DEPARTMENT OF
ECOLOGY
State of Washington

# Preliminary Cost-Benefit and Least-Burdensome Alternative Analysis:

## Chapter 173-442 WAC, Clean Air Rule and Chapter 173-441 WAC, Reporting of Emissions of Greenhouse Gases

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# Preliminary Cost-Benefit and Least-Burdensome Alternative Analysis:

## Chapter 173-442 WAC, Clean Air Rule and Chapter 173-441 WAC, Reporting of Emissions of Greenhouse Gases

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# Executive Summary

This report presents the economic analyses performed by Ecology to estimate the costs and benefits of the proposed Clean Air Rule (Chapter 173-442 WAC), and corresponding amendments to the Reporting of Emissions of Greenhouse Gases rule (Chapter 173-441 WAC). These analyses – the Cost-Benefit Analysis (CBA) and Least-Burdensome Alternative Analysis (LBA) – are based on the best available information at the time of publication.

The purpose of this rulemaking is to reduce greenhouse gas (GHG) emissions to protect human health and the environment. GHG emissions as a result of human activities have increased to unprecedented levels, warming the climate. Washington has experienced long-term climate change impacts consistent with those expected from climate change. Washington faces serious economic and environmental disruption from the effects of these long-term changes.

The proposed rulemaking creates a program limiting greenhouse gas emissions from certain large emission contributors and allowing various compliance options to meet those limitations. It also includes reporting and verification of compliance.

The proposed rule establishes GHG emissions standards for:

- Stationary sources
- Petroleum fuel producers and/or importers
- Natural gas distributors operating in Washington

If they meet GHG emissions thresholds that begin at 100,000 metric tons (MT) per year of carbon-dioxide equivalent emissions in 2017, these parties have a compliance obligation to limit and reduce GHG emissions over time, through 2035.

Covered parties with compliance obligations under the proposed rule must report compliance after every three-year compliance period and have compliance verified by a third party. They have various options for compliance, including:

- Reducing their own GHG emissions;
- Acquiring emissions reduction units from another covered party that has reduced GHG emissions in excess of what is required of them;
- Acquiring or generating emissions reduction units from approved alternative GHG reduction projects in Washington;
- Acquiring emissions reduction units from non-regulated parties that voluntarily participate;
- Acquiring GHG emissions reduction instruments from an approved external market or registry.

**Cost-Benefit Analysis Results**
Ecology determined that, compared to business as usual, the proposed rule has the following costs and benefits:

**Costs**
Likely 20-year present value (if quantified) costs included:

- Average costs of GHG emissions reductions, across multiple compliance scenarios:
  - For covered parties, except petroleum and natural gas fuel importers, approximately $190 million to $460 million
  - For covered petroleum and natural gas importers, approximately $10 million to $40 million for covered imports
- Additional reporting costs of $342,000
- Verification costs of $6.8 million
- Increased reporting fees of $3 million
- Possible associated criteria and toxic air pollutant emissions increases in limited cases

Quantified present-value costs, taking average costs across multiple scenarios, total between $210 million and $510 million over 20 years. For some of the covered parties, these costs are likely to be passed through and borne by their customers.

| **Average Annual Present-Value Costs Above BAU** | | | |
|---|---|---|---|
| | **Covered Party excluding coverage for produced or imported fuels** | **Fuel Producer*** | **Fuel Importer** |
| GHG Emissions Reduction Costs | $49,000 - $131,000 | $137.000 - $363,000 | $23,000 - $91,000 |
| Reporting Costs[1] | $200 | | |
| Verification Costs | $4000 | | |
| Reporting Fees | Up to $2000 | | $2000 |

**Benefits**
Likely benefits include, in 20-year present values where quantified:

- Avoided costs of GHG emissions impacts, between $13 billion and $14 billion
- Avoided costs of associated criteria and toxic air pollutants, if reductions are achieved on site or using in-state projects
- Transfers from emissions reduction unit sales and reduction services, if reductions are achieved on site or using in-state projects
- Co-benefits of emissions reduction projects
- Reduced reporting fees for transportation fuel suppliers, of $196,000

Quantified present-value benefits, regardless of compliance scenario, total at least $13 billion.

[1] Averaged across covered entities that experience new reporting as well as those that already report and are not expected to incur additional costs under the proposed rule.

Ecology concludes, based on reasonable understanding of the quantified and qualitative costs and benefits likely to arise from the proposed rule, that the benefits of the proposed rule are likely greater than the costs.

**Least-Burdensome Alternative Results**
Ecology assessed alternatives to elements of the proposed rule, and determined whether they met the goals and objectives of the authorizing statutes. Of those that would meet these goals and objectives, Ecology determined whether those chosen for the proposed rule were the least burdensome.

Alternatives included:

- Broader applicability (e.g., to include all fuels)
- Broader baseline-determination range
- No offsetting (require all emissions be on-site)
- Not including natural gas or transportation fuels as covered emissions categories
- Linking Washington's program directly to existing market programs
- Efficiency-based emissions standards
- Excluding fuel importers from coverage
- Remove petition system for energy-intensive and trade-exposed (EITE) covered parties
- A different threshold for coverage
- A higher rate of emission reductions over time
- A lower rate of emission reductions over time

# Chapter 1: Background and Introduction

## 1.1 Introduction

This report presents the economic analyses performed by Ecology to estimate the costs and benefits of the proposed Clean Air Rule (Chapter 173-442 WAC), and corresponding amendments to the Reporting of Emissions of Greenhouse Gases rule (Chapter 173-441 WAC). These analyses – the Cost-Benefit Analysis (CBA) and Least-Burdensome Alternative Analysis (LBA) – are based on the best available information at the time of publication.

The Washington Administrative Procedure Act (APA; RCW 34.05.328) 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 through 5 of this document describe that determination.

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.

## 1.2 Summary of the proposed rulemaking

The proposed rulemaking creates a program limiting greenhouse gas (GHG) emissions from certain large emission contributors, and allowing various compliance options to meet those limitations. It also includes reporting and verification of compliance.

The proposed rule establishes GHG emissions standards for:

- Stationary sources
- Petroleum fuel producers and/or importers
- Natural gas distributors operating in Washington

If they meet GHG emissions thresholds that begin at 100,000 metric tons (MT) per year of carbon-dioxide equivalent emissions in 2017, these parties have a compliance obligation to limit and reduce GHG emissions over time, through 2035.

Covered parties with compliance obligations under the proposed rule must report compliance after every three-year compliance period, and have compliance verified by a third party. They have various options for compliance, including:

- Reducing their own GHG emissions;
- Acquiring emissions reduction units from another covered party that has reduced GHG emissions in excess of what is required of them;
- Acquiring or generating emissions reduction units from approved alternative GHG reduction projects in Washington;
- Acquiring emissions reduction units from non-regulated parties that voluntarily participate;
- Acquiring GHG emissions reduction instruments from an approved external market or registry.

## 1.3 Reasons for the proposed rule

The purpose of this rulemaking is to reduce GHG emissions to protect human health and the environment. GHG emissions as a result of human activities have increased to unprecedented levels, warming the climate.[2] Washington has experienced long-term climate change impacts consistent with those expected from climate change.[3] Washington faces serious economic and environmental disruption from the effects of these long-term changes. For instance:

- An increase in pollution-related illness and death due to poor air quality;
- Declining water supply for drinking, agriculture, wildlife, and recreation;
- An increase in tree die-off and forest mortality because of increasing wildfires, insect outbreaks, and tree diseases;
- The loss of coastal lands because of sea level rise;
- An increase in ocean temperature and ocean acidification;
- An increase in disease and mortality in freshwater fish (salmon, steelhead, and trout), because of warmer water temperatures in the summer and more fluctuation of water levels (river flooding and an increase of water flow in winter while summer flows decrease).
- Heat stress to field crops and tree fruit will be more prevalent because of an increase in temperatures and a decline in irrigation water.

Compliance actions to reduce GHG emissions, such as producing cleaner energy and increasing energy efficiency, have the dual benefit of reducing other types of air pollution.

[2] IPCC, 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp.

[3] Snover, A.K, G.S. Mauger, L.C. Whitely Binder, M. Krosby, and I. Tohver. 2013. Climate Change Impacts and Adaptation in Washington State: Technical Summaries for Decision Makers. State of Knowledge Report prepared for the Washington State Department of Ecology. Climate Impacts Group, University of Washington, Seattle.

In 2008, Washington's Legislature required the specific statewide GHG reductions (RCW 70.235.020) below:

- By 2020, reduce overall emissions of greenhouse gases in the state to 1990 levels
- By 2035, reduce overall emissions of greenhouse gases in the state to 25 percent below 1990 levels
- By 2050, reduce overall emissions of greenhouse gases in the state to 50 percent below 1990 levels or 70 percent below the state's expected emissions that year.

Consistent with the Legislature's intent to reduce greenhouse gas emissions, Ecology is using its existing authority under the State Clean Air Act (Chapter 70.94 RCW) to adopt a rule that limits emissions of greenhouse gases.

## 1.4 Document organization

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

- Business as Usual (BAU)[4] and the proposed rule (Chapter 2): Description and comparison of BAU (what would occur in the absence of the proposed rule) and the proposed rule requirements
- Likely costs of the proposed rule (Chapter 3): Analysis of the types and sizes of costs we expect impacted parties to incur as a result of the proposed rule
- Likely benefits of the proposed rule (Chapter 4): Analysis of the types and sizes of benefits we expect to result from the proposed rule
- Cost-benefit comparison and conclusions (Chapter 5): Discussion of the complete implications of the CBA, and comments on the results
- Least-Burdensome Alternative Analysis (Chapter 6): Analysis of considered alternatives to the contents of the proposed rule

[4] Ecology economic analyses typically use the term "baseline" to refer to the regulatory context in the absence of the proposed rule. Because this rule uses "baseline" as a term referring to specific emissions quantities, we chose to use "business as usual" or "BAU" to avoid confusion.

# Chapter 2: BAU and the Proposed Rule

## 2.1 Introduction

Ecology analyzed the impacts of the proposed rule relative to business as usual (BAU), within the context of all existing requirements (federal and state laws and rules). This context for comparison is called BAU, and reflects the most likely regulatory circumstances that parties would face if the proposed rule were not adopted. It is discussed in Section 2.2, below.

## 2.2 Business as usual (BAU)

BAU for our analyses generally consists of existing rules and laws, and their specific requirements. For economic analyses, BAU also includes the implementation of those regulations, including any guidelines and policies that result in behavior changes and real impacts. This is what allows us to make a consistent comparison between conditions that exist with or without the proposed rule and amendments to the existing rule.

For this proposed rulemaking, BAU includes:

- No existing GHG cap and reduction program at the state level
- The existing GHG reporting rule (Chapter 173-441 WAC), which covers a subset of the parties covered by the proposed rule, and requires annual reporting and payment of fees
- The federal and Washington Clean Air Acts
- Existing federal and state regulations, including those covering GHG reporting at the federal level, as well as those establishing energy policy
- Existing federal and state permitting requirements and processes

While they might otherwise have been considered part of BAU, the proposed rule explicitly exempts compliance with the following requirements from being considered part of BAU:

- The Federal Clean Power Plan
- Washington's Emission Performance Standard

## 2.3 Proposed rule requirements

This rulemaking sets out:

- Who must comply (coverage) – section 2.3.1
- Thresholds – section 2.3.2
- Requirements – section 2.3.3
- Compliance options – section 2.3.4
- Corresponding changes to other rules – section 2.3.5

## 2.3.1 Clean Air Rule coverage

The proposed rule establishes GHG emissions standards for:

- Certain stationary sources
- Petroleum fuel producers or importers
- Natural gas distributors in Washington

### 2.3.1.1 Covered stationary emitter emissions

Covered emissions are GHG emissions that are reported under Chapter 173-441 WAC (Reporting of Emissions of Greenhouse Gases) from stationary sources. This includes emissions voluntarily reported under Chapter 173-441 WAC.

The following types of emissions are not covered as stationary sources by the proposed rule:

- GHG emissions from suppliers of petroleum products;
- GHG emissions from suppliers of natural gas and natural gas liquids;
- GHG emissions from manure management;
- Emissions of carbon dioxide from industrial combustion of biomass in the form of fuel wood, wood waste, wood by-products, and wood residuals;
- Coal-based emissions from a coal-fired baseload electric generation facility in Washington that emitted more than one million tons of GHG in any calendar year before 2008.

The above exemptions are based on existing federal and state laws or definitions, or based on coverage under other parts of the proposed rule, except manure management.[5]

### 2.3.1.2 Covered petroleum fuel producer or importer emissions

The proposed rule covers GHG emissions that would result from the complete combustion or oxidation of fuels covered under 40 Code of Federal Regulations (CFR) Part 98, Subpart MM,[6] from producers or importers distributing fuels in Washington. Covered fuels are those reported to Ecology under Chapter 173-441 WAC. This includes emissions voluntarily reported under Chapter 173-441 WAC.

Emissions from the following types of fuel are not covered by the proposed rule:

- Aviation gasoline
- Kerosene-type jet fuel
- Residual Fuel Oil No. 5 (Navy Special)
- Residual Fuel Oil No. 6 (known as “Bunker C”)
- Fuels exported from Washington, where the final distribution of the product occurs outside of Washington

[5] See applicable federal and state law provisions codified at 40 CFR Part 98, Subpart MM; 40 CFR Part 98, Subpart NN; 40 CFR Part 98, Subpart JJ; RCW 70.235.020(3); RCW 80.80.040(3)(c)
[6] http://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title40/40tab_02.tpl

#### 2.3.1.3 Covered natural gas distributor emissions

The proposed rule covers GHG emissions that would result from the complete combustion or oxidation of fuels covered under 40 CFR Part 98, Subpart NN, from natural gas distributors distributing fuels in Washington that are reported to Ecology under Chapter 173-441 WAC. This includes emissions voluntarily reported under Chapter 173-441 WAC.

This does not include GHG emissions from natural gas supplied to another covered party if that covered party has a compliance obligation for those emissions as a stationary emitter under the proposed rule.

### 2.3.2 Thresholds for compliance obligation under the proposed rule

#### 2.3.2.1 Existing emitters

If their covered GHG emissions are at least 100,000 metric tons (MT) per year, in carbon dioxide-equivalent units ($CO_2e$), parties with covered GHG emissions (see 2.3.1.1 through 2.3.1.3) must comply with the proposed rule beginning in 2017. Emissions used for threshold comparisons are determined using a baseline emissions calculation based on past emissions during 2012 – 2016, or other relevant emissions data.[7]

Emissions are compared to thresholds using a three-year rolling average of total covered GHG emissions.

#### 2.3.2.2 New emitters

The parties with covered GHG emissions, discussed above in sections 2.3.1.1 through 2.3.1.3, must comply with the proposed rule beginning in their first year of operation, if they exceed the following thresholds:

- 100,000 MT per year in years 2017 through 2019
- 95,000 MT per year in years 2020 through 2022
- 90,000 MT per year in years 2023 through 2025
- 85,000 MT per year in years 2026 through 2028
- 80,000 MT per year in years 2029 through 2031
- 75,000 MT per year in years 2032 through 2034
- 70,000 MT per year in 2035

Emissions are compared to thresholds using a three-year rolling average of annual total covered GHG emissions.

### 2.3.3 Clean Air Rule requirements

The proposed rule establishes the following requirements not required elsewhere in existing laws or rules:

- GHG emissions standards and reductions over time
- Compliance reporting
- Verification of compliance

[7] See 173-442-070 for specific data and processes to be used.

#### 2.3.3.1 GHG emissions standards and reductions over time

The proposed rule requires parties that exceed the thresholds discussed above in section 2.3.2 to meet GHG emissions standards beginning in 2017 or the first year that GHG emissions exceed the relevant threshold. Under the proposed rule, Ecology must assign a GHG emissions reduction pathway (series of standards over time) for each GHG emissions contributor in Washington that is covered by the proposed rule, and each voluntary participant in the program set out in the proposed rule.

- In the first year a covered party has a compliance obligation under the proposed rule, the emissions reduction pathway establishes allowable emissions at the baseline GHG emissions calculated for the covered party.[8]
- In subsequent years in which a covered party must comply with the proposed rule (excluding voluntary participants), the emissions reduction pathway sets out allowable GHG emissions based on an annual reduction of 1 2/3 (one and two-thirds) percent of the baseline GHG emissions for that covered party.[9]

#### 2.3.3.2 Compliance reporting

Under the proposed rule, each regulated party must submit a compliance report in the emission year following each compliance period. The report must contain records of:

- Emissions reduction generated: For each emissions reduction unit or block of units, the report must list the source of units, and the source of emissions data or computational method used to generate the unit.
- Emissions reduction units banked: The report must document all emissions reduction units currently being banked by the regulated party. This documentation must include each unit's vintage and origination source.
- Emissions reduction unit transactions: The report must document transactions of emissions reduction units, including reduction unit origin, value, transfer destination, and the names and contact information of any third parties who facilitated, brokered, or otherwise provided liaison services between the regulated parties making the exchange.

#### 2.3.3.3 Verification of compliance

The proposed rule requires emissions reductions to be verified by a third party. Covered parties' three-year compliance period GHG reports under Chapter 173-441 must be verified by a third party, for covered parties with a compliance obligation under the proposed rule, and for those voluntarily participating. Verification addresses compliance report information, requirements, methods, and any discrepancies, errors, omissions, and/or misreporting.

[8] See 173-442-080 for specific data and processes to be used.

[9] For example, if a covered party has calculated baseline emissions of 100,000 MT, the emissions reduction pathway lowers the emissions limit for that party by approximately 1.67,000 each year (that is, 1 2/3 percent of 100,000 = 0.01666 x 100,000 = 1,666). This is equivalent to a reduction of 5 percent every three years (1 2/3 x 3 = 5), which for this example is a reduction of 5000 MT every three years.

Verification involves documentation of:

- Reporting party information
- Verifier information
- Compliance with the proposed rule requirements limiting extended use of the same verifier (no more than six years, with no fewer than three years between six-year uses) and prohibiting verifier conflict of interest
- Verification plan including data and methodologies
- Corrections to the compliance report
- Supporting information of findings
- Certification of accuracy, completeness, and truth
- Required on-site visit

## 2.3.4 Clean Air Rule compliance

Covered parties with compliance obligations, may comply with the proposed rule by reducing emissions in any of the following ways:

- Own emissions reductions: Reduction of a covered party's own emissions below the emissions level set in the covered party's reduction pathway.
- Others' emissions reductions: Other parties' reductions of emissions below their emissions reduction pathways. Reductions can also come from those voluntarily participating in the program.
- Emissions reduction projects: Alternate emissions reductions using projects, activities, or programs recognized by Ecology as capable of generating emissions reduction units under the proposed rule.
- External emissions markets: Existing GHG instruments, including programs, registries, and exchanges that are identified in the proposed rule.

### 2.3.4.1 Own emissions reductions

Covered parties may meet their GHG reduction pathway under the proposed rule by reducing emissions at the covered party location they own or operate. Upon providing verified reporting data for a compliance year, if a covered party's reported emissions level is lower than their established GHG emissions reduction pathway under the proposed rule, the covered party may also generate emissions reduction units for banking or exchange, equal to the difference between the reported covered emissions level and the GHG reduction pathway.

### 2.3.4.2 Others' emissions reductions

Covered parties may meet their GHG emissions reduction pathway under the proposed rule by acquiring emissions reduction units generated by other covered parties whose reported covered emissions were lower than their established GHG emissions reduction pathway. These units are generated when other covered parties report emissions below their pathways, and may be banked or traded in the same way that a covered party's own excess reductions may be converted to GHG emissions reduction units under the proposed rule.

Parties voluntarily participating in the program may also generate emissions reductions, which may be used by covered parties to comply with the proposed rule. When voluntary participants reduce their GHG emissions, these reductions may be banked or traded in the same way as other emissions reduction units under the proposed rule.

#### 2.3.4.3 Emissions reduction projects

GHG reduction units may be generated by projects, activities, or programs recognized by Ecology. These projects must meet the following criteria:

- GHG emissions reductions must be real. A specific, identifiable, and quantifiable reduction of GHG emissions must be demonstrable.
- GHG emissions reductions must be permanent. They may not be reversible, or if reversal is a possibility, mechanisms and other protocols must be in place to account for and insure against reversals.
- GHG emissions reductions must be enforceable. They must derive from sources, parties, or persons under the authority of Washington, or from external emission instrument systems where Ecology can assert control or limitations over the usability of the instruments for compliance with the proposed rule.
- GHG emissions reductions must be verifiable. They must be verified according to the reporting and verification procedures required under the proposed rule.
- GHG emissions reductions must not be required by other laws, rules, or other legal requirement, except where allowed under the proposed rule. This generally means the reductions are not likely to have occurred under BAU, except where explicitly allowed under the proposed rule. The proposed rule explicitly accepts as reductions, for the purposes of this rule, reductions resulting from:
  - The Federal Clean Power Plan
  - Washington's Emission Performance Standard
- The industrial combustion of biomass in the form of fuel wood, wood waste, wood by-products, and wood residuals is treated as carbon-neutral when considering how to calculate greenhouse gas emission reductions from these project types.

Projects include certain actions related to:

- Transportation
- Energy
- Livestock
- Waste and wastewater
- Industrial sector activities

See proposed rule language section 173-442-180 for the specific attributes and requirements of acceptable projects in these categories.

#### 2.3.4.4 External emissions markets

Covered parties may meet compliance obligations by purchasing certain GHG reduction instruments from:

- The Regional Greenhouse Gas Initiative (RGGI)[10] allowances
- California's Cap and Trade Program allowances
- Quebec's Cap and Trade Program allowances
- Offset instruments from:
  - Livestock Projects from the California Cap and Trade Program
  - Mine Methane Capture Projects from California's Cap and Trade Program
  - Ozone Depleting Substance (ODS) Projects from the California Cap and Trade Program

### 2.3.5 Corresponding amendments to other rules

Ecology is also proposing amendments to Chapter 173-441 WAC (Reporting of Emissions of Greenhouse Gases). These amendments correspond to and facilitate requirements and compliance set by the proposed rule. They include:

- Updating adoption by reference dates and citations as required by statute
- Adding corresponding definitions
- Adding GHG reporting requirements for petroleum fuel producers and natural gas distributors
- Adding corresponding third-party verification of GHG reporting requirements for covered parties subject to WAC 173-442
- Adding a procedure for Ecology to assign a GHG emissions level to covered parties that have not fulfilled their reporting requirements
- Reallocation of fees:
  - The existing GHG emissions reporting rule requires 75 percent of the reporting program's budget be paid for through facility reporter fees and 25 percent to be paid for through transportation fuel supplier reporter fees.
  - The proposed rule reallocates fees based on 90 percent of the budget being paid for through covered party reporter (except transportation fuel supplier) fees, and 10 percent being paid for through transportation fuel supplier reporter fees.

[10] RGGI is a cooperative effort among the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont to cap and reduce $CO_2$ emissions from the power sector.

# Chapter 3: Likely Costs of the Proposed Rule

## 3.1 Introduction

Ecology estimated the likely costs associated with the proposed rule, as compared to BAU. The rule and BAU are discussed in detail in Chapter 2 of this document. Likely costs of the proposed rule arise from:

- Meeting GHG emissions reduction pathways
- Reporting
- Verification
- Changes to reporting fees

This chapter also discusses:

- Compliance cost variability: How the choice of compliance method affects costs.
- Compliance cost transfers: How the choice of compliance method affects which and where compliance expenditures create transfers (benefits to those providing goods, services, or transferring emissions reduction units for compliance).
- Pass-through costs: How compliance costs might be passed on or distributed to the public and other parties that are not required to comply with the proposed rule, through interactions in the Washington economy.
- In-state GHG emissions reduction unit supply: Attributes of in-state GHG emissions reduction unit supply.

Ecology's standard practice in compliance with the APA is to use the following parameters when analyzing a proposed rule:

- A 20-year timeframe. This timeframe allows for inclusion of short-term and long-term impacts.
- Appropriate discount rates. When calculating present values (summarizing streams of costs or benefits in terms of current dollars and values), appropriate discount rates are used for the values being discounted. For industry expenses, the appropriate discount rate might be the real (inflation-adjusted) rate of return on invested capital, as it represents the opportunity cost of holding money in one time period versus another. For general values held by the public (e.g., for an environmental service), we use the Social Rate of Time Preference (SRTP), which discounts both for inflation and the preference to hold value now versus later. Ecology's SRTP is based on historic risk-free rates of return on US Treasury I-Bonds, which are indexed to inflation.

- Direct impacts of the proposed rule. Cost and benefit considerations are made based on direct impacts. These are typically the primary impacts of a rule, whereas secondary impacts are neither gains nor losses, but transfers within or between industries and professions.
- Indirect and induced impacts of the proposed rule, where appropriate. While the APA does not consider distributional impacts (costs to one party are transferred as benefits to another party), these impacts can be important information for decision makers to understand the context of a rulemaking for parties that are not directly affected by the proposed rule.

## 3.2 Costs of meeting GHG reduction pathways

To meet their respective GHG emissions reduction pathways under the proposed rule, covered parties will need to reduce emissions using some combination of activities that:

- Reduce emissions on-site at the covered party, or obtain the equivalent of similar reductions from other covered or voluntarily participating parties.
- Offset emissions using an in-state emissions reduction project, as allowed by the proposed rule.
- Purchase emissions instruments through one of the existing carbon markets as allowed by the proposed rule.

Depending on which methods covered parties choose, the range of unit costs (the cost of reducing emissions by one metric ton (MT)) will vary. Ecology expects covered parties to:

- Reduce emissions in a cost-minimizing fashion.
- Account for the types and timing of reductions that are viable on-site (for some covered parties, these might be limited or not exist), the complexity and timing of projects, and the availability of GHG emissions reduction instruments in existing markets.

### 3.2.1 Unit costs of compliance

There are multiple options available for compliance with the proposed rule, including:

- On-site emissions reductions. (This cost range includes the cost of emissions reduction units obtained from other covered parties or voluntary participants, created internally.)
- Emissions reduction projects. (This cost range includes the cost of emissions reduction units obtained from other covered parties or voluntary participants, created through projects.)
- Purchasing instruments in the form of market allowances or offsets from approved existing carbon markets.

Each general type of compliance option is associated with a set of unit costs (cost per MT of carbon-equivalent emissions reduction). Ecology surveyed literature, publications, markets, reports, and marginal abatement cost curves to determine a likely range of compliance costs per MT, for each of the three groups of compliance options:

- On-site emissions reductions: $30 – $65 per MT[11]
  Using primarily research by McKinsey,[12] Ecology extracted approximate costs of on-site compliance options that might be available to some covered parties. These included co-firing woody biomass, industrial feedstock substitution, efficiencies in industrial motor systems, use of wind, and capture and use of waste facility emissions. Ecology then converted reported unit costs to 2015 US dollars using historic exchange rates[13] and an index of inflation.[14]

- Emissions reduction projects: $5 – $29 per MT
  Ecology examined direct prices and market prices of emissions reduction projects that might suffice as emissions reductions under the proposed rule. These extended from voluntary carbon markets to projects developed and funded by government entities. For example, voluntary carbon markets with similar projects averaged $5 per MT[15], while projects contracted by the British Columbia, Canada government were forecasted to reach nearly $30 per MT.[16] Ecology then converted reported unit costs to 2015 US dollars using historic exchange rates[17] and an index of inflation.[18]

- Market emissions reductions: $10 – $15 per MT
  Based on average historic market prices, as well as on market minimum prices set by regulators, Ecology estimated a range of unit costs per MT purchased from the approved markets. Where necessary, we then converted reported unit costs to 2015 US dollars using historic exchange rates[19] and an index of inflation.[20]

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[11] Many of the unit costs of GHG emissions abatement found by McKinsey are reported as "negative cost" (e.g., building insulation). Those costs are reported in the aggregate, wherein the costs of implementing the GHG emissions reduction activity are combined with the avoided costs resulting from the activity. Where resulting reduced costs exceed costs of implementation, the net cost is negative. As the implementation costs and resulting cost reductions may be borne or gained by different parties, we limited this cost range to the costs of implementing GHG emissions reduction activities that might be borne by the covered party. Consequently, this range is likely overestimated for on-site GHG emissions reduction activities that result in efficiencies creating avoided (or reduced) operating costs for the covered party.

[12] McKinsey & Company (2010). Impact of the Financial Crisis on Carbon Economics: Version 2.1 of the Global Greenhouse Gas Abatement Cost Curve.
and
Enkvist P., T. Nauclér, and J. Rosander (2007). A Cost Curve for Greenhouse Gas Reduction. McKinsey & Company.

[13] Canadian Foreign Exchange Services (2015). Yearly Average Exchange Rates for Currencies, from 1990 to 2015.

[14] US Bureau of Labor Statistics. Consumer Price Index.

[15] Ecosystem Marketplace (2015). Ahead of the Curve: State of the Voluntary Carbon Markets 2015.

[16] International Emissions Trading Association (2015). BC Carbon Offsets. Revised March 2015.

[17] Canadian Foreign Exchange Services (2015). Yearly Average Exchange Rates for Currencies, from 1990 to 2015.

[18] US Bureau of Labor Statistics. Consumer Price Index.

[19] Canadian Foreign Exchange Services (2015). Yearly Average Exchange Rates for Currencies, from 1990 to 2015.

[20] US Bureau of Labor Statistics. Consumer Price Index.

There are lower current market prices than this range, but they are in markets with significant volatility and price trajectories that indicate possible significant price growth before stabilization. The Regional Greenhouse Gas Initiative (RGGI), for example, currently sells emissions allowances for under $7. Historic RGGI prices since its creation, however, and accounting for inflation, indicate that real prices could continue to increase significantly, depending on when they stabilize. Based on a rough calculation of year-over-year price changes, and allowing for 2 percent inflation, for example, RGGI prices would be nearing $11 if they stabilize in 2025. Ecology, therefore, chose to include the medium-term forecast in this analysis, which is in the $10 – $15 per MT range. If, however, these existing price trajectories continue into 2035, prices could exceed $20 per MT in current dollars.

### 3.2.2 Emissions reduction pathway

Emissions reduction pathways are defined by the proposed rule. They are based, for individual covered parties, on baseline emissions. To develop the emissions reduction pathways, these baseline emissions are then reduced 1 2/3 percent of baseline emissions each year. (This is equivalent to a five percent reduction every three years.) In this way, the specific emissions reductions required for a covered party are based on that party's individual baseline emissions.

Ecology estimated reduction pathways for likely covered parties in the following ways:

- For parties with recorded emissions data:
  - Based on 2012 through 2014 emissions.[21]
  - Based on 2012 through 2014 data, with the addition 2014-level emissions in 2015 and 2016.[22]
- For fuel importers, for which Ecology does not currently have emissions data:
  - An average representative pathway was based on a range of total emissions likely arising from imported fuels divided across 11 – 18 importers with low, medium, or high likelihood of being covered by the proposed rule. Likelihood of coverage was based on existing data on fuels being imported to the state.[23]

Ecology estimated compliance costs tied to required emissions reductions based on these individual emissions reduction pathways, and their sums.

### 3.2.3 Present value of meeting GHG reduction pathways

Based on estimated reduction pathways for each likely covered party, we estimated the following ranges of compliance costs for GHG emissions reductions required under the proposed rule. Present values are a means of converting future flows of costs over time, to current values. This calculation entails multiplying each year's GHG emission reductions by the unit cost of reductions, and converting these values to current dollars using a 2.5 percent discount rate. These values for each year are then summed to calculate the present value.

[21] Ecology GHG Reporting Program records.
[22] Ecology GHG Reporting Program records.
[23] WA Department of Ecology (2015). Preliminary release table of the Washington State Greenhouse Gas Inventory Report for years 2012 and 2013.
WA Department of Commerce (2013). Petroleum Supply and Use in Washington State. October 2013.
WA Department of Commerce (2015). Updated percentage of fuels that is imported to the state. Communication from Neil Caudill on 12/3/2015.

To represent the ranges of compliance options available to covered parties, Ecology performed the present value calculation for low and high estimates of each group of unit costs (on-site, projects, and market purchases). Various costs of acquiring emissions reduction units from other parties are represented in both the on-site category (for units acquired from other covered or voluntary parties reducing GHG emissions internally), and the projects category (for units acquired from other covered or voluntary parties reducing GHG emissions using in-state projects).

**Table 1: 20-Year Present Value Costs of Emissions Reductions, Except Fuel Importers**

| **20-Year Present Value Costs of Emissions Reductions Except Fuel Importers** | | | |
|---|---|---|---|
| **Based on existing data baseline (2012-2014 emissions)** | | **Based on projected baseline (2012-2016 emissions)** | |
| On-Site Emissions Reductions | | On-Site Emissions Reductions | |
| Low | High | Low | High |
| $373 million | $808 million | $375 million | $813 million |
| Emissions Reduction Projects | | Emissions Reduction Projects | |
| Low | High | Low | High |
| $62 million | $360 million | $63 million | $363 million |
| Market Emissions Reductions | | Market Emissions Reductions | |
| Low | High | Low | High |
| $124 million | $186 million | $125 million | $188 million |
| **Average** | | **Average** | |
| Low | High | Low | High |
| $186 million | $451 million | $188 million | $455 million |

**Table 2: 20-Year Present Value Costs of Emissions Reductions, Fuel Importers**

| **20-Year Present Value Costs of Emissions Reductions Fuel importers** | |
|---|---|
| Internal Emissions Reductions | |
| Low | High |
| $20 million | $72 million |
| Emissions Reduction Projects | |
| Low | High |
| $3 million | $32 million |
| Market Emissions Reductions | |
| Low | High |
| $6 million | $17 million |
| **Average** | |
| Low | High |
| $10 million | $40 million |

Present values are based on likely GHG emissions reductions under the proposed rule, through 2035, across all likely covered parties. They are the sums of individual or average GHG emissions reduction under reduction pathways required by the proposed rule, estimated using

two possible baseline calculations, and three general groups of compliance methods. The number of likely covered parties depends on which baseline calculation is used, and estimated volumes of covered fuels for importers.

Present values are based on a 2.5 percent discount rate. Ecology would typically use a broader risk-free discount rate for calculating present values, which is currently approximately one percent.[24] To correspond to discount rates for available benefits, however, Ecology chose to use the 2.5 percent discount rate. (See discussion of the discount rate in section 4.2.3 of this document.)

It is standard practice to use the most appropriate discount rate for the values being discounted over time. Present value calculations on other subjects use a higher discount rate, reflecting contextually appropriate rates such as the rate of return to capital, or inflation rates on bonds used to fund compliance. In this analysis, Ecology could also have used a higher discount rate to reflect, for example, the rate of return covered parties receive from their own capital (the implied interest rate on borrowing from their own invested capital to pay for compliance activities). Doing so might have caused confusion due to multiple discount rates being used in the analysis, but primarily would have excessively discounted costs passed through to consumers and ratepayers (see section 3.7 for more information on pass-through costs). By using the lower 2.5 percent discount rate, we avoid underestimating the present value of costs to consumers, but potentially overestimate the present value of costs to covered parties.

These estimates are each based on the assumption that all compliance will be achieved using a single compliance method. In reality, covered parties as a whole will likely use a combination of these methods, resulting in total compliance costs between the costs depicted in the tables above. Some covered parties – such as natural gas distributors – may have little or no options for on-site compliance, but may still combine project-based and market reductions.

### 3.2.7 New parties meeting GHG reduction pathways

New parties that meet the definition of covered parties will also need to calculate baseline emissions and meet assigned emissions reduction pathways. Ecology could not confidently estimate the number and emissions attributes of such parties, but assumed they would be similar to existing covered parties. Their individual costs would be in line with those of existing covered parties, scaled by the year they must begin reducing GHG emissions, as well as their baseline emissions. They would face the same sets of emissions reduction unit costs discussed above in section 3.2.1.

### 3.2.8 Growth in existing covered parties

Because the proposed rule is not an efficiency standard (e.g., setting a maximum amount of GHG emissions allowed per unit of output that a covered party produces), the growth of a covered party does not affect the party's compliance obligation under the proposed rule. If the existing covered parties experience growth that is associated with higher GHG emissions, it will increase the amount by which they must reduce GHG emissions or acquire GHG emissions reduction units or offsets under the proposed rule. This means costs would be higher than those estimated

[24] US Treasury Department (2015). Historic rates of return and inflation rates for I-Bonds.

for this analysis. It also means that the amount of GHG reduction achieved because of the proposed rule would be larger (a larger reduction to reach the GHG emissions reduction pathway), so the benefits of the proposed rule would also be correspondingly higher than those estimated in this analysis.

### 3.2.9 Energy-intensive and trade-exposed industries

While the costs of compliance over time for individual parties are projected to be relatively modest, there may be other circumstances that would impact the ability of covered energy-intensive or trade-exposed (EITE) parties to comply with the proposed rule while maintaining competitiveness within their industries. For this reason, the proposed rule:

- Delays compliance requirements for EITE covered parties until 2023;
- Includes a process EITE parties can use to petition for modification or exemption from the program in appropriate years.

The petition for compliance obligation relief allows EITE parties to petition Ecology for modification of, or exemption from, their compliance obligation for a year or years in which they experience unusual economic hardship. The availability of this petition offers a potential mitigation of compliance costs, if Ecology approves the petition. This reduction in costs would also be paired with a reduction in benefits, as total emissions would not fall at the rate expected based on calculated baseline emissions and GHG emissions reduction pathways. However, it does serve to keep in-state production and employment by reducing incentive to relocate production due to compliance costs.[25]

## 3.3 Costs of reporting

Some covered parties are already reporters under Chapter 173-441 WAC, the Reporting of Emissions of Greenhouse Gases rule. Other covered parties are not current reporters, and future covered parties may also not be current reporters. Parties that do not currently report emissions will incur the additional costs of submitting an annual GHG emissions report to Ecology.

### 3.3.1 BAU reporting

There are currently 143 parties that report GHG emissions under BAU. There are also 30 transportation fuel suppliers that report GHG emissions under BAU.[26] These parties, regardless of whether they have a compliance obligation under the proposed rule, would continue to report under BAU.

[25] Ecology could not confidently forecast the degree to which this petition process would be used and approved, or in which years. This analysis, therefore, does not quantify costs and benefits reflecting the EITE petition. Note, however, that any reduced costs resulting from EITE exemptions would be paired with corresponding reduced benefits, for each MT of GHG emissions that is emitted instead of reduced under the proposed rule.

This analysis does assume that likely EITE covered entities do delay the first year of compliance by three years. Removing this assumption, both costs and benefits would be correspondingly higher.

[26] Ecology GHG Reporting Program records.

### 3.3.2 New reporting under the proposed rule

Under the proposed rule, one new natural gas distributor would be a covered party and required to report, as well as up to 22 fuel importers.

Ecology estimated reporting costs based on the Environmental Protection Agency's (EPA) estimates of reporting cost,[27] adjusted for state-specific wage rates[28] and to 2015 dollars.[29]

**Table 3: First- and Subsequent-Year Reporting Costs per Covered Party**

| | First year hours | Subsequent year hours | Loaded wage 2015$ | First year total cost | Subsequent year total cost |
|---|---|---|---|---|---|
| Senior Management | 0.05 | 0.04 | $65.40 | $3.27 | $2.62 |
| Middle management | 1.24 | 1.08 | $62.79 | $77.86 | $67.81 |
| Junior Engineer/Technician | 4.13 | 3.73 | $24.51 | $101.24 | $91.43 |
| Senior Operator | 13.81 | 13.1 | $39.53 | $545.93 | $517.86 |
| 3rd-party Licensed Professional Engineer | 8 | 8 | $76.91 | $615.27 | $615.27 |
| | | | **TOTAL** | **$1,343.56** | **$1,294.99** |

### 3.3.3 Present value cost of reporting

Ecology estimated the total present value of reporting costs arising from the proposed rule. Present values were estimated using a 2.5 percent discount rate. Total present value reporting costs were estimated to be $342,000 over 20 years.

### 3.3.4 Reporting costs to new covered parties

New parties such as those beginning operations in Washington, or whose future GHG emissions exceed coverage thresholds, that meet the definition of covered parties will also need to submit annual reports of their GHG emissions. Ecology could not confidently estimate the number and emissions attributes of such parties. Their reporting costs would be in line with those of existing covered parties, scaled by the year their GHG emissions exceed the coverage threshold.

[27] Environmental Protection Agency, US (2010). Economic Impact Analysis for the Mandatory Reporting of Greenhouse Gas Emissions Under Subpart W Final Rule (GHG Reporting). November 2010.
[28] US Bureau of Labor Statistics (2014). May 2014 State Occupational Employment and Wage Estimates for Washington State.
[29] U.S. Bureau of Labor Statistics. Consumer Price Index.

# 3.4 Costs of Verification

Under the existing GHG reporting program (Chapter 173-441 WAC), no parties are required to verify their GHG reports to Ecology, so under the proposed rule, all covered parties under Chapter 173-442 WAC will incur the costs of verification. Parties that report under Chapter 173-441 WAC, but are not covered parties under Chapter 173-442 WAC, would not need to verify their reports in either case.

## 3.4.1 Verification frequency

Verification of reports is required every three-year reporting period.

## 3.4.2 Unit costs of verification

Using a survey of compliance costs,[30] Ecology converted typical costs to 2015 dollars using an inflation index.[31] The survey analysis also confirmed approximate costs of verification that had been previously assumed. In-depth verification including a site visit was assumed to cost approximately $19,000.

## 3.4.3 Verification cost trajectory

The proposed rule requires one in-depth verification per each three-year compliance period.

## 3.4.4 Present value of verification costs

Ecology estimated the present value of verification costs using a 2.5 percent discount rate. Assuming the per-verification costs and cycles above, Ecology estimated a total present value verification cost of the proposed rule of approximately $6.8 million.

## 3.4.5 Verification costs to new covered parties

New parties that meet the definition of covered parties will also need to verify their reports of GHG emissions and compliance with emissions reduction pathways. Ecology could not confidently estimate the number and specific emissions attributes of such parties, but generally assume they would be similar to existing covered parties. Their verification costs would be in line with those of existing covered parties, with cycles of two lower-cost verifications and one high-cost in-depth verification, scaled by the year their GHG emissions exceed the coverage threshold.

[30] Massachusetts Department of Environmental Protection (2015).Massachusetts Greenhouse Gas Reporting Program: 2014 Verification Review. September, 2015

[31] US Bureau of Labor Statistics. Consumer Price Index.

# 3.5 Costs of reporting fee reallocation

As part of the proposed rulemaking, Ecology is proposing a reallocation of reporting fees:

- Under BAU, 75 percent of the program budget is paid for through facility reporter fees and 25 percent is paid through transportation fuel supplier reporter fees.
- Under the proposed rule, this distribution shifts to 90 percent of the program budget being paid for through covered party (except transportation fuel suppliers) reporter fees and 10 percent through transportation fuel supplier reporter fees.

The total program budget is not dictated by rule, and is not affected by the proposed rule. Any change in total costs, will result from additional sources required to report. In addition, costs to some individual sources will increase, while costs for some sources will decrease as a result of the choice Ecology is making to change the proportional share of the budget covered by mandatory vs voluntary reporters. These elements of the proposed rule are inseparable, so Ecology chose to mitigate overestimation caused by including growth in total costs, by assuming future total program costs would grow at the same rate as the present value discount rate, 2.5 percent.

## 3.5.1 BAU reporting fees

Under BAU, the parties required to comply with the GHG reporting rule are:

**Table 4: BAU Reporting Fees**

| Number of Facilities | Cost Per Year | Total |
|---|---|---|
| 143 | $1,147 | $164,000 |
| **Number of Transportation Fuel Suppliers** | **Cost Per Year** | **Total** |
| 30 | $1,444 | $43,000 |

## 3.5.2 Covered parties with higher reporting fees

Under the proposed rule and associated rule amendments, there would be:

**Table 5: Proposed New Reporting Fees**

| Number of Covered Parties (except transportation fuel suppliers) | Cost Per Year | Total |
|---|---|---|
| 155 – 162<br><br>Includes:<br>• One new natural gas distributor<br>• 11 – 18 new covered importers excluding those already required to report under BAU | $1,861 – $1,945 | $302,000 |
| **Number of Transportation Fuel Suppliers** | **Cost Per Year** | **Total** |
| n/a – lower fees under proposed rule<br><br>See Chapter 4 for benefit. | n/a – lower fees under proposed rule | $34,000 |

- 155 to 162 covered parties excluding transportation fuel suppliers, likely paying between $1,861 and $1,945 per year, totaling $302,000.[32]
  - This is based on one new natural gas distributor, and a limited range of new importers Ecology assumed will be covered.
  - This range is based on 11 to 18 new covered importers, excluding those already paying fees under BAU.
- Transportation fuel suppliers paying lower fees (see Chapter 4), totaling $34,000.[33]

Ecology estimated a total present value cost of fee increases, relative to BAU, of nearly $3 million, over 20 years.

### 3.5.3 Reporting fee reallocation and new covered parties

New covered parties required to report GHG emissions to Ecology would also have higher fees under this rulemaking than under BAU. Their fees would be up to $1,945 per year, and begin their first year in the reporting program. Ecology could not confidently estimate how many such parties might enter the program in the next 20 years.

## 3.6 Compliance cost transfers

Ecology analyses typically address only direct costs and benefits, but in the case of this rulemaking, multiple comments have already been heard and received concerning the indirect impacts of the proposed rule. For that reason, Ecology chose to discuss payments of costs to other entities, called transfers. Where transfers go – and whether they contribute to the state economy – depends on how covered parties comply with the proposed rule, as well as how they report and verify reports:

- The costs of reporting performed internally may be transferred as additional income to employees, which is re-spent in the state economy on goods and services. Reporting might also be done using consultants, and costs are transferred to consulting firms that re-spend them on goods and services, operating costs, and employee pay in the state economy.
- Verification done by qualified firms creates transfers of verification costs to those firms, who re-spend them on goods and services, operating costs, and employee pay.
- GHG emissions reduction cost transfers depend on the method(s) used by covered parties to reduce their emissions:
  - On-site reductions might employ additional internal labor, contracted services, or purchased goods. Compliance costs would be mitigated by positive economic activity and employment in these other sectors of the state economy.
  - Project-based reductions might employ consultants in contracted design, engineering, partnership, and development services. Compliance costs would be mitigated by positive economic activity in these other sectors of the state economy.

[32] The total amount remains the same, regardless of the number of entities. The number of participating entities determines the per-party fee.
[33] Note that total costs are anticipated to increase, due to increased fee-eligible workload increasing.

- Market-based purchases of emissions reduction instruments from approved out-of-state carbon markets would be transfers out of the state. These compliance costs would not likely be mitigated by positive economic activity in other sectors of the state economy.

Ecology used the Washington State Office of Financial Management Input-Output (OFM-IO) model[34] to examine some of the upper-bound scenarios that represent the types of transfers described above. Using 20-year present value costs estimated in this chapter, grouped by North American Industry Classification System (NAICS) code, Ecology estimated illustrative net impacts to the state economy's output.

Situations resulting in a net state economy output gain, over 20 years include:

- Reporting cost net impact of nearly $4 million. This assumes reporting is performed by consultants with overhead costs, and compliance costs are payments to the consultants.
- Verification cost net impact of nearly $3 million. This assumes verification is performed by qualified firms in the state, and costs are payments to them.
- Covered party (excluding parties that are only fuel importers, and GHG emissions from fuel imports by parties also covered for GHG emissions other than from imported fuels), on-site GHG emissions reduction net impact of over $1 billion. This assumes on-site reductions are completed using contracted process and engineering improvements. Note that this scenario is an overestimated upper bound (as is the cost estimate), because it assumes fuel producers, importers, and distributors will incur costs for internal actions to reduce GHG emissions, but these parties inherently do not have a mechanism with which to comply on-site.
- Covered party (excluding parties that are only fuel importers, and GHG emissions from fuel imports by parties also covered for GHG emissions other than from imported fuels), project-based GHG emissions reduction net impact of $528 million. This assumes project-based reductions are completed using contracted engineered projects.
- Fuel importer[35] internal ("on site") GHG emissions reduction net impacts of over $62 million. This assumes on-site reductions are completed using contracted process and engineering improvements. Note that this scenario is an overestimated upper bound (as is the cost estimate), because fuel importers inherently do not have a mechanism with which to comply on-site.
- Fuel importer project-based GHG emissions reduction net impacts of nearly $28 million. This assumes project-based reductions are completed using contracted engineered projects.

Situations resulting in a net state economy output loss:

- Covered party (excluding fuel importers), market purchase GHG emissions reductions net impacts of over $251 million lost. This assumes all expenditures in markets go out of state.
- Fuel importer market purchase GHG emissions reductions cost net impacts of nearly $33 million lost. This assumes all expenditures in markets go out of state.

[34] WA Office of Financial Management (2007). Washington State Input-Output Model. http://www.ofm.wa.gov/economy/io/2007/default.asp

[35] This includes producers, importers, and distributors importing covered fuels, accounting for only the GHG emissions from the imported fuels.

These are all bounding scenarios, estimated using high-end compliance costs and baseline emissions based on 2012 – 2014 emissions, except reporting and verification costs. Real output impacts will likely result from a combination of compliance through on-site, project, and market GHG emissions reductions, and will be between these bounds.

## 3.7 Pass-through costs

Ecology analyses typically address only direct costs to the parties that incur them, and benefits to the parties that receive them, but in the case of this rulemaking, multiple comments have already been submitted concerning the likelihood of compliance costs being passed on to consumers and other purchasers of fuels and energy. For this reason, Ecology chose to discuss the issue of pass-through costs in Appendix A of this document.

The appendix provides a technical discussion of how pass-through costs are typically determined, based on measures of the relative responsiveness (elasticity) of supply and demand to changes in price. While many elasticities could not be quantitatively determined (for supply, demand, or both), our review of relative elasticities indicates a high level of pass-through for:

- Fuel importers
- Natural gas distributors (long run)
- Petroleum and natural gas systems
- Power plants
- Pulp and paper
- Refineries and petroleum fuel producers
- Waste facilities

It is important to note that pass-through costs are not in addition to other costs, but are reallocations of costs to other entities. If a covered party in one of the above sectors incurs a compliance cost, it is likely to pass some or all of those costs on to its customers, and the costs will be borne by those parties instead of the covered party. If, for example, an energy supplier incurs costs for reducing GHG emissions, it is likely to pass those costs on to ratepayers.

## 3.8 In-state emissions reduction potential

Cogeneration provides an illustrative example.[36] If one reduces the total estimated CHP energy potential for Washington (2,457 MW) to the 10 percent level of fossil sources which that energy displaces, and apportions the remaining energy equally between coal and gas, that yields an estimated emissions reduction potential of 1.6 million MT of carbon-dioxide equivalent GHG

[36] US Department of Energy (2013). Washington CHP Technical Potential.
And Illustrative calculation provided by Alan Newman, WA Department of Ecology. Communication 11/25/2015.

emissions per year.[37] Higher emission reduction potentials would result if one assumes higher rates of fossil energy displacement, as would be the case on a broader regional basis.[38]

## 3.9 Costs of associated emissions increases

There is potential, in certain circumstances, that in the process of reducing GHG emissions to reach the emissions levels in their pathways, covered parties might increase emissions of criteria or toxic air pollutants. While reducing GHG emissions is generally associated with reducing criteria or toxic air pollutant emissions, methods such as capturing methane emissions and combusting the collected product may reduce carbon-equivalent GHG emissions, but increase emissions of chemicals such as nitrogen oxides and fine particulates.[39]

Ecology could not confidently predict the methods covered parties will use to achieve compliance under the proposed rule, but identified some circumstances in which an increase in associated criteria or toxic air pollutant emissions might occur. For example, if GHG emissions from a landfill are captured and combusted, the reduction in carbon-equivalent GHG emissions could be accompanied by increased combustion emissions of nitrogen oxides. A rise in emissions of air pollutants may incur costs, however Ecology is unable to quantify these costs due to uncertainty surrounding their source or quantity. Example scenarios under which this might occur, however, are limited, and are constrained by existing air quality regulations.

## 3.10 Summary of the likely costs of the proposed rule

Ecology estimated the costs of the proposed rule relative to BAU. Likely 20-year present value (if quantified) costs included:

- Average costs of GHG emissions reductions, across multiple compliance scenarios:
  - For covered parties except fuel importers, approximately $190 million to $460 million.
  - For covered importers, approximately $10 million to $40 million.
- Additional reporting costs of $342,000.
- Verification costs of $6.8 million.

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[37] To estimate the GHG emissions reduction potential for cogeneration (combined heat and power; CHP) Ecology made the following assumptions:

- 10 percent of the electricity currently consumed is from a fossil source, based on Washington in-state fossil and hydropower generation capacity.
- 50 percent of that fossil source is coal-based, and the remainder is natural gas.
- No new fossil fuel is used in the CHP conversion (assumes existing thermal source has generation added, not greenfield CHP unit or new fossil fuel using source required).
- Coal generation emits GHGs at 2,300 lb. CO2e/MWh.[37]
- Natural gas combined cycle combustion turbine emits GHGs at 1,078 lbCO2e/MWh. (Washington average rate).

New CHP would operate 8,760 hours per year (full time). Currently CHP units at industrial operations operate at 90 to 95 percent of their capacity.

[38] Washington State University Energy Extension. Communication 11/30/2015.

[39] All regulated emissions would still need to meet applicable state and federal air quality regulations.

- Increased reporting fees of $3 million
- Possible associated criteria and toxic air pollutant emissions increases in limited cases.

Quantified present-value costs, taking average costs across multiple scenarios, total between $210 million and $510 million over 20 years. For some of the covered parties, these costs are likely to be passed through and borne by their customers.

### 3.10.1 Average annual covered party costs

Actual costs incurred by a covered party in each year will depend on that covered party's baseline emissions, whether they are an EITE party, and which methods they choose to use to meet GHG emissions reduction pathways.

For illustrative purposes, however, Ecology estimated the average likely costs for a covered party, and averaged them over 20 years. Based on this broad simplification, typical covered parties would incur the average annual present-value costs below.

**Table 6: Average annual present-value costs above BAU, per party**

| Average Annual Present-Value Costs Above BAU | | | |
|---|---|---|---|
| | **Covered Party excluding coverage for produced or imported fuels** | **Fuel Producer*** | **Fuel Importer** |
| GHG Emissions Reduction Costs | $49,000 - $131,000 | $137,000 - $363,000 | $23,000 - $91,000 |
| Reporting Costs[40] | $200 | | |
| Verification Costs | $4000 | | |
| Reporting Fees | Up to $2000 | | $2000 |

* Ecology calculated separate per-party annual present value costs for fuel producers because their estimated costs are significantly different from other covered party costs, and an overall average would not have represented either set of covered parties as well as the separate estimates.

[40] Averaged across covered entities that experience new reporting as well as those that already report and are not expected to incur additional costs under the proposed rule.

# Chapter 4: Likely Benefits of the Proposed Rule

## 4.1 Introduction

Ecology estimated the likely benefits associated with the proposed rule, as compared to BAU (both described in Chapter 2 of this document). Likely benefits include:

- Avoided costs of GHG emissions
- Avoided costs of associated criteria or toxic air pollutant emissions
- Profits from emissions reduction unit sales
- Co-benefits of offset GHG emissions reduction projects
- Benefits of reporting fee reallocation

This chapter also discusses:

- Carbon benefit variability: Avoided carbon emissions variability and unquantified avoided costs.
- Emissions reduction unit sale variability: How the choice of compliance method affects which and where emissions reduction sale benefits occur.
- Co-benefit variability: How the choice of compliance method affects which and where co-benefits of GHG emissions reduction projects occur.
- Pass-through benefits: How compliance expenditures might be passed on or distributed to the public and other parties that are not required to comply with the proposed rule, through interactions in the Washington economy.

## 4.2 Avoided costs of GHG emissions

As covered parties reduce their GHG emissions, society will benefit by avoiding various impacts of climate change. Ecology estimated this value using estimates of the social cost of carbon (SCC), and the expected trajectory of GHG reductions as covered parties meet their GHG emissions reduction pathways.

### 4.2.1 The social cost of carbon (SCC)

Ecology quantified the value of reduced GHG emissions using an estimate of the social cost of carbon (SCC) developed and used by the federal government.[41] The SCC is an estimate of the value of the negative impacts to society caused by GHG emissions. The estimate of the SCC

[41] 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 And 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.

rises each year, and Ecology chose the modeled annual discount rate of 2.5 percent (see below in section 4.2.2 for rationale).

There exist many estimates of the social cost of carbon, 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, and how much we value impacts that do not occur locally. As with each estimate available, the SCC we use in this document has been challenged, based on what is included in the scope of costs, how the future is discounted, and how costs are distributed. Ecology (as well as the federal workgroup that developed the SCC we use in this analysis) acknowledges the limitations of any quantitative estimate of the SCC. In particular, the workgroup 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.[42]

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 offer 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.[43]

Ecology finds that these issues, among others, exist for all estimates of the SCC, 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 their 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

[42] 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

[43] 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.

sheer number of variables involved – will carry greater uncertainty. Ecology chose to use the federal SCC estimate in part because it attempts to broadly deal with some of these uncertainties, but also Ecology chose within the available estimates of SCC to use those inputs most-closely resembling those typically made in Ecology analyses in discounting social values.

### 4.2.2 Scope of the SCC for Washington

Comments received on past rulemaking analyses involving the SCC expressed concern that global emissions contribution was not an appropriate measure of the benefits of this rule. Ecology believes, 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. 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.[44] Ecology believes this is consistent with our analytic practices and the requirements of the Administrative Procedure Act for cost and benefit analysis (RCW 34.05.328).

For typical costs and benefits, Ecology uses Washington-State-only values, but GHG emissions are unique, and require a broader approach to valuation, especially as applies to the co-externality impacts of carbon emissions. The US Interagency Working Group on the Social Cost of Carbon describes this need as follows.

> 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.
>
> When quantifying the damages associated with a change in emissions, a number of analysts … employ "equity weighting" to aggregate changes in consumption across

[44] 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.

> regions. This weighting takes into account the relative reductions in wealth in different regions of the world. A per-capita loss of $500 in GDP, for instance, is weighted more heavily in a country with a per-capita GDP of $2,000 than in one with a per-capita GDP of $40,000. The main argument for this approach is that a loss of $500 in a poor country causes a greater reduction in utility or welfare than does the same loss in a wealthy nation. Notwithstanding the theoretical claims on behalf of equity weighting, the interagency group concluded that this approach would not be appropriate for estimating a SCC value used in domestic regulatory analysis. For this reason, the group concluded that using the global (rather than domestic) value, without equity weighting, is the appropriate approach.[45]

Ecology similarly considers it appropriate to use a broader scope when choosing estimates of SCC.

### 4.2.3 Discount rates for SCC

In choosing a discount rate for the broad set of social values underlying the SCC, Ecology chose the rate nearest the social rate of time preference (SRTP) typically used for Ecology analyses. There are also additional arguments in favor of using the 2.5 percent discount rate (the lowest rate for which the federal government estimated SCC), made in the Washington State Department of Commerce memo quoted extensively below.[46]

> "Below are five justifications for why we recommend using a 2.5% discount rate.
>
> 1. **Align with OFM Real Discount Rate**: RCW 39.35.030(9) "'Life-cycle cost' means the initial cost and cost of operation of a major facility over its economic life. This shall be calculated as the initial cost plus the operation, maintenance, and energy costs over its economic life, reflecting anticipated increases in these costs discounted to present value at the current rate for borrowing public funds, as determined by the office of financial management." When choosing the discount rate column for public decision-making processes it can be argued that agencies should choose the column of data that most closely matches the current real discount rate established by the Washington State Treasury and published by the Office of Financial Management within the Washington Life Cycle Cost Tool. The current real discount rate of .9% indicates that the column of data associated with the 2.5% discount is the closest match.
>
> 2. **Anticipate Additional External Costs**: The federal SCC values do not include all expected external costs of carbon dioxide equivalent emissions. Instead they focus just on the impacts which could be clearly monetize (sic)

[45] 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

[46] Washington State Department of Commerce (2014). The Social Cost of Carbon: Washington State Energy Office Recommendation for Standardizing the Social Cost of Carbon when used for Public Decision-Making Processes. Interagency memo from Tony Usibelli, Washington State Energy Office. Dated 11/04/2014.

at the time of the study. For this reason the SCC is expected to increase over time as additional impacts are monetized and a greater scope of social costs are applied to those impacts already monetized. This trend can be seen in the 2013 revision of the 2010 SCC values. Note the 2013 3% column is roughly equal to the 2010 2.5% column. An argument could be made that we can stay ahead of this trend by choosing the higher SCC values represented by the 2.5% discount rate.

*2010 Published SCC (2007$)*

| Discount Rate | 5% | 3% | 2.5% | 3% |
|---|---|---|---|---|
| Year | Avg | Avg | Avg | 95th |
| 2010 | 4.7 | 21.4 | 35.1 | 64.9 |
| 2015 | 5.7 | 23.8 | 38.4 | 72.8 |
| 2020 | 6.8 | 26.3 | 41.7 | 80.7 |
| 2025 | 8.2 | 29.6 | 45.9 | 90.4 |
| 2030 | 9.7 | 32.8 | 50.0 | 100.0 |
| 2035 | 11.2 | 36.0 | 54.2 | 109.7 |
| 2040 | 12.7 | 39.2 | 58.4 | 119.3 |
| 2045 | 14.2 | 42.1 | 61.7 | 127.8 |
| 2050 | 15.7 | 44.9 | 65.0 | 136.2 |

*2013 Published SCC (2007$)*

| Discount Rate | 5.0% | 3.0% | 2.5% | 3.0% |
|---|---|---|---|---|
| Year | Avg | Avg | Avg | 95th |
| 2010 | 11 | 32 | 51 | 89 |
| 2015 | 11 | 37 | 57 | 109 |
| 2020 | 12 | 43 | 64 | 128 |
| 2025 | 14 | 47 | 69 | 143 |
| 2030 | 16 | 52 | 75 | 159 |
| 2035 | 19 | 56 | 80 | 175 |
| 2040 | 21 | 61 | 86 | 191 |
| 2045 | 24 | 66 | 92 | 206 |
| 2050 | 26 | 71 | 97 | 220 |

3. **Incorporate Intergenerational Discount Rates**: The discount rate applied to GHG emissions is an "intergenerational discount rate" applied to society as a whole. An intergenerational discount rate is not well represented by private sector discount rates which seek profit, or the cost of governments to obtaining capital in a low-risk environment. The papers below discuss some of the scientific thinking surrounding the challenge of discounting intergenerational costs. There is no clear conclusion on what value should be used but generally it is agreed that the value should be much lower than

private sector discount rates. This is why the SCC tables do not present data for discount rates above 5% despite the fact many profit-seeking institutions use discount rates from 8-15%.

4. **Recognize Public Responsibility**: Overestimating the SCC for public asset decision-making processes will result in more energy efficient buildings and vehicles which reduce operational costs, increase resiliency to price spikes, and reduce the government's contribution to climate change. However, these benefits are obtained at a higher upfront capital cost than was warranted due to the overestimation. Underestimating the SCC results in less energy efficient buildings and vehicles, larger operation costs, and a greater contribution to climate change. Both overestimating and underestimating the SCC lead to a net economic loss to society.

| Game Theory | | Value Chosen | |
|---|---|---|---|
| | | 2.5% | 3% |
| Correct Value | 2.5% | Optimal Desgin | Wasted money, higher operational costs, higher costs to society |
| | 3% | Wasted money, lower operational costs, lower costs to society | Optimal Design |

Game theory points out that there is a higher risk associated with underestimating the SCC than there is with overestimating the SCC as it is easier to operate an efficient asset in a low cost environment than it is to operate an inefficient asset in a high cost environment. As much of the risk associated with underestimating the SCC falls on society, public entities are under a unique responsibility to mitigate the risk associated with underestimation.

5. **Washington State Leads on Climate Issues**: The federal interagency working group that developed the SCC table provided no guidance as to which discount rate should be used for government design and procurement processes. However, many federal processes reference the 3% discount rate as the "central estimate". This may simply mean that it is the middle of the three proposed discount rates but it has led to the 3% rate being the more commonly quoted value for federal processes. As Washington wants to lead on climate issues it makes sense for us to adopt the lower 2.5% discount rate column, and the higher associated social cost of carbon, for our public building design and vehicle acquisition processes."

## 4.2.4 SCC by year carbon is emitted[47]

**Table 7: Interagency Work Group Social Cost of Carbon, per MT, by Year**

| Year | Average at 2.5% discount rate | In 2015$ | Year | Average at 2.5% discount rate | In 2015$ |
|---|---|---|---|---|---|
| 2015 | $58.00 | $66.53 | 2026 | $71.00 | $81.44 |
| 2016 | $60.00 | $68.82 | 2027 | $72.00 | $82.59 |
| 2017 | $61.00 | $69.97 | 2028 | $73.00 | $83.74 |
| 2018 | $62.00 | $71.12 | 2029 | $74.00 | $84.88 |
| 2019 | $63.00 | $72.27 | 2030 | $76.00 | $87.18 |
| 2020 | $65.00 | $74.56 | 2031 | $77.00 | $88.33 |
| 2021 | $66.00 | $75.71 | 2032 | $78.00 | $89.47 |
| 2022 | $67.00 | $76.85 | 2033 | $79.00 | $90.62 |
| 2023 | $68.00 | $78.00 | 2034 | $80.00 | $91.77 |
| 2024 | $69.00 | $79.15 | 2035 | $81.00 | $92.91 |
| 2025 | $70.00 | $80.30 | 2036 | $82.00 | $94.06 |

## 4.2.5 GHG emissions reduction trajectory

Ecology estimated total cumulative reductions in GHG emissions from covered parties over the upcoming 20 years. These are the sums of individual party GHG emissions reductions in each year. The low value represents reductions from baseline emissions based on a forecast of 2012 – 2016 GHG emissions, and the high value represents reductions from baseline emissions based only on 2012 – 2014 emissions. (See section 3.2.2 for more information on GHG emissions reduction pathways and baseline calculations.)

GHG reductions achieved under the proposed rule are cumulative because compliance is achieved using permanent reductions or offsets. Therefore, an emission reduction in a given year is followed by years where that reduction is still occurring.

[47] There are multiple historic values found for the SCC, varying based on assumptions, inputs, weighting, and discount rates chosen. For other SCC values and surveys of ranges, see for example:

- Tol (2008). The Social Cost of Carbon: Trends, Outliers, and Catastrophes. Economics Vol. 2, 2008-25. August 12, 2008. Mean of peer-reviewed SCCs of $88 to $127, depending on distributional assumptions and sample range among 211 studies, in "around 1995" dollars.
- Clarkson and Deyes (2002). Estimating the Social Cost of Carbon Emissions. Department for Environment, Food, and Rural Affairs, HM Treasury, UK. Available through http://www.hm-treasury.gov.uk. SCC range approximately $2 to $200 (1990$).
- Moore and Diaz (2015). Temperature impacts on economic growth warrant stringent mitigation policy. Nature Climate Change. Published online 12 January 2015. CSS of $220 (2015$).
- Ackerman and Stanton (2012). Climate risks and carbon prices: Revising the social cost of carbon, Economics: The Open-Access, Open-Assessment EJournal, Vol. 6, Iss. 2012-10, pp. 1-25, http://dx.doi.org/10.5018/economics-ejournal.ja.2012-10. SCC of potentially $900 in 2010 and $1,500 in 2050.

**Table 8: Total GHG Emissions Reductions, in MT, by Year**

| Total GHG Emissions Reduction (MT CO2e) | | | | | |
|---|---|---|---|---|---|
| **Year** | **Low** | **High** | **Year** | **Low** | **High** |
| 2016* | 0 | 0 | 2026 | 28,731,271 | 38,342,231 |
| 2017* | 0 | 0 | 2027 | 33,469,335 | 44,802,661 |
| 2018 | 809,846 | 861,358 | 2028 | 38,306,173 | 51,404,911 |
| 2019 | 1,619,693 | 1,722,717 | 2029 | 43,241,785 | 58,148,982 |
| 2020 | 2,429,539 | 2,584,075 | 2030 | 48,770,042 | 65,746,795 |
| 2021 | 6,566,226 | 8,189,215 | 2031 | 53,952,589 | 72,848,235 |
| 2022 | 10,801,687 | 13,936,177 | 2032 | 59,233,910 | 80,091,496 |
| 2023 | 15,135,922 | 19,824,959 | 2033 | 64,619,195 | 87,480,501 |
| 2024 | 19,568,931 | 25,855,562 | 2034 | 70,103,255 | 95,011,328 |
| 2025 | 24,100,714 | 32,027,986 | 2035 | 75,686,088 | 102,683,976 |

* Emissions reductions in 2016 and 2017 are zero because covered parties are not required to reduce emissions in accordance with their assigned pathways until 2018.

### 4.2.6 Present value of avoided GHG emissions

Ecology used standard present value calculations to estimate the present value of avoided GHG emissions over 20 years under the proposed rule, as compared to BAU. Present value calculations convert a stream of future impacts to current values, using a 2.5 percent discount rate. Each year's 2015-dollar value of the SCC is multiplied by the total estimated GHG emissions reduction in that year (in MT CO2e), and the resulting values for each year are summed.

Based on estimated emissions reductions across covered parties, Ecology calculated a present value benefit using the SCC. The total benefit of the proposed rule, for reductions in GHG emissions, is estimated to be between approximately $13 billion and $14 billion compared to BAU, over 20 years.[48]

### 4.2.7 Value of avoided GHG emissions at new covered parties

New parties that meet the definition of covered parties will also need to calculate baseline emissions and meet emissions reduction pathways. Ecology could not confidently estimate the number and emissions attributes of such parties, but assumed they would be similar to existing covered parties. The benefits of their avoided GHG emissions would be in line with the value of other avoided GHG emissions, the SCC discussed above in this chapter, and would be scaled by the year they must begin reducing GHG emissions, as well as their baseline emissions.

[48] Ecology performed a sensitivity analysis of this result, based on varying the SCC to those calculated using a 3-percent discount rate and a 5-percent discount rate. These alternative sets of SCC values yielded total present value benefits of $8.7 billion and $2.7 billion, respectively.

# 4.3 Avoided costs of associated emissions

Depending on how covered parties meet their GHG emissions reduction pathways, there may be associated reductions in other emissions, such as criteria pollutants and toxic air pollutants. It is important to note, however, that there is potential for some means of compliance to increase certain air pollutants as well (see Chapter 3), depending on GHG reduction measures taken.

Associated emissions that might also be reduced include nitrogen oxides, sulfur oxides, fine particulates, and various toxic air pollutants. Avoiding or reducing these emissions may improve air quality and reduce associated health endpoints, such as asthma and other lung disorders, and contributors to certain cancers.

## 4.3.1 Quantifiable benefits of avoided emissions

While estimation of actual avoided costs of associated emissions would require knowledge (or confident estimates) of the methods and locations of GHG emissions reduction activities, Ecology provides illustrative estimates of the magnitude of damage per MT of certain criteria pollutants.

The estimates provided here are based on damage costs reported in EPA rulemakings[49] and are heavily dependent on the location of the avoided emissions:

- On-site reductions in associated emissions benefit local populations. Benefits of these reductions, especially of fine particulate matter (PM2.5), depend on variables such as the population density of the area benefitting.
- Off-site projects, or purchased emissions reductions from other covered parties, benefit populations near those reductions.
- Purchases of emissions reduction instruments from out-of-state markets benefit populations near the projects or reductions that created the instrument in the first place.

Ecology provide additional information about populations potentially affected by associated emissions in sections 4.3.2 and 4.3.3 below.

**Table 9: Value of damages from select criteria pollutants**

| Criteria Pollutant | Damages per MT in 2015$ |
|---|---|
| PM2.5 | $1.45 - 1.6 million |
| Volatile Organic Compounds (VOCs) | $1,120 - 1,220 |
| Nitrogen Oxides (NOx) | $4,675 - 5,080 |

[49] 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.

— EUS 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.

## 4.3.2 Benefitting populations for on-site reductions

When evaluating benefits of on-site reductions of associated emissions, Ecology examined the populations within a three-mile radius of stationary GHG emissions sources expected to be covered and have compliance obligations under the proposed rule.[50] Environmental justice variables were noted.

- **Population:** Surrounding population ranges from roughly 200 to nearly 129,000. (Note: One covered stationary GHG emissions source with a surrounding population of 11 was excluded from the analysis as an outlier; this party is not likely to have on-site reductions of associated emissions.)
- **Minority population:** Two covered stationary GHG emissions sources (with surrounding populations of nearly 2000 and 129,000) have surrounding minority populations (as a percentage of total population) in at least the 80th percentile in the state. This means they have higher percentages of minority populations than 80 percent of the state as a whole.
- **Low-income population:** Four covered stationary GHG emissions sources (with surrounding populations between 1700 and 33,000) have surrounding low-income populations (as a percentage of total population) in at least the 80th percentile in the state. This excludes one outlier party that is not likely to have on-site reductions of associated emissions.
- **Linguistically isolated populations:** Three covered stationary GHG emissions sources (with surrounding populations between 1200 and 129,000) have surrounding linguistically isolated populations (as a percentage of total population) in at least the 80th percentile in the state. This excludes one outlier party that is not likely to have on-site reductions of associated emissions.
- **Less than high school educated population:** Two covered stationary GHG emissions sources (with surrounding populations of 1700 and 25,000) have surrounding populations with less than a high school education (as a percentage of total population) in at least the 80th percentile in the state. This excludes one outlier party that is not likely to have on-site reductions of associated emissions.
- **Vulnerable young populations:** One covered party is in the 82nd percentile of vulnerable young populations – children under age 5 as a percentage of total population.
- **Vulnerable elderly populations:** Three covered stationary GHG emissions sources are in at least the 80th percentile of vulnerable elderly populations – adults over age 64 as a percentage of total population.

The extent to which these populations benefit depends on the types of emissions projects that covered parties use to comply with their GHG reduction pathways.

## 4.3.3 Benefitting populations for off-site reductions

Off-site GHG emissions reductions might also benefit populations near them, through reductions in associated emissions. The extent of this benefit depends on the types of emissions projects that covered parties use to comply with their GHG emissions reduction pathways.

Projects that reduce transportation emissions – such as commute trip reduction programs – would benefit primarily populations living near highways and roads. Populations living along major

[50] US Environmental Protection Agency (2015). EJSCREEN. www.epa.gov/ejscreen. Accessed November 9, 2015.

transportation corridors are disproportionally minority and low-income as compared to the state as a whole. These are some of the same populations that overlap with populations benefitting from on-site reductions.

Other types of transportation emission reduction projects would also benefit vulnerable communities. For example, projects that improve transit service as a means to reduce emissions could offer valuable benefits to these communities since they frequently are more dependent on transit services for mobility than the general population.

## 4.4 Transfers from emissions reduction unit sales and reduction services

Covered parties that reduce GHG emissions in excess of what is required under their respective GHG emissions reduction pathway, will likely benefit under the proposed rule from sales of those emissions reduction units and offsets. Parties that develop GHG reduction programs or offsets for other covered parties will likely benefit from the sales of those offsets.

Ecology typically addresses only direct costs and benefits of proposed rules, but in the case of this rulemaking, multiple comments have already been provided about the indirect impacts of the proposed rule. For this reason, Ecology chose to discuss these payments of costs to other entities, called transfers. Where transfers go – and whether they contribute to the state economy – depends on how covered parties comply with the proposed rule, as well as how they report and verify reports. If transfers of compliance costs occur to entities in state, providing the goods, labor, and services required to reduce GHG emissions on-site or through projects, or to perform reporting or verification tasks, costs are mitigated by positive economic activity in the industries receiving these transfers.

In Section 3.6 of this document, we discuss the transfer context in further detail, and provide illustrations of upper-bound scenarios of how compliance costs might be transferred to other in-state entities. Ecology also discusses upper-bound scenarios in which compliance costs are paid to out-of-state entities, and in-state costs are not mitigated by positive local economic activity.

## 4.5 Co-benefits of emissions reduction projects

Offset projects used to meet GHG emissions reduction pathways may also carry co-benefits in forms not directly connected to emissions. Ecology could not confidently identify which reduction methods covered parties would choose under the proposed rule, but identified examples of projects that would provide co-benefits to the public and environment.

Energy efficiency projects, such as home insulation improvements for select populations (e.g., low-income households) would reduce energy demand and associated GHG emissions, but could also:[51]

- Relax income and spending constraints for low-income families
- Improve quality of life
- Reduce incidence of illness
- Address lead or mold contamination
- Reduce use of wood as a fuel and local emissions source, reducing local incidence or exacerbation of asthma and air quality-related illness. This is particularly notable in areas with high numbers of homes using wood as their primary heat source, or pressed by cost to use wood for heat despite burn bans, in low-income areas.

Transportation projects, such as commute trip reduction programs, could contribute to co-benefits for those using the program, as well as other commuters:

- Lower fuel expenditures
- Contribution to reduced traffic
- Lower parking and automotive maintenance costs
- Lower employee stress and improved quality of life

Other types of emission reduction projects also provide similar co-benefits. Methane management projects can reduce odor issues for communities. Industrial process improvements can have a wide variety of other benefits, including improving safety and reducing the generation of waste. Regardless of the project type, co-benefits are common to emission reduction activities.

# 4.6 Benefits of reporting fee reallocation

As part of the proposed rulemaking, Ecology is proposing a reallocation of reporting fees in the associated GHG reporting rule (Chapter 173-441 WAC):

- Under BAU, 75 percent of the program budget is paid for through facility reporter fees, and 25 percent is paid through transportation fuel supplier reporter fees.
- Under the proposed rule, this distribution shifts to 90 percent of the program budget being paid for through covered party (except transportation fuel supplier) reporter fees, and 10 percent through transportation fuel supplier reporter fees.

The total program budget is not dictated by rule, and is not affected by the proposed rule. Any change in total costs, will result from additional sources required to report. In addition, costs to some individual sources will increase, while costs for some sources will decrease as a result of the choice Ecology is making to change the proportional share of the budget covered by mandatory versus voluntary reporters. These elements of the proposed rule are inseparable, so Ecology chose to mitigate overestimation caused by including growth in total costs, by assuming future total program costs would grow at the same rate as the present value discount rate, 2.5 percent.

[51] Tonn, Bruce, et al. (2014). Weatherization Works—Summary of Findings from the Retrospective Evaluation of the US Department of Energy's Weatherization Assistance Program. Oak Ridge National Laboratory. Sept 2014.

### 4.6.1 Covered parties with lower reporting fees

Under the proposed rule and associated amendments to related rules, 30 existing transportation fuel suppliers would pay lower fees than under BAU:

- BAU fee: $1,444 per year
- Proposed estimated fee: $1,117 per year

Ecology estimated a total present value benefit of fee reductions of over $196,000 over 20 years.

### 4.6.2 Reporting fee reallocation and new covered parties

New transportation fuel suppliers required to report GHG emissions to Ecology would also have lower fees under this rulemaking than under BAU. Because they are new reporters, they would incur the full lower estimated fee cost of $1,117 per year. Ecology could not confidently estimate how many such parties might enter the program in the next 20 years.

## 4.7 Growth in existing covered parties

Because the proposed rule is not an efficiency standard (e.g., setting a maximum amount of GHG emissions allowed per unit of output that a covered party produces), the growth of a covered party does not affect the party's compliance obligation under the proposed rule. If the existing covered parties experience growth that is associated with higher GHG emissions, it will increase the amount by which they must reduce GHG emissions under the proposed rule. This means benefits would be higher than those estimated for this analysis. It also means that the costs of the proposed rule would also be correspondingly higher than those estimated in this analysis.

## 4.8 Summary of the likely benefits of the proposed rule

The proposed rule provides the following likely benefits, as compared to BAU. Likely benefits include in 20-year present values where quantified:

- Avoided costs of GHG emissions impacts, between $13 billion and $14 billion
- Avoided costs of associated criteria and toxic air pollutants, if reductions are achieved on site or using in-state projects (not estimated quantitatively)
- Transfers from emissions reduction unit sales and reduction services, if reductions are achieved o site or using in-state projects (not estimated quantitatively)
- Co-benefits of emissions reduction projects (not estimated quantitatively)
- Reduced fees of $196,000 for transportation fuel GHG emissions reporters

Quantified present-value benefits, regardless of compliance scenario, total at least $13 billion.

# Chapter 5: Cost-Benefit Comparison and Conclusions

## 5.1 Summary of the costs and benefits of the proposed rule

Ecology determined that, compared to BAU discussed in Chapter 2 of this document, the proposed rule has the following costs and benefits:

### Costs

Likely 20-year present value (if quantified) costs included:

- Average costs of GHG emissions reductions, across multiple compliance scenarios:
  - For covered parties except petroleum and natural gas fuel importers, approximately $190 million to $460 million.
  - For covered petroleum and natural gas importers, approximately $10 million to $40 million.
- Additional reporting costs of $342,000
- Verification costs of $6.8 million
- Increased reporting fees of $3 million
- Possible associated criteria and toxic air pollutant emissions increases in limited cases

Quantified present-value costs, taking average costs across multiple scenarios, total between $210 million and $510 million over 20 years. For some of the covered parties, these costs are likely to be passed through and borne by their customers.

### Benefits

Likely benefits include in 20-year present values where quantified:

- Avoided costs of GHG emissions impacts, between $13 billion and $14 billion
- Avoided costs of associated criteria and toxic air pollutants, if reductions are achieved on site or using in-state projects
- Transfers from emissions reduction unit sales and reduction services, if reductions are achieved on site or using in-state projects
- Co-benefits of emissions reduction projects
- Reduced reporting fees for transportation fuel suppliers, of $196,000

Quantified present-value benefits, regardless of compliance scenario, total at least $13 billion.

## 5.2 Conclusion

Ecology concludes, based on reasonable understanding of the quantified and qualitative costs and benefits likely to arise from the proposed rule, that the benefits of the proposed rule are likely greater than the costs.

# 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 are:

> (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 rule making 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 propose and adopt the rule, Ecology is required to determine that the contents of the rule are the least burdensome set of requirements that still achieve the goals and objectives of the authorizing statute(s).

Ecology assessed alternatives to elements of the proposed rule, and determined whether they met the goals and objectives of the authorizing statutes. Of those that would meet these goals and objectives, Ecology determined whether those chosen for the proposed rule were the least burdensome.

## 6.2 Goals and objectives of the authorizing statutes

Ecology has developed the proposed rule under Chapter 70.94 RCW (Washington Clean Air Act) and consistent with Chapter 70.235 RCW (Limiting Greenhouse Gas Emissions).

Chapter 70.94 RCW includes the following sections:

- RCW 70.94.011 states that it is the intent of this chapter to maintain levels of air quality that protect human health and to comply with the requirements of the Federal Clean Air Act.
- RCW 70.94.141 states the powers of any activated authority in addition to any other powers vested in them by law. This section gives Ecology the authority to issue orders to execute the purposes of this chapter.
- RCW 70.94.151 directs Ecology to adopt greenhouse gas reporting rules.
- RCW 70.94.331 requires Ecology to adopt rules establishing emission standards, air quality objectives, and air quality standards.
- RCW 70.94.850 allows Ecology to establish an emissions credit-banking program.

Chapter 70.235 RCW includes the following sections:

- RCW 70.235.005 notes that, "It is the intent of the legislature that the state will: (a) Limit and reduce emissions of greenhouse gas consistent with the emission reductions established in RCW 70.235.020; (b) minimize the potential to export pollution, jobs, and economic opportunities; and (c) reduce emissions at the lowest cost to Washington's economy, consumers, and businesses."
- RCW 70.235.020 establishes statewide GHG emission reductions.
- RCW 70.235.040 requires Ecology to consult with the Climate Impacts Group at the University of Washington within eighteen months of the next and each successive global or national assessment of climate change science, and provide a report to the legislature summarizing that science and make recommendations regarding whether the GHG emissions reductions required under RCW 70.235.020 need to be updated.

## 6.3 Alternatives considered and why they were not included

As part of this rulemaking, Ecology considered alternatives to the rule content being proposed. Alternatives included:

- Broader applicability (e.g., to include all fuels):
  - GHG emissions from mobile sources are indirectly covered as part of fuel producers' and importers' compliance obligation.
  - Marine and aviation are excluded because the vast majority of the emissions occur outside the state, and in-state emissions represent a small percentage of statewide emissions.
  - Emissions associated with electricity that is imported into the state generally occur out-of-state.
- Broader baseline-determination range:
  - While a broader baseline determination range might be less burdensome for some covered parties, representative, verifiable data is not available for years before 2012. Washington's first reporting year was 2012.
  - EPA GHG reporting data begins in 2010, but due to interim changes, is not sufficiently representative of actual emissions until the 2012 reporting year.
- No offsetting (require all emissions be on-site):

  - Allowing compliance only through on-site emissions reductions would be more burdensome, and would limit the ability to comply with the proposed rule. Offsets give covered parties choices to make reductions at the lowest cost.
  - Fuel producers, importers, and distributors cannot reduce emissions from their fuel products, except through reduced production or consumption.
- Not including natural gas or transportation fuels as covered emissions categories:
  - Excluding natural gas and petroleum would dramatically reduce the scope of the GHG emissions reduction program.
  - Limiting coverage would severely limit the ability to achieve the goals and objectives of the authorizing statutes.
- Linking the Washington program directly to existing market programs:
  - The rule does propose one-way linkage to existing systems.
  - The rule does not establish an allowance system, which would be required for full linkage between this program and cap-and-trade systems.
  - Existing market programs also differ fundamentally in their definitions, requirements, restrictions, and standards, as compared to the Washington GHG reporting program and the proposed rule.
- Efficiency-based emissions standards:
  - Under a standard that sets maximum GHG emissions per unit of output or product, total emissions could increase. There would be no cap.
  - This would limit the ability to meet the goals and objectives of the authorizing statutes.
- Excluding fuel importers from coverage:
  - Inclusion of fuel importers expands the coverage of the program, and limits behaviors that would reduce its effectiveness.
  - Excluding fuel imports from coverage would create incentives to move production out of state, or to export and re-import fuels to avoid coverage under the proposed rule.
  - This would limit the ability to meet the goals and objectives of the authorizing statutes.
- Remove petition system for energy-intensive and trade-exposed (EITE) covered parties:
  - EITE coverage under the proposed rule may expose certain covered parties to reduced competitiveness in their markets, and create incentives to move production out of the state.
  - If covered parties are forced to close facilities or move them out of state, it limits the ability of the proposed rule to meet the goals and objectives of the authorizing statute, especially if covered parties move to locations without GHG emissions reduction programs. This would also inherently be more burdensome.
- A different threshold for coverage:
  - Based on known emissions below the proposed threshold, a lower threshold would be more burdensome through expanding the number of covered parties while not appreciably reducing emissions. It would also not increase the quantity of covered emissions in a way that significantly improved ability to meet the goals and objectives of the authorizing statutes.
  - A higher threshold would reduce the scope of the GHG emissions reduction program. Reducing coverage would severely limit the ability to achieve the goals and objectives of the authorizing statutes.

- A higher rate of emission reductions over time:
  - A rate of GHG emissions reduction that is higher than 1 2/3 percent would be more burdensome to covered parties. A higher rate would also drive larger reductions sooner, and increase incentives to acquire out-of-state emissions. Allowing more time to spread out emissions reductions also allows time for development of on-site and in-state emissions reduction projects that will benefit the local economy and local populations.[52]
- A lower rate of emission reductions over time:
  - A rate of GHG emissions reduction that is lower than 1 2/3 percent would achieve fewer reductions. The proposed rule is intended to at a minimum make significant progress toward achieving the statutory reductions in RCW 70.235, which would not be possible with a lower rate.

## 6.4 Conclusion

After considering alternatives to the proposed rule's contents, as well as the goals and objectives of the authorizing statute, Ecology determined that the proposed rule represents the least-burdensome alternative of possible rule contents meeting these goals and objectives.

[52] While we might have assumed that covered entities will always choose the least-cost compliance option of acquiring all GHG emissions reductions from out-of-state markets, there are inherent benefits to reducing GHG emissions locally that may mitigate higher direct compliance costs. These include, but are not limited to, community and public relations (marketing) benefits, as well as reduced annual operating costs of efficiency improvements. For this reason, we assumed that covered entities would also consider higher direct cost GHG emissions projects that also benefit local populations or the entities themselves. Not setting a higher rate of GHG emissions reductions over time supports the development of such projects.

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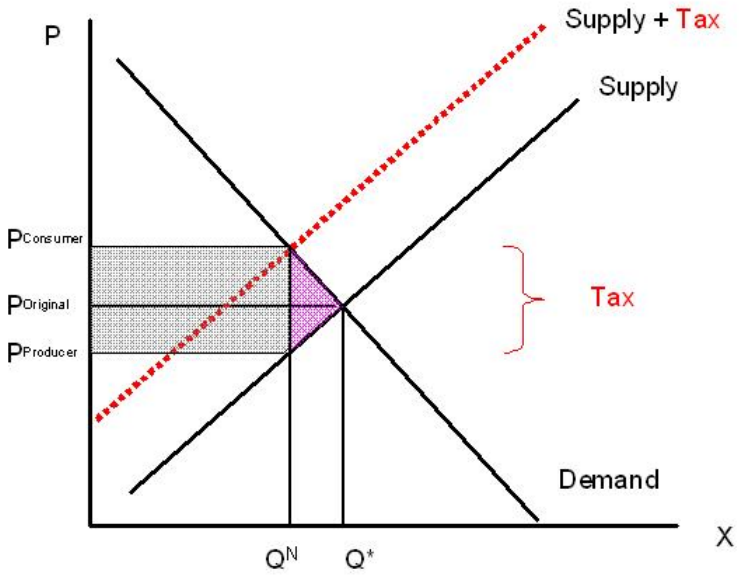
# Appendix A

Cost pass-through describes the process of a firm increasing the price of goods or services it provides to consumers in response to any increase in its costs. Pass-through is usually measured as a percentage of the cost increase. Generally, a firm attempting to maximize its profits will pass – through as much of any cost increases as possible. How much pass – through occurs depends on several factors, primarily how responsive the seller and buyer are to changes in price. This is called the price elasticity of supply and the price elasticity of demand respectively.

## A.1 Economic Discussion - Theory and Practice

The concept of cost pass-through is usually discussed in the area of tax incidence in the supply/demand paradigm. If a per-unit tax is levied on an industry, it acts to shift the supply curve for the firm (or industry) straight upward by exactly the amount of the tax as shown below in Figure 1.[53] This is true for any increase in the per-unit costs or production.

**Figure 1: Pass-through**




The difference between P(original), the pre-tax price, and P(consumer), the after-tax price charged to consumers is the amount passed through to the consumer. Pass-through is measured as a percentage of the total cost increase of the tax. It should be noted that this difference is less than the entire amount of the cost increase. If a firm is acting to maximize profits, it will attempt to pass through as much of the cost increase as it is able in all cases.

[53] http://www.econport.org/econport/request?page=web_experiments_modules_taxes_lecture

The share of cost increases able to be passed on to consumers is impacted by several factors. These factors are captured by the concept of elasticity. Elasticity measures how price responsive the firm is (in the case of the Price elasticity of Supply, Es) and the consumers are (in the case of the Price elasticity of Demand, Ed).

The more price responsive demand is, the less able the firm is to pass along cost increases. The more price responsive firms are, the more able they are to pass along cost increases. The final share of pass-through is determined by comparing the price responsiveness of demanders and suppliers. A general relationship between pass-through and price responsiveness can be written as follows:

$$Pass-through = \frac{Price\ responsiveness\ of\ Supplier}{Price\ responsiveness\ of\ Demander + Price\ responsiveness\ of\ Supplier} = \frac{Es}{Ed + Es}$$

Note that Es and Ed are numbers. Therefore, the ratio can be written as a percentage. The higher the percentage, the greater share of the cost increase that is passed through to consumers.

While there are several things that will impact the price elasticities of supply and demand, a few are most relevant to the current discussion. On the demand side, the availability of substitutes, or lack thereof, will make an item more or less price responsive. On the supply side, capacity constraints will make the item less price responsive. On both sides, the more general your definition of the good or service in question, the less responsive it will be. Time will also impact responsiveness, in the long-run, goods are more responsive than in the short-run. For a full discussion of pass-through, please see RBB Economics (2014).

When discussing industry-specific pass-through, it is necessary to discuss the relevant Ed and Es. Estimates exist for these measures for many industries, more so on the demand side than the supply side. However, it must be noted that these will only act as estimates. The true responsiveness of a given industry for a specific geographic location (e.g. the refining industry for Washington) could differ from estimates from a different or larger sample.

# A.2 Industry-specific pass-through discussion

For the current analysis, pass-through shares are estimated based on available data. Where data is not available, discussion is offered on the likely price responsiveness. The key determinant of pass-through rates is how responsive one side is when compared to the other.

Each of the relevant industries are limited to activities that occur within Washington. The industry categories include:

- Chemicals
- Food Production
- Fuel Importers
- Manufacturing

- Metals
- Minerals
- Natural Gas Distributors
- Petroleum and Natural Gas Systems
- Power Plants
- Pulp and Paper
- Refineries and Petroleum Fuel Producers
- Waste

## A.2.1 Chemicals

The firm in this category deals in fertilizer. Hansen (2004) found the Ed for this industry to be 0.45. No estimates of Es were found. It is unclear whether Ed or Es would be more responsive in this case.

## A.2.2 Food Production

At this extreme level of aggregation, estimates of Es and Ed could not be found.

## A.2.3 Fuel Importers

There are two scenarios where fuel would be imported into Washington:

- Imported fuel is cheaper than non-imported fuel.
- There is not enough non-imported fuel available to the market.

Each case indicates that Es is significantly more responsive than Ed.

This indicates a high level of pass-through.

## A.2.4 Manufacturing

At this extreme level of aggregation, estimates of Es and Ed could not be found.

## A.2.5 Metals

At this extreme level of aggregation, estimates of Es and Ed could not be found.

## A.2.6 Minerals

At this extreme level of aggregation, estimates of Es and Ed could not be found.

## A.2.7 Natural Gas Distributors

Aurora (2014) discusses available estimates in the literature for both Ed and Es. He finds short-run Ed ranges from 0.10 to 0.16 and long-run Ed ranges from 0.24 to 0.29. Also, Es ranges from 0.01 to 0.26 in the short-run and 0.08 to 0.96 in the long-run.

Given the ranges of estimates (as well of overlap in the ranges), it is unclear how much pass-through would occur in the short-run. However, in the long-run, a significant level of pass-through is likely.

## A.2.8 Petroleum and Natural Gas Systems

The demand facing these industries illustrate derived demand, meaning that their demand follows directly from the demand for gasoline, natural gas, and electricity (for which natural gas is an input for production). Each of these industries has a very inelastic Ed. EIA (2014) place the short-run Ed at 0.02, with the long-run Ed at 0.6. Genc (2004) analyses available estimates for power and found a range of 0.02 - .08 for Ed. Aurora (2014) discusses available estimates for both Ed and Es in the natural gas industry and found short-run Ed ranges from 0.10 to 0.16 and long-run Ed ranges from 0.24 to 0.29.

No viable estimates for Es in the petroleum and natural gas systems industry were found, however they are likely much more responsive than Ed.

This indicates a high level of pass-through.

## A.2.9 Power Plants

Genc (2004) analyses available estimates for power and found a range of 0.02 - 0.08 for Ed. Though no viable estimates for Es were found, capacity constraints likely make it somewhat inelastic. However, the extreme inelasticity of Ed makes it very likely that Es is much more responsive than Ed.

This indicates a high level of pass-through.

## A.2.10 Pulp and Paper

The pulp and paper industry has faced significant competition in recent years from electronic alternatives to print media. Those demanders that were able to use substitutes have likely done so at this point, leaving a demand that has few viable alternatives, indicating a fairly inelastic demand. Brown (2004) estimates a short-run Es of roughly 1 and a long-run Es of 2.2 for the industry.

This indicates a high level of pass-through.

## A.2.11 Refineries and Petroleum Fuel Producers

The demand facing refineries and fuel producers is a *derived* demand, meaning that their demand follows directly from the demand for gasoline. EIA (2014) place the short-run Ed at 0.02, with the long-run Ed at 0.6. Though no viable estimates for Es were found, capacity constraints likely make it inelastic. However, the extreme inelasticity of Ed makes it very likely that Es is much more responsive than Ed.

This indicates a high level of pass-through.

## A.2.12 Waste

The primary firms in this category are landfills. OECD (2004) found that available estimates of the Ed for landfills clustered tightly around 0.2, indicating a highly unresponsive demand. No relevant estimates for Es were found. It is highly likely that Es is inelastic, given the strict

regulatory environment for the industry, particularly in the short-run. However, the extreme inelasticity of Ed makes it very likely that Es is much more responsive than Ed.

This indicates a high level of pass-through.

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