27,678,034	746,683	746,910	-
2031	31,464,875	6,708,334	4,932,744	4,813,678	15,010,120	12,423,763	40,737,212	26,482,846	714,440	715,031	-
2032	29,097,111	6,134,572	4,622,529	4,505,281	13,834,729	11,428,929	38,876,018	25,287,658	682,196	198,043	-
2033	26,917,140	5,600,654	4,307,624	4,235,855	12,773,006	10,486,802	37,125,878	24,092,471	649,953	58,067	-
2034	24,761,336	5,094,893	3,987,465	3,945,155	11,733,823	9,567,060	35,292,279	22,897,283	617,710	-	-
2035	22,844,182	4,654,671	3,662,372	3,714,169	10,812,971	8,728,529	33,548,365	21,702,095	-	-	-
2036	20,654,331	4,317,528	3,316,312	3,298,911	9,721,579	7,953,810	31,495,134	20,506,907	-	-	-
2037	18,528,746	4,093,231	2,969,775	2,864,899	8,600,842	7,299,396	29,391,857	19,311,719	-	-	-
2038	16,436,159	3,878,442	2,617,608	2,431,977	7,508,131	6,648,333	27,150,918	18,116,531	-	-	-
2039	14,614,167	3,663,057	2,259,910	2,173,318	6,517,882	6,007,946	24,950,546	16,921,344	-	-	-
2040	12,870,260	3,444,021	1,896,681	1,932,259	5,597,299	5,361,981	22,709,819	15,726,156	-	-	-
2041	11,306,003	3,241,310	1,527,591	1,767,148	4,769,954	4,742,300	20,802,497	14,530,968	-	-	-1,826,589
2042	9,826,258	3,077,634	1,153,276	1,592,263	4,003,085	4,160,895	19,072,717	13,335,780	-	-	-2,466,462
2043	8,441,104	2,927,950	773,906	1,424,432	3,314,815	3,595,977	17,461,103	11,763,164	-	-	-4,679,354
2044	7,149,424	2,791,805	389,463	1,251,533	2,716,623	3,046,299	15,917,890	10,190,549	-	-	-3,628,680
2045	5,958,348	2,670,147	-	1,082,973	2,205,228	2,513,187	14,442,484	8,617,933	-	-	-2,390,285
2046	5,243,450	2,568,604	-	896,834	1,778,011	2,414,488	13,409,501	7,045,318	-	-	-729,908
2047	4,602,765	2,484,589	-	729,007	1,389,169	2,335,514	12,371,031	5,472,702	-	-	-
2048	4,056,956	2,412,429	-	589,961	1,054,566	2,267,684	11,357,658	3,900,087	-	-	-
2049	3,616,315	2,348,193	-	465,551	802,571	2,207,302	10,470,058	2,327,471	-	-	-
2050	3,273,753	2,295,146	-	360,988	617,619	2,157,437	9,721,375	754,855	-	-	-

H.20 Central scenario (no frontloading of APCR allowances) with high financial sector hurdle rate

Table 125: Central scenario with high hurdle rate, prices by year

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2023	63.33	45.37	58.31	19.41	71.23
2024	64.04	47.65	61.21	20.39	74.79
2025	70.00	50.03	64.28	21.40	78.54
2026	72.97	52.53	67.49	22.47	82.46
2027	75.66	55.15	70.87	23.60	86.59
2028	80.77	57.91	74.41	24.77	90.92
2029	88.53	60.81	78.13	26.02	95.46
2030	95.12	63.85	82.04	27.32	100.23
2031	90.64	67.04	86.15	28.69	105.24
2032	91.92	70.40	90.45	30.11	110.50
2033	96.53	73.91	94.98	31.62	116.03
2034	99.73	77.61	99.73	33.20	121.83
2035	63.41	81.49	104.71	34.86	127.92
2036	58.11	85.57	109.95	36.60	134.32
2037	58.44	89.84	115.44	38.43	141.04
2038	59.72	94.33	121.21	40.35	148.08
2039	46.00	99.05	127.27	42.38	155.49
2040	44.49	104.00	133.63	44.49	163.27
2041	46.72	109.20	140.32	46.72	171.43
2042	49.05	114.66	147.34	49.05	180.00
2043	51.50	120.39	154.70	51.50	189.00
2044	54.08	126.42	162.43	54.08	198.46
2045	56.78	132.74	170.56	56.78	208.37
2046	59.62	139.38	179.09	59.62	218.80
2047	63.52	146.34	188.04	62.61	229.73
2048	67.43	153.66	197.44	65.74	241.22
2049	72.92	161.35	207.31	69.03	253.28

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2050	82.58	169.41	217.68	72.48	265.95

Table 126: Central scenario with high hurdle rate, volumes by year

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2023	56,874,994	12,216,569	10,972,931	8,406,896	25,278,598	27,750,932	58,354,932	58,501,299	1,578,216	1,577,918	-
2024	52,846,298	11,248,078	9,094,768	8,213,335	24,290,117	24,293,648	55,248,639	54,097,976	1,578,216	1,577,918	-
2025	48,192,462	10,609,362	6,959,114	7,925,235	22,698,751	20,889,320	51,877,213	49,694,652	1,459,425	1,459,137	-
2026	43,994,139	9,982,731	5,353,109	7,136,877	21,521,423	17,848,569	48,633,872	45,291,328	1,340,635	1,341,052	-
2027	41,427,760	9,333,738	5,292,773	6,556,615	20,244,635	16,480,739	47,114,812	40,888,005	1,221,844	1,222,013	-
2028	38,964,427	8,657,243	5,379,086	5,990,751	18,937,347	15,585,921	45,684,197	36,484,681	1,103,054	1,103,054	-
2029	36,640,629	7,978,002	5,569,488	5,472,566	17,620,572	14,835,183	44,333,454	32,081,358	984,264	984,264	-
2030	33,996,628	7,281,056	5,256,464	5,165,627	16,293,481	13,448,081	42,546,031	27,678,034	865,473	864,679	-
2031	31,425,068	6,640,882	4,932,744	4,828,650	15,022,792	12,366,245	40,737,212	26,482,846	746,683	746,902	-
2032	29,014,876	6,036,403	4,622,529	4,516,274	13,839,670	11,341,235	38,876,018	25,287,658	714,440	714,542	-
2033	26,802,858	5,475,837	4,307,624	4,245,680	12,773,717	10,373,369	37,125,878	24,092,471	682,196	682,668	-
2034	24,629,937	4,948,555	3,987,465	3,956,820	11,737,098	9,433,268	35,292,279	22,897,283	649,953	649,763	-
2035	22,713,169	4,487,262	3,662,372	3,735,038	10,828,498	8,576,019	33,548,365	21,702,095	617,710	460,768	-
2036	20,534,269	4,148,303	3,316,312	3,330,487	9,739,166	7,799,691	31,495,134	20,506,907	-	-	-
2037	18,416,625	3,910,463	2,969,775	2,898,338	8,638,050	7,132,257	29,391,857	19,311,719	-	-	-
2038	16,324,429	3,714,027	2,617,608	2,459,515	7,533,278	6,497,779	27,150,918	18,116,531	-	-	-
2039	14,533,192	3,551,396	2,259,910	2,195,489	6,526,396	5,906,053	24,950,546	16,921,344	-	-	-
2040	12,832,744	3,398,237	1,896,681	1,949,516	5,588,310	5,320,979	22,709,819	15,726,156	-	-	-
2041	11,290,539	3,238,028	1,527,591	1,779,134	4,745,785	4,740,354	20,802,497	14,530,968	-	-	-1,088,168
2042	9,786,613	3,071,672	1,153,276	1,597,502	3,964,163	4,155,668	19,072,717	13,335,780	-	-	-2,604,067
2043	8,378,433	2,916,434	773,906	1,421,631	3,266,462	3,585,014	17,461,103	11,763,164	-	-	-2,515,018
2044	7,062,721	2,770,276	389,463	1,239,890	2,663,092	3,025,759	15,917,890	10,190,549	-	-	-4,554,689
2045	5,845,311	2,632,492	-	1,062,439	2,150,380	2,477,730	14,442,484	8,617,933	-	-	-3,504,152
2046	5,101,274	2,507,521	-	868,245	1,725,508	2,357,070	13,409,501	7,045,318	-	-	-2,308,410
2047	4,428,355	2,392,819	-	694,433	1,341,103	2,249,250	12,371,031	5,472,702	-	-	-591,599
2048	3,849,105	2,284,706	-	551,921	1,012,478	2,147,624	11,357,658	3,900,087	-	-	-
2049	3,376,836	2,183,643	-	426,597	766,596	2,052,624	10,470,058	2,327,471	-	-	-
2050	3,007,260	2,096,509	-	323,194	587,558	1,970,718	9,721,375	754,855	-	-	-

H.21 Central scenario (no frontloading of APCR allowances) with slower power sector decarbonization

Table 127: Central scenario with slower power sector decarbonization, prices by year

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2023	71.23	45.37	58.31	19.41	71.23
2024	71.62	47.65	61.21	20.39	74.79
2025	78.09	50.03	64.28	21.40	78.54
2026	80.77	52.53	67.49	22.47	82.46
2027	81.56	55.15	70.87	23.60	86.59
2028	85.85	57.91	74.41	24.77	90.92
2029	93.32	60.81	78.13	26.02	95.46
2030	99.72	63.85	82.04	27.32	100.23
2031	92.60	67.04	86.15	28.69	105.24
2032	92.12	70.40	90.45	30.11	110.50
2033	94.98	73.91	94.98	31.62	116.03
2034	99.73	77.61	99.73	33.20	121.83
2035	64.81	81.49	104.71	34.86	127.92
2036	59.00	85.57	109.95	36.60	134.32
2037	59.43	89.84	115.44	38.43	141.04
2038	60.51	94.33	121.21	40.35	148.08
2039	46.81	99.05	127.27	42.38	155.49
2040	44.49	104.00	133.63	44.49	163.27
2041	46.72	109.20	140.32	46.72	171.43
2042	49.05	114.66	147.34	49.05	180.00
2043	51.50	120.39	154.70	51.50	189.00
2044	54.08	126.42	162.43	54.08	198.46
2045	56.78	132.74	170.56	56.78	208.37
2046	59.62	139.38	179.09	59.62	218.80
2047	63.11	146.34	188.04	62.61	229.73
2048	66.74	153.66	197.44	65.74	241.22
2049	72.01	161.35	207.31	69.03	253.28

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2050	80.93	169.41	217.68	72.48	265.95

Table 128: Central scenario with slower power sector decarbonization, volumes by year

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2023	57,669,319	12,053,805	12,070,224	8,367,494	25,177,797	28,660,024	59,452,225	58,501,299	1,578,216	1,578,216	1,891,688
2024	53,439,781	11,102,909	10,004,244	8,175,142	24,157,486	25,035,954	56,158,116	54,097,976	1,459,425	1,458,813	-
2025	48,458,892	10,450,374	7,655,025	7,875,654	22,477,838	21,401,100	52,573,124	49,694,652	1,340,635	1,341,247	-
2026	44,010,734	9,825,875	5,888,420	7,016,746	21,279,694	18,174,287	49,169,182	45,291,328	1,221,844	1,221,844	-
2027	41,386,079	9,173,905	5,822,051	6,397,617	19,992,507	16,788,764	47,644,089	40,888,005	1,103,054	1,102,832	-
2028	38,901,117	8,493,114	5,916,995	5,811,086	18,679,921	15,893,913	46,222,105	36,484,681	984,264	984,485	-
2029	36,591,097	7,808,505	6,126,437	5,282,883	17,373,273	15,157,705	44,890,403	32,081,358	865,473	865,473	-
2030	33,908,898	7,101,298	5,782,110	4,971,188	16,054,302	13,739,048	43,071,678	27,678,034	746,683	746,155	-
2031	31,325,274	6,464,344	5,426,018	4,632,661	14,802,250	12,634,305	41,230,486	26,482,846	714,440	714,967	-
2032	28,923,939	5,873,653	5,084,782	4,326,623	13,638,881	11,598,290	39,338,271	25,287,658	682,196	682,196	-
2033	26,733,734	5,330,536	4,738,386	4,062,758	12,602,054	10,621,620	37,556,640	24,092,471	649,953	628,126	-
2034	24,566,833	4,821,351	4,386,211	3,780,084	11,579,187	9,672,096	35,691,026	22,897,283	617,710	289,637	-
2035	22,650,060	4,378,339	4,028,609	3,561,486	10,681,627	8,804,005	33,914,602	21,702,095	-	-	-
2036	20,499,390	4,073,873	3,647,944	3,167,873	9,609,700	8,031,090	31,826,765	20,506,907	-	-	-
2037	18,426,645	3,885,931	3,266,753	2,752,256	8,521,706	7,380,939	29,688,835	19,311,719	-	-	-
2038	16,365,592	3,713,661	2,879,369	2,333,682	7,438,880	6,739,111	27,412,679	18,116,531	-	-	-
2039	14,571,082	3,551,256	2,485,901	2,083,575	6,450,350	6,116,194	25,176,537	16,921,344	-	-	-
2040	12,865,336	3,398,420	2,086,349	1,851,689	5,528,878	5,499,277	22,899,487	15,726,156	-	-	-510,977
2041	11,312,139	3,238,821	1,680,350	1,692,747	4,700,221	4,885,651	20,955,256	14,530,968	-	-	-2,571,990
2042	9,797,827	3,073,719	1,268,604	1,523,177	3,932,328	4,267,568	19,188,044	13,335,780	-	-	-2,517,703
2043	8,376,326	2,920,843	851,297	1,359,457	3,244,729	3,663,503	17,538,494	11,763,164	-	-	-4,602,979
2044	7,046,031	2,778,645	428,409	1,189,788	2,649,190	3,071,270	15,956,836	10,190,549	-	-	-3,604,608
2045	5,812,894	2,646,799	-	1,023,850	2,142,245	2,491,063	14,442,484	8,617,933	-	-	-2,447,632
2046	5,093,369	2,529,761	-	842,351	1,721,256	2,377,976	13,409,501	7,045,318	-	-	-770,708
2047	4,443,146	2,424,375	-	678,513	1,340,258	2,278,913	12,371,031	5,472,702	-	-	-
2048	3,883,532	2,325,596	-	543,498	1,014,438	2,186,061	11,357,658	3,900,087	-	-	-
2049	3,425,413	2,231,924	-	423,488	770,001	2,098,008	10,470,058	2,327,471	-	-	-
2050	3,064,677	2,149,320	-	323,830	591,527	2,020,361	9,721,375	754,855	-	-	-

H.22 Central scenario (no frontloading of APCR allowances) with faster power sector decarbonization

Table 129: Central scenario with faster power sector decarbonization, prices by year

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2023	60.97	45.37	58.31	19.41	71.23
2024	61.21	47.65	61.21	20.39	74.79
2025	66.17	50.03	64.28	21.40	78.54
2026	68.86	52.53	67.49	22.47	82.46
2027	71.41	55.15	70.87	23.60	86.59
2028	76.24	57.91	74.41	24.77	90.92
2029	83.34	60.81	78.13	26.02	95.46
2030	89.63	63.85	82.04	27.32	100.23
2031	87.20	67.04	86.15	28.69	105.24
2032	90.21	70.40	90.45	30.11	110.50
2033	94.98	73.91	94.98	31.62	116.03
2034	96.23	77.61	99.73	33.20	121.83
2035	64.30	81.49	104.71	34.86	127.92
2036	58.66	85.57	109.95	36.60	134.32
2037	58.79	89.84	115.44	38.43	141.04
2038	59.87	94.33	121.21	40.35	148.08
2039	46.22	99.05	127.27	42.38	155.49
2040	44.49	104.00	133.63	44.49	163.27
2041	46.72	109.20	140.32	46.72	171.43
2042	49.05	114.66	147.34	49.05	180.00
2043	51.50	120.39	154.70	51.50	189.00
2044	54.08	126.42	162.43	54.08	198.46
2045	56.78	132.74	170.56	56.78	208.37
2046	59.62	139.38	179.09	59.62	218.80
2047	63.31	146.34	188.04	62.61	229.73
2048	67.10	153.66	197.44	65.74	241.22
2049	72.52	161.35	207.31	69.03	253.28

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2050	81.58	169.41	217.68	72.48	265.95

Table 130: Central scenario with faster power sector decarbonization, volumes by year

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2023	55,896,578	12,276,026	9,875,638	8,423,284	25,321,631	26,723,695	57,257,639	58,501,299	1,578,216	1,576,670	-
2024	52,120,161	11,344,645	8,185,291	8,234,067	24,356,158	23,492,706	54,339,162	54,097,976	1,459,425	872,013	-
2025	47,707,403	10,677,664	6,263,202	7,957,400	22,809,137	20,278,046	51,181,302	49,694,652	1,340,635	1,929,192	-
2026	43,769,553	10,074,227	4,817,798	7,216,931	21,660,597	17,439,915	48,098,561	45,291,328	1,221,844	1,222,074	-
2027	41,295,314	9,452,587	4,763,496	6,669,142	20,410,089	16,113,606	46,585,535	40,888,005	1,103,054	1,102,378	-
2028	38,889,142	8,805,122	4,841,178	6,124,659	19,118,183	15,244,150	45,146,288	36,484,681	984,264	985,110	-
2029	36,598,104	8,153,239	5,012,539	5,619,392	17,812,933	14,502,435	43,776,506	32,081,358	865,473	865,473	-
2030	34,015,312	7,477,188	4,730,817	5,319,764	16,487,543	13,158,931	42,020,385	27,678,034	746,683	746,683	-
2031	31,479,913	6,848,547	4,439,470	4,985,811	15,206,086	12,115,657	40,243,938	26,482,846	714,440	713,761	-
2032	29,079,891	6,244,501	4,160,276	4,667,715	14,007,400	11,116,298	38,413,765	25,287,658	681,997	-	-
2033	26,866,767	5,678,713	3,876,861	4,391,147	12,920,046	10,170,099	36,695,115	24,092,471	650,153	270,988	-
2034	24,696,580	5,143,095	3,588,718	4,094,969	11,869,796	9,249,490	34,893,533	22,897,283	617,710	-	-
2035	22,766,073	4,672,526	3,296,135	3,860,671	10,936,742	8,410,787	33,182,128	21,702,095	-	-	-
2036	20,573,942	4,321,002	2,984,681	3,439,400	9,828,859	7,652,324	31,163,503	20,506,907	-	-	-
2037	18,446,306	4,074,321	2,672,798	2,994,143	8,705,044	7,007,164	29,094,880	19,311,719	-	-	-
2038	16,315,742	3,823,038	2,355,848	2,544,921	7,591,936	6,352,550	26,889,157	18,116,531	-	-	-
2039	14,441,878	3,556,243	2,033,919	2,273,260	6,578,456	5,695,590	24,724,555	16,921,344	-	-	-
2040	12,760,726	3,399,211	1,707,013	2,019,004	5,635,498	5,140,425	22,520,151	15,726,156	-	-	-940,497
2041	11,246,845	3,239,351	1,374,832	1,843,056	4,789,606	4,594,911	20,649,738	14,530,968	-	-	-2,610,501
2042	9,773,401	3,073,935	1,037,949	1,655,916	4,005,601	4,046,674	18,957,389	13,335,780	-	-	-2,491,615
2043	8,396,160	2,920,574	696,516	1,474,759	3,304,312	3,514,118	17,383,713	11,763,164	-	-	-4,617,315
2044	7,113,227	2,777,606	350,516	1,287,860	2,697,244	2,994,950	15,878,943	10,190,549	-	-	-3,531,377
2045	5,930,691	2,644,625	-	1,105,420	2,180,646	2,489,263	14,442,484	8,617,933	-	-	-2,290,650
2046	5,182,364	2,526,063	-	904,552	1,751,748	2,374,500	13,409,501	7,045,318	-	-	-607,744
2047	4,506,948	2,418,847	-	725,105	1,362,997	2,273,716	12,371,031	5,472,702	-	-	-
2048	3,925,892	2,318,146	-	577,639	1,030,108	2,179,057	11,357,658	3,900,087	-	-	-
2049	3,451,242	2,222,816	-	447,848	780,578	2,089,447	10,470,058	2,327,471	-	-	-
2050	3,078,240	2,139,078	-	340,630	598,532	2,010,733	9,721,375	754,855	-	-	-

H.23 Central scenario (no frontloading of APCR allowances) with slower transportation sector decarbonization

Table 131: Central scenario with slower transportation sector decarbonization, prices by year

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2023	69.17	45.37	58.31	19.41	71.23
2024	69.20	47.65	61.21	20.39	74.79
2025	75.43	50.03	64.28	21.40	78.54
2026	78.22	52.53	67.49	22.47	82.46
2027	80.82	55.15	70.87	23.60	86.59
2028	86.15	57.91	74.41	24.77	90.92
2029	94.10	60.81	78.13	26.02	95.46
2030	100.23	63.85	82.04	27.32	100.23
2031	98.32	67.04	86.15	28.69	105.24
2032	100.63	70.40	90.45	30.11	110.50
2033	105.06	73.91	94.98	31.62	116.03
2034	105.70	77.61	99.73	33.20	121.83
2035	78.00	81.49	104.71	34.86	127.92
2036	71.97	85.57	109.95	36.60	134.32
2037	71.56	89.84	115.44	38.43	141.04
2038	72.29	94.33	121.21	40.35	148.08
2039	51.36	99.05	127.27	42.38	155.49
2040	47.63	104.00	133.63	44.49	163.27
2041	47.57	109.20	140.32	46.72	171.43
2042	49.05	114.66	147.34	49.05	180.00
2043	51.50	120.39	154.70	51.50	189.00
2044	54.08	126.42	162.43	54.08	198.46
2045	56.78	132.74	170.56	56.78	208.37
2046	60.66	139.38	179.09	59.62	218.80
2047	66.28	146.34	188.04	62.61	229.73
2048	71.75	153.66	197.44	65.74	241.22
2049	78.80	161.35	207.31	69.03	253.28

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2050	89.78	169.41	217.68	72.48	265.95

Table 132: Central scenario with slower transportation sector decarbonization, volumes by year

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2023	56,409,245	11,862,415	10,972,931	8,372,229	25,201,671	27,374,373	58,354,932	58,501,299	1,578,216	1,577,609	-
2024	52,569,284	11,102,905	9,094,768	8,181,312	24,190,300	24,130,004	55,248,639	54,097,976	1,459,425	1,460,032	-
2025	47,814,371	10,450,361	6,959,114	7,878,775	22,526,121	20,706,720	51,877,213	49,694,652	1,340,635	1,339,430	-
2026	43,477,892	9,825,847	5,353,109	6,976,528	21,322,408	17,621,213	48,633,872	45,291,328	1,221,844	1,221,534	-
2027	41,047,488	9,173,394	5,292,773	6,310,701	20,270,619	16,222,737	47,262,357	40,888,005	1,103,054	1,104,570	-
2028	38,728,316	8,491,549	5,379,086	5,680,310	19,177,371	15,302,986	45,982,556	36,484,681	984,264	984,264	-
2029	36,544,402	7,806,229	5,569,488	5,111,588	18,057,097	14,536,113	44,785,506	32,081,358	865,473	865,473	-
2030	34,009,790	7,096,134	5,256,464	4,752,202	16,904,990	13,139,943	43,153,312	27,678,034	746,683	746,683	-
2031	31,487,709	6,442,107	4,932,744	4,337,104	15,775,754	12,045,224	41,500,280	26,482,846	714,440	714,440	-
2032	29,122,674	5,812,381	4,622,529	3,975,671	14,712,094	11,002,224	39,785,325	25,287,658	682,196	682,196	-
2033	26,939,079	5,224,909	4,307,624	3,664,648	13,741,899	10,015,827	38,174,406	24,092,471	649,953	649,953	-
2034	24,919,520	4,774,408	3,987,465	3,353,692	12,803,956	9,158,109	36,473,367	22,897,283	617,710	617,710	-
2035	23,076,974	4,349,832	3,662,372	3,099,094	11,965,677	8,342,113	34,857,461	21,702,095	-	-	-
2036	21,037,497	4,061,666	3,316,312	2,694,322	10,965,197	7,624,409	32,963,471	20,506,907	-	-	-
2037	19,108,737	3,879,742	2,969,775	2,327,355	9,931,865	7,020,907	31,031,589	19,311,719	-	-	-
2038	17,208,846	3,708,331	2,617,608	1,992,777	8,890,130	6,423,516	28,928,277	18,116,531	-	-	-
2039	15,534,404	3,545,803	2,259,910	1,792,754	7,935,937	5,845,057	26,835,704	16,921,344	-	-	-
2040	13,897,077	3,392,621	1,896,681	1,590,385	7,017,390	5,273,380	24,676,880	15,726,156	-	-	-
2041	12,397,076	3,232,008	1,527,591	1,449,436	6,188,041	4,703,375	22,828,509	14,530,968	-	-	-
2042	10,880,394	3,064,640	1,153,276	1,299,314	5,363,164	4,127,588	21,135,488	13,335,780	-	-	-133,759
2043	9,424,895	2,907,513	773,906	1,155,678	4,587,798	3,563,597	19,539,602	11,763,164	-	-	-3,227,825
2044	8,034,171	2,758,266	389,463	1,006,611	3,879,831	3,008,405	17,991,786	10,190,549	-	-	-2,118,454
2045	6,719,582	2,616,017	-	861,255	3,242,311	2,461,640	16,491,186	8,617,933	-	-	-886,661
2046	5,872,768	2,485,490	-	705,710	2,681,568	2,336,361	15,413,124	7,045,318	-	-	-
2047	5,070,957	2,364,966	-	564,769	2,141,223	2,223,068	14,291,175	5,472,702	-	-	-
2048	4,347,213	2,252,337	-	450,404	1,644,472	2,117,197	13,146,460	3,900,087	-	-	-
2049	3,750,865	2,149,484	-	349,011	1,252,370	2,020,515	12,115,074	2,327,471	-	-	-
2050	3,279,738	2,063,006	-	263,973	952,759	1,939,226	11,214,928	754,855	-	-	-

H.24 Central scenario (no frontloading of APCR allowances) with faster transportation sector decarbonization

Table 133: Central scenario with faster transportation sector decarbonization, prices by year

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2023	66.03	45.37	58.31	19.41	71.23
2024	65.83	47.65	61.21	20.39	74.79
2025	71.69	50.03	64.28	21.40	78.54
2026	74.47	52.53	67.49	22.47	82.46
2027	74.87	55.15	70.87	23.60	86.59
2028	78.59	57.91	74.41	24.77	90.92
2029	85.28	60.81	78.13	26.02	95.46
2030	91.72	63.85	82.04	27.32	100.23
2031	86.15	67.04	86.15	28.69	105.24
2032	86.93	70.40	90.45	30.11	110.50
2033	91.38	73.91	94.98	31.62	116.03
2034	92.63	77.61	99.73	33.20	121.83
2035	58.53	81.49	104.71	34.86	127.92
2036	53.04	85.57	109.95	36.60	134.32
2037	52.73	89.84	115.44	38.43	141.04
2038	53.41	94.33	121.21	40.35	148.08
2039	43.95	99.05	127.27	42.38	155.49
2040	44.49	104.00	133.63	44.49	163.27
2041	46.72	109.20	140.32	46.72	171.43
2042	49.05	114.66	147.34	49.05	180.00
2043	51.50	120.39	154.70	51.50	189.00
2044	54.08	126.42	162.43	54.08	198.46
2045	56.78	132.74	170.56	56.78	208.37
2046	59.62	139.38	179.09	59.62	218.80
2047	62.60	146.34	188.04	62.61	229.73
2048	65.74	153.66	197.44	65.74	241.22
2049	70.57	161.35	207.31	69.03	253.28

Year	Allowance price ($)	APCR1 trigger price ($)	APCR2 trigger price ($)	Price floor ($)	Price ceiling ($)
2050	79.11	169.41	217.68	72.48	265.95

Table 134: Central scenario with faster transportation sector decarbonization, volumes by year

Year	Total emissions (MTCO2e)	Industry emissions (MTCO2e)	Power emissions (MTCO2e)	Building emissions (MTCO2e)	Transport emissions (MTCO2e)	No cost emissions (MTCO2e)	BAU emissions (MTCO2e)	Cap excluding all reserves (MTCO2e)	APCR1 releases (MTCO2e)	APCR2 releases (MTCO2e)	Price ceiling/floor releases (MTCO2e)
2023	56,899,375	12,264,375	10,972,931	8,401,965	25,260,105	27,795,592	58,354,932	58,501,299	1,578,216	1,576,483	-
2024	52,878,336	11,292,980	9,094,768	8,212,352	24,278,237	24,338,015	55,248,639	54,097,976	1,459,425	1,461,158	-
2025	48,225,113	10,662,414	6,959,114	7,929,813	22,673,772	20,944,736	51,877,213	49,694,652	1,340,635	1,340,635	-
2026	44,111,488	10,060,482	5,353,109	7,176,758	21,521,140	17,943,891	48,633,872	45,291,328	1,221,844	1,220,941	-
2027	41,336,892	9,446,654	5,292,773	6,633,558	19,963,907	16,622,341	46,903,869	40,888,005	1,103,054	1,102,836	-
2028	38,707,941	8,815,990	5,379,086	6,100,449	18,412,415	15,783,095	45,269,135	36,484,681	984,264	984,516	-
2029	36,278,707	8,189,461	5,569,488	5,609,059	16,910,699	15,090,617	43,723,671	32,081,358	865,473	866,342	-
2030	33,562,177	7,545,093	5,256,464	5,326,452	15,434,168	13,749,464	41,754,646	27,678,034	746,683	746,683	-
2031	30,964,696	6,950,707	4,932,744	5,023,704	14,057,541	12,711,972	39,779,315	26,482,846	714,440	105,657	-
2032	28,539,794	6,378,353	4,622,529	4,732,122	12,806,790	11,715,354	37,775,635	25,287,658	682,085	-	-
2033	26,329,830	5,840,313	4,307,624	4,478,826	11,703,068	10,766,204	35,904,777	24,092,471	650,065	-	-
2034	24,168,713	5,325,450	3,987,465	4,201,267	10,654,531	9,834,208	33,971,195	22,897,283	617,710	-	-
2035	22,255,961	4,876,656	3,662,372	3,986,398	9,730,536	8,984,489	32,147,600	21,702,095	-	-	-
2036	20,073,924	4,522,775	3,316,312	3,581,280	8,653,557	8,189,317	30,011,988	20,506,907	-	-	-
2037	17,969,088	4,278,814	2,969,775	3,128,076	7,592,423	7,511,476	27,848,935	19,311,719	-	-	-
2038	15,861,473	4,036,744	2,617,608	2,649,005	6,558,115	6,828,685	25,595,375	18,116,531	-	-	-
2039	14,019,615	3,779,710	2,259,910	2,356,164	5,623,830	6,142,782	23,418,162	16,921,344	-	-	-
2040	12,253,718	3,499,525	1,896,681	2,091,230	4,766,282	5,432,880	21,226,027	15,726,156	-	-	-2,913,080
2041	10,678,811	3,241,131	1,527,591	1,910,088	4,000,001	4,755,711	19,384,443	14,530,968	-	-	-3,454,854
2042	9,248,845	3,076,335	1,153,276	1,718,058	3,301,176	4,168,731	17,731,912	13,335,780	-	-	-3,173,032
2043	7,914,404	2,924,489	773,906	1,532,264	2,683,745	3,598,007	16,204,155	11,763,164	-	-	-5,114,303
2044	6,669,156	2,784,289	389,463	1,340,760	2,154,645	3,041,554	14,747,216	10,190,549	-	-	-4,064,840
2045	5,519,403	2,655,740	-	1,153,811	1,709,852	2,499,857	13,358,552	8,617,933	-	-	-2,879,671
2046	4,835,787	2,543,490	-	946,706	1,345,591	2,390,880	12,410,428	7,045,318	-	-	-1,199,962
2047	4,238,337	2,444,273	-	761,755	1,032,310	2,297,617	11,481,112	5,472,702	-	-	-89,431
2048	3,741,534	2,352,493	-	609,196	779,845	2,211,343	10,603,100	3,900,087	-	-	-13,033
2049	3,333,469	2,265,413	-	474,522	593,534	2,129,488	9,835,340	2,327,471	-	-	-
2050	3,010,156	2,187,872	-	363,094	459,190	2,056,600	9,190,077	754,855	-	-	-