Appendix P: Public Services and Utilities Technical Resource Report

For Programmatic Environmental Impact Statement on Utility-Scale Onshore Wind Energy Facilities in Washington State

By

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For the

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Acronyms and Abbreviations List

BESS	battery energy storage system
BLM	Bureau of Land Management
BMP	best management practice
CFR	*Code of Federal Regulations*
DNR	Washington Department of Natural Resources
DoD	U.S. Department of Defense
Ecology	Washington State Department of Ecology
EMT	Emergency Medical Technician
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
gen-tie line	generation-tie transmission line
HAZMAT	Hazardous Materials Team
IBC	International Building Code
IFC	International Fire Code
medevac	medical evacuation
MW	megawatt
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration
PEIS	Programmatic Environmental Impact Statement
PPE	personal protective equipment
PUD	public utility district
RCW	Revised Code of Washington
SCADA	Supervisory Control and Data Acquisition
USC	*United States Code*
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
UW	University of Washington
WAC	Washington Administrative Code

Summary

This technical resource report describes the conditions of public services and utilities in the study area. It also describes the regulatory context, potential impacts, and measures to avoid or reduce impacts.

The impacts on public services and utilities identified in this technical resource report include those from the construction, operation, and decommissioning phases of the onshore wind energy facilities considered in the Programmatic Environmental Impact Statement (PEIS). This impact assessment considers whether onshore wind energy facilities would result in a significantly increased demand for public services (e.g., fire and law enforcement response, emergency medical response, schools) such that the capacities of existing service providers would be exceeded. The assessment considers whether onshore wind energy facilities would result in solid waste capacity exceedances or utility service interruptions and whether project structures such as substations, meteorological towers, and generation-tie transmission lines (if overhead) may have the potential to obstruct or interfere with communications systems, aerial firefighting, or aerial medical evacuation capabilities.

A probable increase in the demand for emergency response public services would occur in the study area as utility-scale onshore wind energy facilities would introduce new risks to remote areas during construction, operation, and decommissioning. Such projects also likely require the construction of new facilities to connect the onshore wind energy facilities to the energy grid. Construction and decommissioning of utility-scale onshore wind energy facilities have the potential to result in service interruptions, which would require coordination and communication with local utility districts. Operation of onshore wind energy facilities has the potential to result in interference with emergency alert systems and other communications signals. Decommissioning also has the potential to exceed solid waste capacities, due to turbine blade waste and other potentially hazardous materials likely to be present in wind energy components.

Findings for public services and utilities impacts described in this technical resource report are summarized below.

- Through compliance with laws and permits and with the implementation of measures to avoid and reduce impacts, most construction, operation, and decommissioning activities would likely result in **less than significant impacts** on public services and utilities.
- A facility would result in **potentially significant adverse impacts** to fire response if activities required a large fire response in remote locations with limited response capabilities or if there are other unique aspects of a facility site.
- Depending on turbine recycling facilities, methods available at the time of decommissioning, and the volume of waste, facility decommissioning would result in **potentially significant adverse impacts** on solid waste and recycling if there are large volumes of solid waste.

Construction, operation, and decommissioning of utility-scale onshore wind facilities may result in a **potentially significant and unavoidable adverse impact** if activities require a large fire response in remote locations with limited response capabilities or if there are other unique aspects of a facility site that affect fire response. Determining if mitigation options would reduce or eliminate impacts below significance would be dependent on the specific project and site.

Crosswalk with Public Services and Utilities Technical Resource Report for Utility-Scale Solar Energy

Two PEISs are being released at the same time, one for utility-scale solar energy facilities and one for utility-scale onshore wind energy facilities. This crosswalk identifies the areas with substantial differences between the public services and utilities technical resource reports for each PEIS.

Utility-Scale Solar Energy PEIS	Utility-Scale Onshore Wind Energy PEIS (this document)
• Differences in specific impacts on public service and utility providers • Some differences in measures to avoid and reduce impacts	• Potential for significant adverse impacts on fire response related to turbines • Potential for significant adverse impacts on solid waste and recycling during decommissioning or repowering • Some differences in measures to avoid and reduce impacts

1 Introduction

This technical resource report describes public services and utilities within the onshore wind energy program study area and assesses probable impacts associated with types of facilities (alternatives) and a No Action Alternative. Chapter 2 of the State Environmental Policy Act Programmatic Environmental Impact Statement (PEIS) provides a description of the types of facilities evaluated (alternatives). Where impacts are identified, the section identifies mitigation measures designed to reduce potential impacts.

This section provides an overview of the public services and utilities evaluated in the technical resource report and lists relevant regulations that contribute to the evaluation of potential impacts.

1.1 Resource description

Key features of public services described in this technical resource report consist of considerations for emergency response including fire prevention and response, security and law enforcement, emergency medical, and public schools in the study area as potentially affected by onshore wind energy facilities. Key features of utilities and service systems described in technical resource report include natural gas, electrical and communications systems, water supply, wastewater, and solid waste management.

The following resources could have impacts that overlap with impacts to public services and utilities. Impacts on these resources are reported in their respective technical resource reports:

- **Water:** Additional discussion regarding water impacts is provided in the *Water Resources Technical Report* (Appendix F).
- **Environmental health and safety:** Details regarding public health and safety, including wildfire risk as it informs this analysis is included in the *Environmental Health and Safety Technical Resource Report* (Appendix I)
- **Transportation:** Information related to transportation systems which may affect emergency response, is included in the *Transportation Resources Technical Report* (Appendix O).

1.2 Regulatory context

Potentially applicable federal, state, and local regulations are listed in Table 1, which will contribute to the evaluation of potential public services and utilities impacts.

Table 1. Applicable laws, plans, and policies

Regulation, statute, guideline	Description
Federal	
42 *United States Code* (USC) 6901 et seq., Solid Waste Disposal Act	Applicable to solid waste generated during construction, decommissioning, and operation and maintenance phases.
36 *Code of Federal Regulations* (CFR) 251, Subpart B, U.S. Department of Agriculture (USDA) U.S. Forest Service (USFS)	Includes USFS-administered lands; note the regulation stipulates that various plans, such as emergency action plans and site security plans, be implemented as conditions of approval.
43 USC 1701 et seq., Federal Land Policy and Management Act of 1976	Governs how the Department of the Interior's Bureau of Land Management (BLM) and USFS (under USDA) administer public lands, including grants of rights-of-way for the transmission lines associated with wind and solar facility development. See also the BLM Right-of-Way Regulations (43 CFR 2800).
Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act (42 USC 6901 et seq.) and the Hazardous Solid Waste Amendments of 1984	The regulations governing hazardous materials influence the destinations and process for solid waste reclamation. Applicable to solid and hazardous waste generated during construction, operation, and decommissioning.
29 CFR 1910.269, Occupational Safety and Health Act	Establishes the Occupational Safety and Health Administration, which regulates worker safety and hazards in the United States. Safe worker practices and training are applicable to wind energy facilities and associated electrical systems installation and maintenance.
47 USC 303(q) Antenna Tower Lighting and Marking Requirements; 47 CFR 17.21-17.58, Federal Aviation Administration (FAA) Advisory Circular 70/7460-1M	Standards and specifications set forth in FAA advisory documents govern antenna tower lighting and marking requirements, which are mandatory under the Federal Communications Commission (FCC) rules. The FCC requirements for filing with FAA for proposed structures vary based on a number of factors including height, proximity to an airport, location, and frequencies emitted from the structure, etc. Depending on such factors, communication facilities and turbines may be subject to FAA standards (FAA 2020).
National Fire Protection Association 855 Standards for Installation of Energy Storage Systems	Applies to facilities with co-located battery energy storage system (BESS). Provides the minimum requirements for mitigating the hazards associated with BESS.
State	
Revised Code of Washington (RCW) 36.70A.070, Washington State Growth Management Act	Requires cities and counties to include a utilities element in their comprehensive plans.

Regulation, statute, guideline	Description
Chapter 51-50, State Building Code adoption and amendment of the 2021 edition of the International Building Code (IBC)	Establishes the Washington State Building Code's adoption of the IBC, which sets standards for commercial construction. This chapter also adopts National Fire Protection Association (NFPA) 70, National Electric Code, which sets national standards for electric, and communications components installed in buildings, structures, and in open-air settings. The IBC has adopted parts of and full standards of NFPA sections including NFPA 241, Standard for Safeguarding Construction, Alteration, and Demolition Operations, which sets construction and demolition fire safety standards.
Chapter 51-56 Washington Administrative Code (WAC), adoption and amendment of the 2021 edition of the Wildland-Urban Interface Code	The International Wildland-Urban Interface Code sets additional requirements code officials can require for structures and subdivisions located within the wildland-urban interface areas. These include a site plan, vegetation management plan, vicinity plan, fire apparatus access roads, and water supply.
Chapter 51-52 WAC, State Building Code adoption and amendment of the 2021 edition of the International Mechanical Code	Establishes the Washington State Building Code's adoption of the International Mechanical Code, which sets standards for mechanical infrastructure in buildings and structures. This chapter also adopts several NFPA standards including NFPA 72 National Fire Alarm and Signaling Code.
Chapter 51-54A WAC, State Building Code Adoption and Amendment of the 2021 Edition of the International Fire Code	Establishes Washington State's adoption of the International Fire Code (IFC) and also adopts some IFC standards including NFPA 855 Standards for Installation of Energy Storage Systems relevant to BESS installation. Washington State provides amendments to each iteration of the IFC. The current Washington State amendments to the 2021 IFC have been effective since March 15, 2024. The IFC sets standards for fire preparedness and safety.
WAC 173-303-573, Standards for universal waste management	Applicable for lithium-ion battery disposal.
RCW 70.95.010 et seq., Solid Waste Management – Reduction and Recycling	Applicable mostly to decommissioning of wind energy facilities.
RCW 70.105.005 et seq., Hazardous Waste Management	Applies to storage, handling, transportation, use, and disposal of hazardous materials associated with the facilities.
RCW 70.118.010 et seq., On-site Sewage Disposal System	Applicable requirements pertain to on-site septic systems, if proposed.
RCW 80.28.440, Wildfire mitigation plan—Review/revision	Requires wildfire mitigation plan for investor-owned utilities.
Local	
Comprehensive plan goals and objectives, and local codes and requirements pertaining to public services and utilities	A local planning effort by cities and counties that provides a vision for the community and identifies steps needed to meet that vision. Many counties and cities in Washington defer to the state regulations.

2 Methodology

2.1 Study area

The study area for public services and utilities includes the PEIS geographic scope of study for onshore wind energy facilities and the surrounding areas that have potential for off-site impacts.

The study area for public services and utilities is defined as the service territories of all relevant public services (emergency response, including law enforcement, fire prevention and response, emergency medical services and hospitals, and public schools) and utilities (communications, natural gas and electric, water and wastewater, and solid waste landfills and recycling) that provide service to areas within the overall PEIS geographic scope of study (Figure 1). The PEIS does not approve, authorize, limit, or exclude facilities on a site-specific basis. Future facility proponents would need to consider specific options available for public service and utility provision when considering potential facility siting.

The PEIS geographic scope of study includes various federal, state, and locally managed lands; however, national parks, wilderness areas, and wildlife refuges; state parks; Tribal reservation lands; and areas within cities and urban growth areas were excluded.

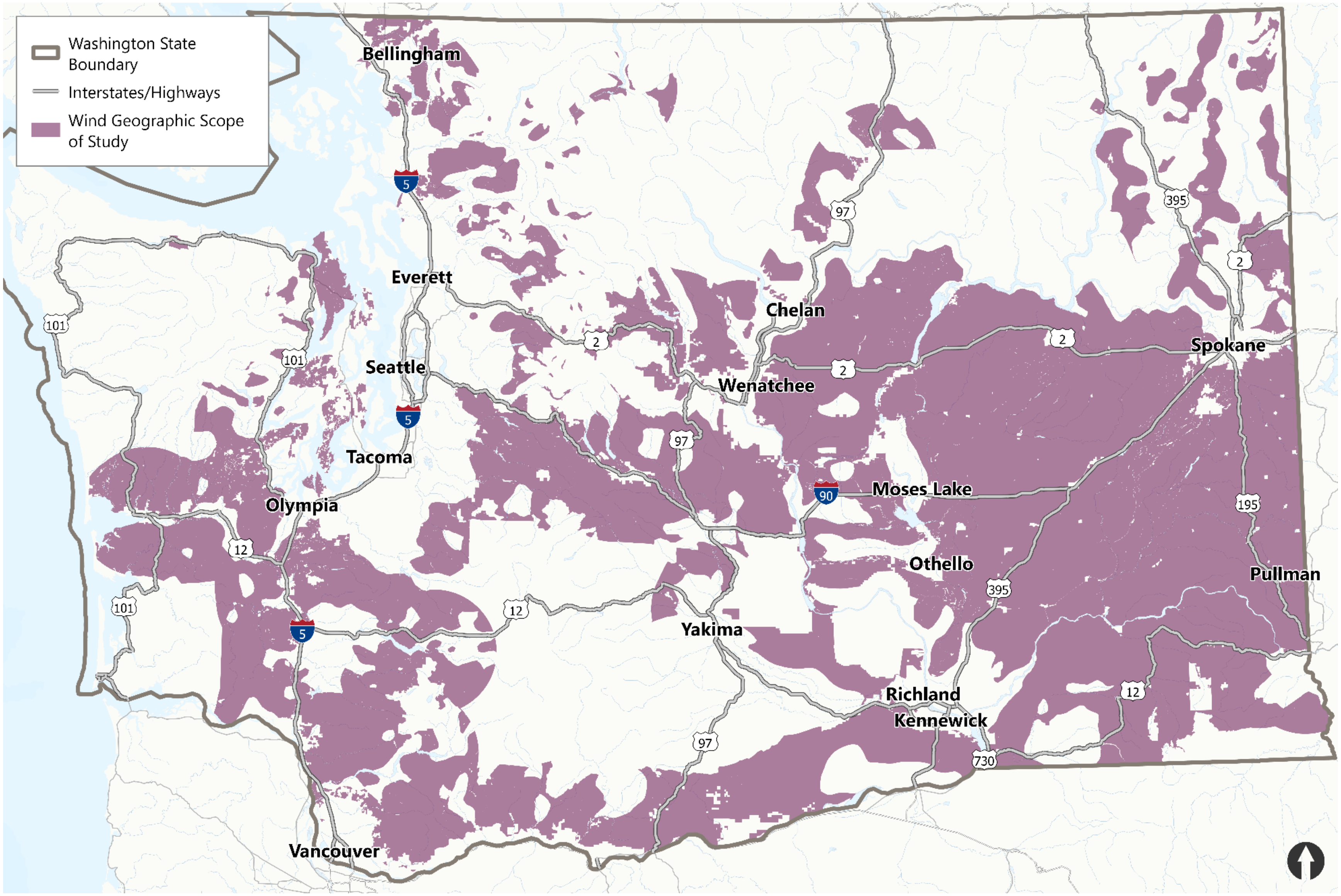

Figure 1. Onshore Wind Energy Facilities PEIS – geographic scope of study

2.2 Technical approach

To evaluate the potential impacts on public services and utilities, existing providers in the study area were identified using information obtained through public websites, mapped sources, and personal communications. Impacts associated with construction, operation and maintenance, and decommissioning were qualitatively analyzed.

This programmatic evaluation considered siting and design parameters, regulatory requirements, and plans and procedures intended to reduce effects. For analytical purposes, it is assumed that the onshore wind energy facilities would comply with existing regulations and that the requirements would be enforced by the applicable local, state, and/or federal jurisdictions.

The technical approach included a review of the typical siting criteria and assumptions for facilities considered in the PEIS. The desktop analysis used publicly available federal, state, and local planning documents and environmental impact statements from similar utility-scale onshore wind energy facilities. Available datasets, such as the wind energy environmental documents compiled by the State of Washington Energy Facility Site Evaluation Council, were accessed to inform high-level considerations.

The analysis assumed that projects would be required to adhere to regulatory standards such as those in effect for solid waste and fire safety. Standard measures and best management practices (BMPs) may be considered for integration as actions to avoid and reduce impacts. Geographic/regional variation would likely influence whether facility impacts on public services and utilities rise to the level where mitigation would be required. For example, fire risk is highly variable in Washington state, so public safety response would place variable demands on service providers depending on the facility location and associated risks. The analysis also considered climate change and its influence with respect to wildfire risk as related to emergency response. The identified potential actions to avoid and reduce impacts are specific to impacts identified for public services and utilities, except where crossovers with other resource areas exist. In these cases, potential impacts and mitigation are cross-referenced from other PEIS technical resource reports. Additional details regarding public health and safety, including wildfire risk as it informs this analysis, are provided in the *Environmental Health and Safety Technical Resource Report*.

2.3 Impact assessment approach

The PEIS analyzes a time frame of up to 20 years of potential facility construction and up to 30 years of potential facility operations (totaling up to 50 years into the future). The potential impacts on public services and utilities include those from the construction, operation and maintenance, and decommissioning phases of the onshore wind energy facilities analyzed in the PEIS. This impact assessment considers if any phase would result in a significantly increased demand for public services (e.g., fire and law enforcement, emergency medical response, schools) such that the capacities of existing service providers would be exceeded. The assessment considers whether the onshore wind energy facilities would result in relocation or prolonged service interruptions of existing utilities, interfere with emergency alert communication systems, or require construction of new or modified utilities. The assessment also considers whether structures associated with the onshore wind energy facilities would have the potential to impact aerial firefighting and aerial medical evacuation capabilities.

A project developer would need to ensure there are sufficient utilities for a project available by establishing agreements with utility providers. A developer would also need to ensure there is sufficient water available for a project, both physically and legally.

For the purposes of this assessment, a potentially significant impact would occur if a facility resulted in the following:

- Significantly increased demand for public services during construction or decommissioning that would exceed existing capacities of public service providers
- Significantly increased demand for public services during operation such that unplanned new or physically altered governmental facilities would be needed to serve the facility
- Facility would require the relocation or construction of new or modified utilities or service systems during construction, operations, or decommissioning
- Facility would result in the presence of structures with the potential to obstruct or otherwise impact aerial emergency response capabilities

2.3.1 Construction and decommissioning

The use of construction workers from outside of locations where the onshore wind energy facilities are proposed may result in a temporary increase in demand for public services, including police, providers of emergency medical services, and local fire departments. For example, blasting specialists may be needed prior to trenching in rocky areas. However, construction of onshore wind energy facilities is not anticipated to require a permanent workforce. The analysis assumes that workers hired to construct onshore wind energy facilities within the study area would not take up residence or relocate their families to the region as a result of this temporary construction employment.

Decommissioning is expected to include the dismantling and removal of aboveground facility components and is considered with relation to solid waste utilities. Removal of turbine components and related infrastructure would include dismantling the turbines, support towers, transformers, on-site substations and/or switching stations, buildings, battery energy storage system (BESS), and foundations; excavating them to a specified depth below grade; and removing them from the facility site to be reused, recycled, sold, or otherwise disposed of. Facility roadways no longer needed to access turbine sites (after the turbines have been dismantled and removed) are expected to be restored or naturally revegetate. Underground collection and communication cables may be disconnected and abandoned in place.

When a wind energy facility reaches the end of its design life, repowering may be an option instead of decommissioning. Repowering consists of replacing (partially or totally) the old wind turbines with more powerful and more efficient models using the latest technologies. This may include replacing the turbine blades, rotor, nacelle, and tower, or the tower may remain in place with a new nacelle, rotor, and blades added.

2.3.2 Operation and maintenance

Onshore wind energy facilities may not have staff on site on a daily basis; however, this analysis assumes that up to 20 people would be needed to operate and maintain the facility. If a utility-scale onshore wind energy facility does not have permanent staff, facility operators would likely use remotely monitored security systems that tie into a facility's Supervisory Control and Data Acquisition (SCADA) system and private site security. Maintenance would likely entail periodic routine repair and replacement of system components, vegetation control, inspection, cleaning, turbine and equipment servicing, and access road maintenance. Many of these activities could be accomplished using part-time or contracted personnel.

3 Technical Analysis and Results

3.1 Overview

This section describes the public services and utilities conditions in the study area and provides an analysis of potential impacts that could occur in the study area for the utility-scale onshore wind energy facility types analyzed in the PEIS. This section also evaluates measures to avoid, minimize, or reduce the identified impacts and potential unavoidable significant adverse impacts.

3.2 Affected environment

The affected environment represents the existing conditions at the time this study was prepared. The study area includes various public service and utility providers. For the purposes of the analysis, the temporal scope of affected environment considerations consists of 20 years within which potential onshore wind energy projects may be constructed and approximately 30 years of operation. The conditions described in this section include a high-level consideration of climate change over this time frame and its potential to alter conditions for public services and utilities in the study area.

3.2.1 Public services

The study area is served by a variety of public service providers funded in part through public resources, such as sales and business tax revenue. Depending on the local conditions, public services may be provided by federal, Tribal, state, county, or local governments, as well as volunteer fire departments and other volunteer groups. Public services described in this section include fire protection, law enforcement, emergency or other medical services, and schools. The service areas for fire and emergency medical response providers in the study area (as described in this section) are depicted in Figures 2 and 3, respectively.

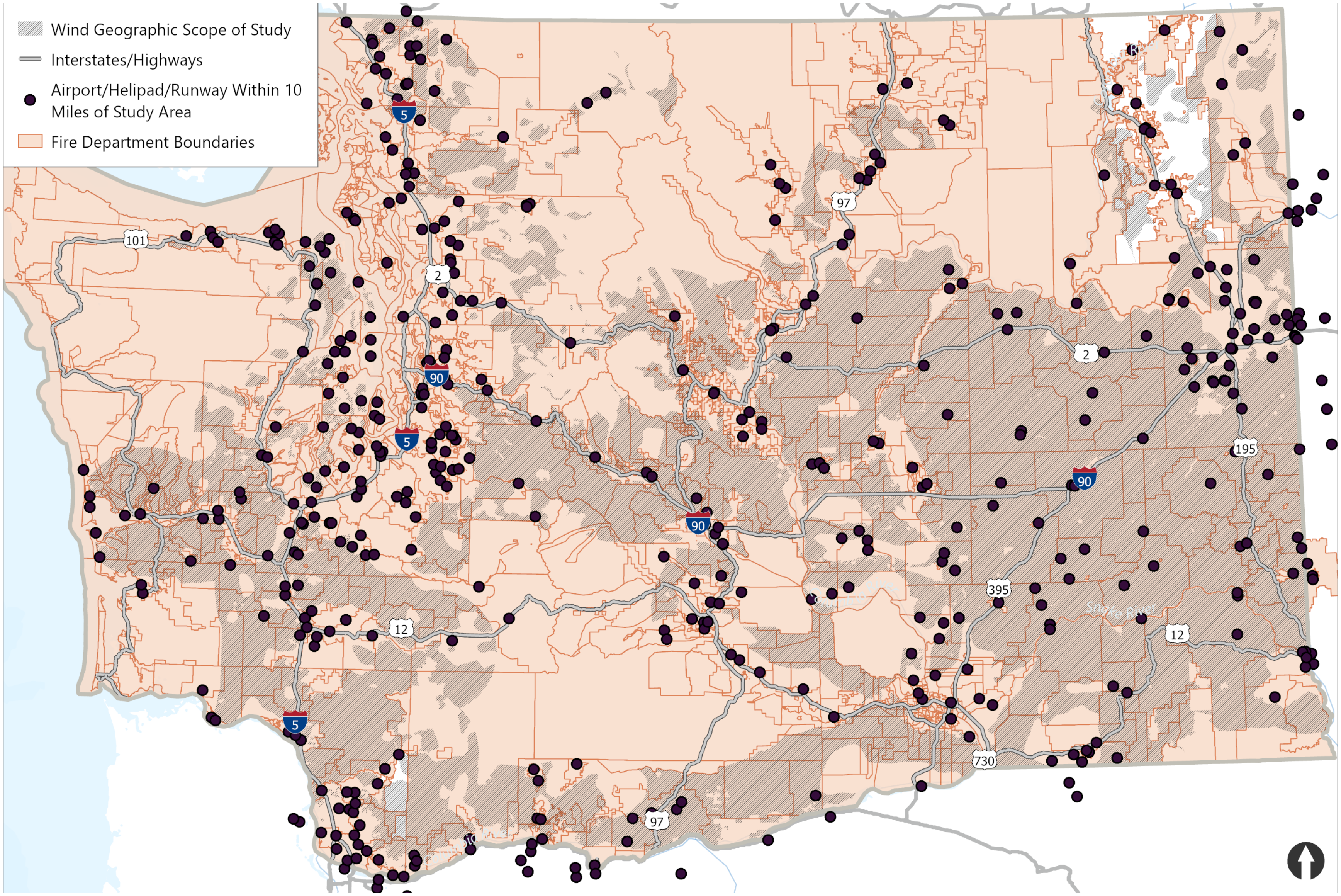

Figure 2. Fire response in the wind study area

Data sources: DNR 2023; FAA 2024; WSGDP 2024a

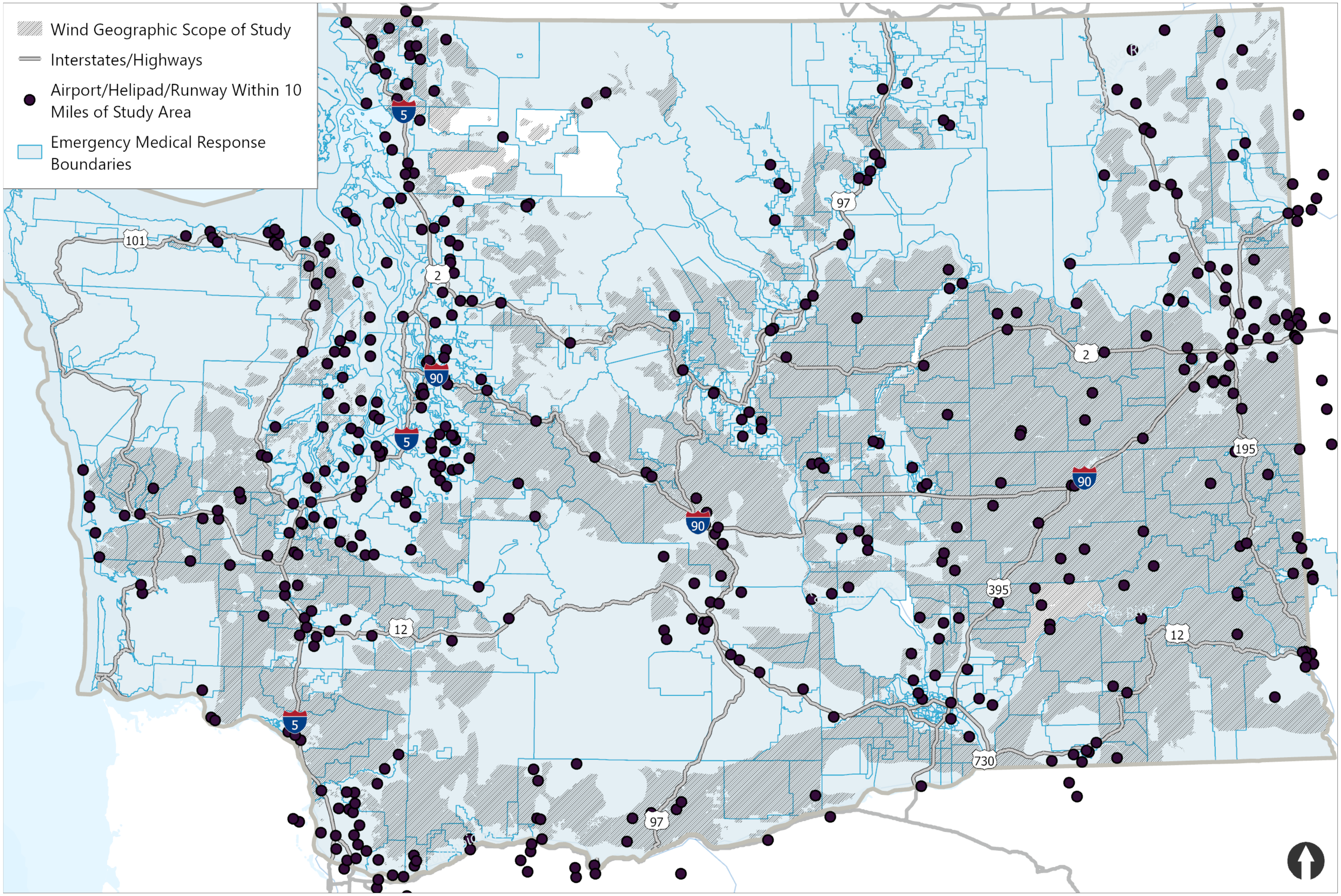

Figure 3. Emergency medical response in the wind study area

Data sources: FAA 2024; WSGDP 2024b

3.2.1.1 Emergency response

Emergency response in the study area includes fire departments, emergency medical services, and law enforcement. Coordination and emergency alert communication are conveyed through subscriber-based text alerts via cell phone and email; radio and other media are used to communicate with the public about hazard conditions and natural disasters. Emergency management services are provided at the county level and consist of various divisions that carry out dispatch services to all law enforcement, and fire and emergency management and response services (including 9-1-1 response) through centers within their respective divisions. Lands within the study area under state and federal jurisdiction also have emergency communication and dispatch networks that operate through the Washington Department of Natural Resources (DNR), U.S. Forest Service (USFS), and Bureau of Land Management (BLM).

Certain characteristics of onshore wind energy facilities can complicate emergency response. The height of wind turbines, aviation restrictions near wind turbines, and potential safety hazards on the ground beneath wind turbines during accidents can all contribute to emergency response challenges. Wind turbine accidents are uncommon but can be dangerous. Emergency responders need to have knowledge of the hazards associated with wind turbine and other energy facility infrastructure, in order to safely respond to these accidents. Limited data on onshore wind energy facility accidents are available, but a study of onshore wind turbine accidents from 1995 to 2012 estimated that, each year, 0.07% (7 out of 10,000) of wind turbines experience blade failure, 0.06% (6 out of 10,000) have structural fires, and 0.03% (3 out 10,000) experience structural failure (Uadiale et al. 2014).

Law enforcement

Law enforcement in Washington is provided by various county, municipal, and state entities. Unincorporated areas of the state are served by local county sheriff's offices. All state routes are patrolled by the Washington State Patrol. The Washington State Patrol provides traffic enforcement on state highways, drug enforcement, Hazardous Materials Team (HAZMAT) oversight, and incident response. Washington State Department of Ecology (Ecology) also has a spill response team.

Portions of the study area include federal lands under USFS or BLM jurisdiction and these agencies have law enforcement capabilities. DNR also provides ranger patrol on properties it manages.

Fire prevention and response

Fire prevention and response in the study area are under the control of local county fire departments with support from volunteer units and other response teams depending on the jurisdiction. Counties and local jurisdictions coordinate proactive controls, such as promoting defensible space vegetation removal, prescribed burning, or invoking burn bans, as conditions warrant, to prevent the uncontrolled spread of wildfires. Although each jurisdiction maintains the primary responsibility for providing services within its boundaries, mutual aid response agreements exist among different fire jurisdictions and regions through which they assist each other in the event one jurisdiction or region is unable to contain a structure fire or another emergency situation using its own resources and personnel (WSF 2023). Figure 2 depicts fire response providers in the study area.

Wildfire response
Portions of the study area are not under local jurisdictions for fire response. Locations in or near national forests or on BLM land are under the jurisdiction of USFS or BLM jurisdiction for fire response. At the state level, DNR provides fire protection on properties it manages. DNR works with other state, federal, and local agencies to respond to wildfires and offers local fire districts and volunteer units with support with fire protection and safety equipment requirements. DNR implements industrial fire precaution levels to limit certain activities as conditions warrant in lands under their jurisdiction.

DNR manages an aviation response and helitack program available for dispatch throughout Washington. Crews are staged in multiple locations statewide during the fire season and respond to threats to human life, property, and natural resources. Helitack crews are teams of firefighters who are transported by helicopter to wildfires. Available for dispatch throughout all of Washington state, these small teams provide initial attack capacity to fires occurring in areas not easily reached by ground (Figure 4).

Figure 4. Example of type of helicopter used to respond to wildfires

Image source: DNR 2024

DNR Wildfire Aviation is a highly trained air-ground firefighting team available for initial attack rapid response to wildland fires (Figure 5). Wildfire Aviation has 10 UH-1H(M) Huey helicopters modified for water/suppressant delivery in remote locations with the capability to deliver helitack crews into otherwise unreachable terrain. The primary aviation bases are in Olympia and Yakima. Historically, DNR helitack program crews have been staged in Omak, Deer Park, Dallesport, Pomeroy, Wenatchee, Colville, and Olympia (DNR 2024).

Figure 5. Example of aerial firefighting response

Image source: DNR 2024

DNR implements industrial fire precaution levels to limit certain activities as conditions warrant in a given region. USFS and BLM also provide aerial fire response through aviation and helitack operations for lands under federal jurisdiction.

As discussed in the *Environmental Health and Safety Technical Resource Report*, wildland fires affect grasslands, forests, and brushlands, as well as any structures on these lands. They carry the potential for injury, loss of life, and damage. Such fires can occur from either human or natural causes. The type and amount of topography (e.g., slope, elevation, and aspect), weather/climate conditions (e.g., wind, temperature, and humidity), and vegetation/fuels are the primary factors influencing the degree of fire risk and fire behavior in an area. The combination of these factors, described in more detail below, can fuel or arrest the spread of wildfire if it occurs. The sections below also discuss wildfires and air pollution, as well as climate change and fire risk.

Washington has experienced many extreme fire events in recent years, partly attributed to climate change effects and the legacy of forest fire suppression practices, and this is expected to increase in the future. The combination of longer fire seasons, population growth, declining forest health, and other changing risk factors has made wildfire considerations a top priority in the state, as outlined in the *Washington State Wildland Fire Protection 10-Year Strategic Plan* (DNR 2019). The plan recognizes the need for proactive management of the landscape, the importance of maintaining a highly capable fire response workforce, and the need to prepare for expected increases in wildland fires in future years, among other considerations (DNR 2019). In addition to the DNR mapping tools, a statewide energy safety workgroup (established by the Washington Department of Commerce) is developing risk maps for natural hazards including wildfire.

Climate change considerations for wildfire risk

The utility-scale onshore wind PEIS considers projects constructed in Washington from the year 2025 through 2045. Once constructed, the assumed operational life is 30 years. The analysis in this report therefore includes a consideration of climate change effects on wildfire risk over this extended time frame, as related to emergency response. Climate change is expected to impact multiple variables related to fire risk, including air temperature, precipitation, humidity, wind, solar radiation, and other interactive issues, such as forest health, invasive species (notably including mountain pine beetle infestations), and prolonged drought, all of which influence fire risk and associated emergency response.

As discussed in the *Environmental Health and Safety Technical Resource Report*, the University of Washington (UW) has conducted climate resilience mapping to model wildfire risk across the state through time. The map shows the projected increase in high fire danger days[1] across the state compared to historical (1971 to 2000) averages. An increase in high fire danger days indicates a greater potential for wildfire danger to damage infrastructure, interrupt businesses, and affect public health and wellbeing (UW 2024). Although the severity of fire risk is variable across the geography of the state, with a higher number of high fire danger days in the eastern part of the state, it is notable that all counties show a significant increase in the projected number of high fire days between the years 2040 and 2069, roughly coinciding with the extended time frame of the onshore wind energy facilities.

Emergency medical services

Fire departments throughout the state maintain a staff of paramedics to respond to medical emergencies. The Washington State Department of Health coordinates emergency medical services and trauma care in various regions throughout the state. Emergency Medical Technician (EMT) dispatch is handled through county emergency management divisions. Figure 3 depicts emergency response providers in the onshore wind energy facility study area.

Hospitals and other medical facilities

At a local level, there are multiple healthcare facilities and hospitals throughout the state providing public health preparedness and response services. Local emergency planning efforts by hospitals, public health providers, and other community entities are integrated with county comprehensive planning. Medical evacuation (medevac) services are contracted through the public and private health facilities, and on state and federal lands with the support of agencies (such as DNR and USFS).

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[1] A high fire-danger day is defined by UW in the context of climate resilience mapping as a day in which in which 100-hour fuel moisture (i.e., the amount of water in fuel/vegetation available for combustion) is less than the historical 20th percentile.

3.2.1.2 Public schools

A variety of public education school districts serve portions of the study area. These districts range in size from small, rural school districts to larger districts with numerous schools.

In Washington state, the number of school-age students increased an average of 11,300 per year between 2013 and 2023. Enrollment peaked at 1.1 million K–12 students in 2019, then leveled off during and following the Covid-19 pandemic. Enrollment increases are expected to be moderate as the growth in the school-age population is projected to ease after 2023 (OFM 2024).

3.2.2 Utilities

The study area includes utility service areas and areas without services. Utilities described in this section include communications, gas and electrical, water, wastewater, and solid waste management. Depending on the area, utilities may be provided by county, city, Tribal, or private suppliers. In general, utility infrastructure often correlates to the size of the population it serves. As a result, population levels, coupled with any topographic or other constraints on where utilities can be provided, often dictate how well a community is served by utility systems.

3.2.2.1 Communications

Internet, broadband, and cell phone services are available in portions of the study area, generally aligning with the more populated regions. In the rural or unpopulated parts of the study area, cell phone and internet service is limited or unavailable. Public emergency alert systems report natural hazards (such as flooding or wildfire) through local radio stations, cell phones, and email notifications. The various counties in the study area provide emergency alert and notification systems allowing subscribers to access alerts in real time. In unpopulated or sparsely populated areas (where these cell service and internet systems are unavailable), these jurisdictions also utilize radio signals to broadcast alerts and communicate information pertaining to fire, police, severe weather, and other public hazards. There are stand-alone communications sites throughout the study area. These sites include cell towers, radio towers, and microwave towers, which serve to relay communications signals. Microwaves travel along direct line-of-sight paths, and their transmission requires the use of multiple towers to receive, amplify, and retransmit signals over long distances. Communications lines enabling internet or cellular signals can be mounted in a shared configuration with electrical lines on dual use poles or buried underground as cables or in conduits.

3.2.2.2 Gas and electric

Four natural gas companies operate in Washington state. The gas systems, including storage and distribution pipelines, are owned and managed by Avista Utilities, Cascade Natural Gas Corporation, Northwest Natural Gas Company, and Puget Sound Energy, with distribution supported through various public utility districts (PUDs) throughout the state. Electrical utilities are provided in the State of Washington through PUDs and three main corporations, including Avista Utilities, Pacific Power and Light, and Puget Sound Energy. There are 28 PUDs providing electric, water, sewer, communications, renewable natural gas, and renewable hydrogen (in some cases via retail service agreements) in the state. PUDs are not-for-profit community-owned entities governed by locally elected commissioners who live in the communities they serve (WPUDA 2024). With regulatory oversight from the Washington Utilities and Transportation Commission and the Federal Energy Regulatory Commission, these utilities maintain natural gas systems and energy transmission and distribution networks in various geographies throughout the state. Generally, onshore wind energy projects are unlikely to require gas service connections; however, locations of existing subsurface utilities including gas lines would need to be identified prior to construction to reduce potential ground-disturbance conflicts.

3.2.2.3 Water and wastewater

Water supply in the study area is provided through various sources, including groundwater wells, surface water, and other supplies depending on the geographic location. The Washington Departments of Health and Ecology share responsibilities under the state's Municipal Water Law under coordinated planning, engineering, and public health and safety agreements related to water resources and supply systems. Connecting to a public water system requires a service connection application to a PUD, municipal, or county system. Allocation and development of water supplies may be subject to restrictions depending on the location. Appropriation of groundwater and well construction, with limited exceptions, requires local permits. Such activities near surface waters may need to demonstrate that the allocation will allow for the maintenance of instream flow requirements adequate to support fisheries habitats. Water resources are discussed in additional detail in the *Water Resources Technical Report*.

It is expected that most onshore wind facilities may use septic systems or portable sanitary systems if day-to-day operational staff are needed for a facility. The analysis assumes that if septic or sanitary systems are used, such systems would be required to conform to local permit design and installation requirements to protect public health and (surface and ground) water resources. Existing subsurface utilities (including wells and water lines) would also require identification prior to ground-disturbing construction and avoidance during operation and maintenance.

3.2.2.4 Solid waste landfills and recycling

Solid waste generated throughout the study area is collected and managed by the various cities, counties, and private waste management entities in the study area. There are nearly 1,000 solid waste handling facilities of various types throughout Washington. There are 14 municipal solid waste landfills operating in the state: 11 are publicly owned and 3 are privately owned. These landfills received 5.5 million tons of waste in 2019 and have an estimated capacity of 280 million tons, or about 40 years of capacity at current disposal rates. There is also one "Waste-to-Energy" facility in Spokane, which is the only incinerator in the state that burns municipal solid waste (Ecology 2021). Ecology tracks and measures waste generation in Washington through review of submitted annual reports and recycling surveys from the regulated solid waste handling facilities in the state. Quantified waste generation activities include landfill disposal, incineration of mixed municipal solid waste, recycling, composting, anaerobic digestion, land application, and burning source-separated materials for energy. Other than municipal and commercial solid waste, by category, the largest quantities of solid waste generated in the state include construction and demolition debris, industrial waste, and cured concrete. In rural areas, where no collection systems are available, nonhazardous waste is removed by regulated providers and trucked to regional landfills.

Solid waste diversion incorporates a sustainable materials management approach intended to serve human needs by increasing productive reuse from the point of extraction to materials disposal (Ecology 2021). Metals and other materials capable of reuse may be collected and sold for reuse, recycled, or otherwise managed separately consistent with state requirements.

Wind turbine waste is an emerging area of concern due to the number of facilities that have come online globally in recent years. In 2017, it was estimated that by 2050 global wind assets would approach 100 gigawatts per year. It is estimated that 43 million tons of cumulative blade waste will be generated by then, with China leading at 40% of global waste generated, followed by Europe at 25%, the United States at 16%, and the rest of the world at 19%. Based on this, it is estimated that there could be 6.88 million tons of turbine blade solid waste generated in the United States by 2050. To address the problem of solid waste capacity challenges in disposing of these materials, there have been initiatives in Washington state and globally to make composite materials recyclable and provide end-of-life strategies to limit turbine blade discharge into landfills (ACP 2023a).

Lithium-ion, zinc-hybrid, and flow batteries have lifespans that are shorter than a typical onshore wind energy facility. Facilities with co-located BESSs would have to dispose of or recycle batteries after they reach their lifespan. Lithium-ion batteries are considered a hazardous waste that cannot be hauled away with a standard solid waste pickup. Coordination with local solid waste providers would be needed to determine whether they can recycle zinc-hybrid batteries and, if not, what guidelines need to be followed for disposal. Flow batteries can be recycled. Hazardous waste disposal is discussed in the *Environmental Health and Safety Technical Resource Report.*

3.3 Potentially required permits and approvals

The following permits related to public services and utilities would potentially be required for construction, operation, or decommissioning of typical onshore wind energy facilities and activities described in the alternatives:

- **Construction and development permits (e.g., road access, grading, building, mechanical, lights, signage) (local agency):** Various project construction activities and placement of new or modification of existing facilities would be subject to local permits to ensure compliance with land use, grading and drainage, stormwater management, building standards, fire codes, etc.
- **Electrical permits (Washington State Department of Labor and Industries):** These permits ensure all electrical installations meet federal and state safety standards.
- **Federal Communications Commission (FCC) filing**: Federal Aviation Administration (FAA) advisory documents govern antenna tower lighting and marking requirements, which are

mandatory under the FCC rules. The FCC may require filing with FAA for proposed structures based on a number of factors, including height, proximity to an airport, location, and frequencies emitted from the structure. Depending on such factors, communication structures associated with onshore wind energy facilities may be subject to FAA standards.

- **Land use permits (e.g., comprehensive plan amendments, conditional use permit/special use permit, or zoning amendments) (local agency):** Required if changes to a comprehensive plan or zoning designation and/or if a conditional use permit, special use permit, or variance is required for the project. The use permit process would include review of PSU considerations.
- **Local utility connection permits/approvals (local utility):** Needed to connect to utility infrastructure through utility provider.
- **Right-of-way or lease (federal, state, or local agency):** Placement of facility infrastructure such as roads, generating facilities, and transmission lines on lands under federal, state, or local agency management jurisdiction would require approval from the land manager.
- **Water Right Authorization (Ecology):** Needed to use any amount of surface water (stream, river, lake, spring) for any purpose. Also needed to withdraw groundwater from a well for any uses not covered by a groundwater permit exemption pursuant to RCW 90.44.050 (e.g., typically limits domestic and industrial uses to no more than 5,000 gallons per day each, although some areas are more restrictive). A new water right or change in water right would be reviewed by Ecology.
- **U.S. Department of Defense (DoD) Clearance for Radar Interference.** Wind turbines can cause interference with radar systems because towers and blades reflect electromagnetic radiation. As part of FAA's No Hazard to Air Navigation Approval, FAA notifies other federal agencies with radar assets near the facility, such as DoD, Department of Homeland Security, and the National Oceanic and Atmospheric Administration (NOAA). DoD assesses potential impacts on DoD missions and may issue a preliminary determination to inform the developer prior to the FAA Form 7460-1 submittal. DoD may work with the developer to mitigate the issues. Tools available to assist developers include the DoD Preliminary Screening Tool and the NOAA NEXRAD Screening Toolbase (EERE 2024).

3.4 Utility-scale onshore wind facilities

3.4.1 Impacts from construction and decommissioning

Potential adverse impacts associated with the site characterization, construction, and decommissioning of onshore wind energy facilities could consist of those related to exceeding emergency response capacity, conflicts with other existing utilities, and potential prolonged service interruptions that may occur over portions of the facility construction period.

3.4.1.1 Emergency response

An impact during project site characterization, construction, and decommissioning could occur if significantly increased demands were placed on emergency services providers that exceed response capacities. Construction of utility-scale onshore wind energy facilities would entail employment of a temporary workforce (estimated to range from 100 to 400 workers for a typical 150-megawatt [MW] facility) that could result in an increased demand for public services including law enforcement, fire departments, and emergency medical service response within and near the study area.

Law enforcement

Construction, site characterization, and decommissioning activities would entail the use of equipment and presence of materials, which may increase the potential for theft, vandalism, trespass, fire, safety issues, and/or accidents requiring law enforcement or other emergency response services. Facilities are assumed to include provisions for site security, including restricting access to portions of the project. High-voltage electrical equipment within the facility would be separately fenced and access-controlled for safety and increased security. Lighting would likely be provided at construction trailers or buildings and facility entrances as necessary for the safety and security of employees and the facilities. Materials and equipment staging areas would be fenced and security cameras installed and monitored to protect the facility site, and the presence of workers during the site characterization, construction, and decommissioning phases may also deter incidents that would require a law enforcement response.

Fire prevention and response

Activities during site characterization, construction, and decommissioning of onshore wind energy facilities could include the introduction of ignition sources (such as blasting, welding, and use of vehicles and equipment) and fuel sources (such as vehicle fuels and flammable building materials), all of which introduce fire risks during construction. Wildfire risks are discussed in the *Environmental Health and Safety Technical Resource Report*. Further, the presence of wind turbine towers can limit an aerial response to fire at an onshore wind facility to the edges of the facility and can affect aerial access to other wildfires in the vicinity. The potential for increased fire response demand at construction of any particular facility would vary by facility and location.

Emergency medical services

A probable increase in the demand for emergency response services would occur in the study area as utility-scale onshore wind energy facilities would introduce new risks and specialized response equipment needs to remote areas during construction, operation, and decommissioning. For example, a fire in a wind turbine nacelle or a maintenance worker's medical emergency (e.g., heart attack) at a height of 400 feet or greater above ground level requires a different kind of response than the demands for response at ground level. Winter conditions can exacerbate medical response access considerations if, for example, snow, ice, or other weather conditions prevent a medevac landing or access roads are closed. The presence of wind turbines and other tall structures (depending on the phase of construction completed) can prolong transport time for medevac flights by causing pilots to skirt a landscape that could be crossed more directly if the onshore wind energy facility were not sited there.

Onshore wind energy facilities are frequently sited in remote locations, away from hospitals or other emergency treatment facilities. This can be a concern with regard to the provision of timely medical treatment if a worker falls, gets trapped, or otherwise is hurt. The interior dimensions of wind turbines vary among manufacturers, but in general they all involve close enough quarters that a person 6 feet tall with a trim build would have to crouch and bend to access interior spaces. Entrapment is possible. Estimates of emergency medical service response times should be considered by facility operators for all times of the day and night when workers could be on duty or needed to respond to an unscheduled facility maintenance need. Fire and personal injury are the principal emergency situations that could affect an onshore wind energy facility and require emergency service response; however, the kinds of risks attendant to all electrical and high-voltage work must be considered and planned for to manage potential impacts related to an increased demand for emergency response services. Additional discussion is included in the *Environmental Health and Safety Technical Resource Report*.

As described for law enforcement, construction and decommissioning of utility-scale facilities would increase the potential for accidents and incidents requiring emergency medical response services. Compliance with Occupational Safety and Health Administration (OSHA) requirements and appropriate site management for construction and decommissioning would alleviate demand on local EMT response services and reduce such risks. Worker safety training and adherence to safety procedures during construction, for example, would limit potential emergency response demands. Consultation or early coordination with emergency response providers to ensure access and other proactive safety planning would also reduce such risks.

Emergency response impact summary

Through compliance with laws and permits and with the implementation of measures to avoid and reduce impacts, most construction activities would likely result in **less than significant impacts** on law enforcement, emergency medical response, and most fire response.

A facility would result in **potentially significant adverse impacts** to fire response if activities required a large fire response in remote locations with limited response capabilities or if there are other unique aspects of a facility site.

3.4.1.2 Public schools

The impact on local schools would be minor because few out-of-area construction workers would be likely to permanently relocate their families to the onshore wind project location. For this reason, construction-related impacts on school enrollment are expected to be minor and temporary. Most workers are unlikely to be permanently relocated into the onshore wind energy study area for long enough to require and obtain such services. Therefore, impacts on school enrollment during construction would be **less than significant**.

3.4.1.3 Gas, electrical, and communications systems

The onshore wind facilities would not require natural gas lines; however, existing gas lines would need to be located, marked, and avoided prior to ground-disturbing activities during site characterization, construction, and decommissioning. For these reasons, it is anticipated that potential impacts associated with gas systems would be **less than significant** and are not discussed in further detail.

Wind facilities are likely to require the relocation of electrical and communications facilities and/or the construction of new facilities to connect the facilities to the energy grid. Construction and decommissioning of utility-scale onshore wind energy facilities have the potential to result in service interruptions, which would require coordination and communication with local utility districts. The contractor and developer would have to coordinate, apply for permits, and meet the design specifications of the local power provider for connections.

During construction and decommissioning, there is the potential for temporary service interruptions as electrical and communications systems or other utilities may require disengagement or rerouting to connect the onshore wind facility’s collection system to generation-tie transmission lines (gen-tie lines) and the electrical grid. Occasional and temporary service interruptions could occur during construction duration of each facility, which would be considered a **less than significant impact**. It is recommended that measures be implemented to reduce conflict with existing electrical and communication systems or other subsurface utilities (such as existing or planned electric, gas, or water lines).

Additionally, due to the height and nature of wind turbines, interference with communications systems may occur, starting from the point at which these tall structures are erected. For example, the specific location of wind turbine generators could affect existing electronic communications infrastructure, including emergency response-related communications capabilities associated with federally licensed (FCC) microwave and fixed station radio frequency facilities, and broadcast AM radio and television signals. Large metallic structures, such as wind turbines, can adversely affect the transmitted signals of AM broadcast stations up to 1.8 miles (3 kilometers) away. Television receiver locations can be affected to some extent within 3 miles of a large turbine when the turbine is between the television station and the receiver. Rotating electrical machines generate a certain amount of electrical noise as a combination of various frequencies. As a result, each generator and its associated systems can interfere with existing signals. Potential wind-turbine-caused interference at land mobile/public safety radio transmitter stations typically occurs only within 425 meters, or about 1,400 feet, of a turbine site (Angulo et al. 2014). The potential for earth satellite stations depends on satellite arc; generally, a 65-mile study radius of a proposed new onshore wind energy facility site would encompass any stations that could have impacts from wind facilities (ESA 2020). Other design considerations relate to turbine siting to avoid interference with communications infrastructure, in light of the critical function of effective communications during an emergency response and because interference with cell, radio, television, and other communications could adversely affect human health and the physical environment if emergency response communications were prevented, interrupted, or delayed. FCC-licensed microwave and fixed station radio frequency facilities may be adversely impacted depending on the location of individual wind turbines introduced into the landscape.

Microwave communication also can be affected by wind turbines. Microwaves are a type of electromagnetic wave used to carry information such as radio, cellular phone, and digital communications at high speeds. Microwaves travel along direct line-of-sight paths, and their transmission requires the use of multiple towers to receive, amplify, and retransmit signals over long distances. It is recommended that siting and design for onshore wind energy facilities consider existing emergency response communications frequencies and locate turbines and other structures (with the potential to generate signal interference) outside the range of these signals to ensure minimal or no disruption of signals conveying emergency response information. FCC requirements for communications towers include antennae structure registration, compliance with FCC rules and implementing regulations, lighting, marking and tower construction requirements, and applicable rules based on FAA Advisory Circulars (FAA 2020). An evaluation of specific potential communications conflicts would occur as part of the FCC review or during the conditional use permit/land use approval process. With appropriate siting and design, potentially signal interference impacts on low-wave radio and communications systems would be **less than significant**.

3.4.1.3 Water and wastewater

Water demand during construction and decommissioning would include supply needed for activities such as concrete mixing and dust control, fire control, or initial revegetation efforts. Water for non-potable uses may be accessed through reclaimed/recycled water supplies where available. Potable water would be needed for drinking water and could be supplied by a commercial supplier, on-site well, or a public or community water system.

Sanitation and wastewater could be managed through contracted portable systems or septic systems. Compliance with water discharge permit conditions and site certification review would limit construction-related impacts and would not be expected to compromise stormwater systems.

Additional discussion regarding water impacts is provided in the *Water Resources Technical Report*. A developer would need to have sufficient water rights for a project to be feasible, so the PEIS assumes adequate water is available. Potential conflicts with existing subsurface water and wastewater lines could be addressed through utility mark and locate activities, which would be required prior to ground-disturbing work for site characterization, construction, and decommissioning activities. Through compliance with laws and permits and with the implementation of measures to avoid and reduce impacts, construction and decommissioning activities would likely result in **less than significant impacts** on water and wastewater utilities.

3.4.1.4 Solid waste and recycling

During construction and decommissioning, the primary solid waste generated would consist of solid construction debris such as scrap metal, cable, wire, wood pallets, cardboard, packaging for construction materials, and a limited amount of waste associated with the construction or decommissioning workforce. A portion of this waste (e.g., scrap metal, cardboard) could be recycled; the remainder would be accumulated into receptacles and transported to a licensed transfer station or landfill. As noted previously, there are nearly 1,000 solid waste providers in the state and 14 landfills that could likely accommodate the level of waste generated during construction.

Through compliance with laws and permits and with the implementation of measures to avoid and reduce impacts, construction activities would likely result in **less than significant impacts** on solid waste and recycling.

Solid waste generated during decommissioning is assumed to consist of all aboveground components not capable of being reused or repowered. It is assumed that decommissioning of onshore wind energy facilities would occur in a manner consistent with the state requirements, and that scrap metal and other materials of value would be recycled to the extent feasible, thereby reducing solid waste effects. Concrete foundations would be removed to the extent feasible and dismantled for recycling or disposal. As noted in the *Environmental Health and Safety Technical Resource Report*, shredding wind turbine blades can generate airborne particulate matter that can act as an irritant to the skin, lungs, and eyes due to the hazardous substances contained in these materials. For this reason, it is recommended that measures be implemented to limit solid waste disposal of wind turbine blades and other hazardous materials (such as glass fiber-reinforced polymers) associated with onshore wind energy facility decommissioning or repowering.

Most turbine blades consist of glass fiber-reinforced polymers and may lack an established market for reuse and/or recycling. These components may be disposed of in landfills, disassembled, and repurposed, as permitted by law. Recycling wind turbine blades is not currently a viable option in Washington, with no industrial-scale recycling options available within cost-feasible transportation distances. A feasibility study commissioned by the Washington State Legislature and conducted in 2023 assessed the feasibility and cost of multiple methods of recycling wind turbine blades. It is estimated that under existing conditions, thousands of tons of turbine blade waste will soon reach the end of its useful life in the state. Based on the growing wind energy industry and lack of alternatives in the region, recycling options for wind turbine blades might be available by the time of decommissioning of facilities (Booth and Nath 2023).

There are recent developments in recycling or upcycling of turbine waste materials; however, with each of the methods, there are tradeoffs in terms of energy use and transportation challenges. Further, it is unclear whether such technologies would operate at a scale adequate to address the solid waste challenges posed during future decommissioning.

Depending on turbine recycling facilities, recycling methods available at the time of decommissioning, and the volume of waste, there could be a range of **less than significant** to **potentially significant adverse impacts** on solid waste and recycling if there are large volumes of solid waste.

3.4.2 Impacts from operation

3.4.2.1 Emergency response

Law enforcement
As with construction and decommissioning, onshore wind energy facility operations could increase the demand for law enforcement services due to potential theft, accidents, vandalism, or trespassing. However, various security measures (e.g., fencing portions of the site to protect substations and equipment; employing security personnel; providing motion-triggered lighting and facility monitoring systems) would typically be in place as part of normal operations to protect the facilities. Such measures would reduce demand for external security or law enforcement response services.

Fire prevention and response
Fire risks associated with project operations are described in the *Environmental Health and Safety Technical Resource Report*. Fire risks during operation include those caused by facility equipment or operational activities and fires started outside of facilities that have altered behavior (i.e., spread, movement, or ability to suppress) due to the presence of an onshore wind energy project. This analysis assumes that onshore wind energy projects would be regularly maintained and monitored to reduce these risks. However, accidents and fires could still occur.

Local and/or volunteer fire departments and responders may not be adequately trained and equipped to respond to wildfires that may occur on utility-scale onshore wind energy facility sites. Due to the rural nature of much of the study area, responding fire departments can be several miles away and may need to travel over roads that require four-wheel-drive vehicles. Other challenges that can limit fire department intervention in a turbine fire include the height of the fire and the extremely limited vertical access inside the tower.

A turbine fire actively fought, controlled, and extinguished by fire department personnel would be a rare event. The general rule established in standard operating procedures for onshore wind energy facility fire response is not to attempt to physically attack a fire inside the tower and generator assembly, but rather to establish an exterior defensive that protects exposed structures and vegetation near the affected area. Preparedness and training can result in better outcomes, including advance interaction of emergency responders with onshore wind energy facility operators to create, implement, and maintain pre-emergency response planning; to familiarize responders with onshore wind energy facilities in their jurisdiction; and to engage in simulation emergency exercises.

Wind turbines are anticipated to be 750 feet or taller with blades extended. Given the height of the structures, onshore wind energy facilities could also introduce obstacles affecting air navigation for aerial firefighting capabilities. Aerial firefighting within the site would likely be limited for safety reasons, particularly on lands along ridgelines or near steep slopes. Depending on the site layout, turbine spacing, and topography, surrounding lands may also be affected. FAA advisory guidelines for obstruction lighting and marking would apply to wind turbine siting and design. Although spacing between turbines could be large and areas in use would be much smaller than the overall site perimeter, development of an onshore wind energy facility represents a change of land use warranting site-specific fire prevention and response planning. It is not likely that wind facilities would include overall perimeter fencing, but other access and response challenges are likely, especially in mountainous regions of the study area.

Emergency medical services

Emergency medical services could be needed for employees. For example, periodic routine maintenance activities could involve a fire or entrapment in a confined space or a maintenance worker's medical emergency hundreds of feet above the ground surface. The challenges of an emergency medical response could be exacerbated by winter conditions, distance of the facility site from medical services, access to the site, and the height at which emergency response is needed. Further, equipment failure or an extreme event could lead to turbine failure or rotor failure.[2] Turbine siting and design guidelines could identify setback distances to protect facility workers, area residents, and travelers on public roadways from harm to reduce the need for emergency response.

However, the operational staffing for onshore wind energy facilities would likely be small. Additionally, facility operators would be expected to use appropriately trained technicians to operate and maintain the equipment. These considerations should result in a minimal increase in emergency medical service needs.

Emergency response impact summary

Through compliance with laws and permits and with the implementation of measures to avoid and reduce impacts, operations would likely result in **less than significant impacts** on law enforcement, emergency medical response, and most fire response.

A project would result in **potentially significant adverse impacts** to fire response if activities required a large fire response in remote locations with limited response capabilities or if there are other unique aspects of a facility site.

3.4.2.2 Public schools

Utility-scale onshore wind facilities may not require full-time permanent staff for facility operation and maintenance, and any permanent staff would be in small numbers. Operations could occur in tandem with remote facility (SCADA system) monitoring; periodic maintenance could occur through temporary or contracted staff. Utility-scale facilities would not increase the population such that new or modified public schools would be needed and impacts on local school enrollment during the operations phase would be **less than significant**.

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[2] "Rotor failure," also known as "blade throw," refers to the disconnection of a wind turbine blade or blade fragment from the tower, typically due to equipment failure or an extreme event, such as a lightning strike.

3.4.2.3 Communications systems

Onshore wind energy facilities involve special communications siting and design considerations that could impact emergency response communications. As discussed in Section 3.4.1 (in the context of construction and decommissioning), the placement of turbines and other tall structures, and the operation of rotating turbines, if within line-of sight of microwave signal paths, may obstruct or interfere with existing electronic communications signals (i.e., radio transmission, microwave, cellular, digital, and their boosting signal components). Local emergency response teams may have a system in place that notifies registered cell phones in the event of emergency situations or critical community alerts, such as emergency evacuation notices, bio-terrorism alerts, and missing child reports. Such notification systems, if specific to cell phones, may be affected by onshore wind energy facility-caused interruptions in microwave communications. Wind turbine interference at land mobile public safety radio transmitter stations would typically occur only within 425 meters, or about 1,400 feet of a turbine site. FCC-licensed microwave and fixed station radio signals may also be affected by onshore wind energy facilities, if located within the line-of-sight path of these signals. AM radio broadcast stations up to 3 kilometers (or 1.8 miles) away may be adversely affected by wind turbine interference. For television broadcast facilities, approximately 10% of receiver locations can be affected within 3 miles of a large turbine if the turbine is between the TV station and the receiver. Interference with aircraft navigational communications is not anticipated from structures (turbines) more than 10 miles from a navigational radio beacon. Nevertheless, the distance between the proposed wind turbines and navigational beacons should be considered among other siting and design considerations. An evaluation of specific potential communications conflicts would occur as part of the FCC review or during the conditional use permit/land use approval process.

With appropriate siting and design, potential signal interference impacts on communications systems would be **less than significant**.

3.4.2.4 Gas and electric

Once operational, the wind facilities would not be anticipated to increase demand for gas or electricity services. New and modified electrical facilities (such as the facility substation systems, gen-tie lines, and interconnections) would be operated and maintained to connect, convert, and transmit the generated wind energy to the electrical grid; however, these systems would not increase demand such that new transmission lines or other electric systems would be required. Through compliance with laws and permits and with the implementation of measures to avoid and reduce impacts, operations would likely result in **less than significant impacts** on gas and electric services.

3.4.2.5 Water and wastewater

During the operation and maintenance period, water may be needed for dust control, irrigation of on-site vegetation, fire water supply, and plumbed facilities such as sinks or toilets, if installed. If consistent with public health requirements and available supply, reclaimed water may supply some of these water demands. Potable water also may be needed for on-site drinking water, which could be supplied by a well or trucked to the site, as needed. A developer would need to have sufficient water rights for a project to be feasible, so the PEIS assumes adequate water is available.

If onshore wind energy facilities include on-site septic systems during operation, such systems would conform to the state requirements for siting and design (Revised Code of Washington 70.118.010 et seq.) for the protection of water resources and public health. Septic systems or portable units, if utilized, would typically be maintained by a licensed service provider. As discussed, the small number of expected operational staffing would limit impacts associated with wastewater capacity.

Through compliance with laws and permits and with the implementation of measures to avoid and reduce impacts, construction activities would likely result in **less than significant impacts** on water and wastewater utilities.

3.4.2.6 Solid waste and recycling

A small amount of solid waste would be generated as part of normal operation and maintenance activities. Periodic replacement of wind components, which could include large items (such as damaged turbine blades) may occur over the 30-year operational time frame. Typical waste includes broken or rusted metal, defective or malfunctioning equipment, electrical materials, empty containers, miscellaneous solid waste, and typical refuse from operations and maintenance staff. Approximately 1 cubic yard of waste per week would be expected, which should be able to be collected by a commercial waste management service. The volume of waste anticipated from periodic replacement of damaged components would not be expected to exceed the capacities of solid waste management providers or landfills.

Through compliance with laws and permits and with the implementation of measures to avoid and reduce impacts, operations would likely result in **less than significant impacts** on solid waste and recycling.

3.4.3 Measures to avoid, reduce, and mitigate impacts

The PEIS identifies a variety of measures to avoid, reduce, and mitigate impacts. These measures are grouped into five categories:

- **General measures:** The general measures apply to all projects using the PEIS.
- **Recommended measures for siting and design:** These measures are recommended for siting and design in the pre-application phase of a project.
- **Required measures:** These measures must be implemented, as applicable, to use the PEIS. These include permits and approvals, plans, and other required measures.
- **Recommended measures for construction, operation, and decommissioning:** These measures are recommended for the construction, operation, and decommissioning phases of a project.
- **Mitigation measures for potential significant impacts:** These measures are provided only in sections for which potential significant impacts have been identified.

3.4.3.1 General measures

- **Laws, regulations, and permits:** Obtain required approvals and permits and ensure that a project adheres to relevant federal, state, and local laws and regulations.

  ***Rationale*:** Laws, regulations, and permits provide standards and requirements for the protection of resources. The PEIS impact analysis and significance findings assume that developers would comply with all relevant laws and regulations and obtain required approvals.

- **Coordination with agencies, Tribes, and communities:** Coordinate with agencies, Tribes, and communities prior to submitting an application and throughout the life of the project to discuss project siting and design, construction, operations, and decommissioning impacts, and measures to avoid, reduce, and mitigate impacts. Developers should also seek feedback from agencies, Tribes, and communities when developing and implementing the resource protection plans and mitigation plans identified in the PEIS.

  ***Rationale*:** Early coordination provides the opportunity to discuss potential project impacts and measures to avoid, reduce, and mitigate impacts. Continued coordination provides opportunities for adaptive management throughout the life of the project.

- **Land use:** Consider the following when siting and designing a project:
  - Existing land uses
  - Land ownership/land leases (e.g., grazing, farmland, forestry)
  - Local comprehensive plans and zoning
  - Designated flood zones, shorelines, natural resource lands, conservation lands, priority habitats, and other critical areas and lands prioritized for resource protection
  - Military testing, training, and operation areas

  ***Rationale*:** Considering these factors early in the siting and design process avoids and minimizes the potential for land use conflicts. Project-specific analysis is needed to determine land use consistency.

- **Choose a project site and a project layout to avoid and minimize disturbance:** Select the project location and design the facility to avoid potential impacts to resources. Examples include the following:
  - Minimizing the need for extensive grading and excavation and reducing soil disturbance, potential erosion, compaction, and waterlogging by considering soil characteristics
  - Minimizing facility footprint and land disturbances, including limiting clearing and alterations to natural topography and landforms and maintaining existing vegetation
  - Minimizing the number of structures required and co-locating structures to share pads, fences, access roads, lighting, etc.

***Rationale*:** Project sites and layouts may differ substantially in their potential for environmental impacts. Thoughtful selection of a project site and careful design of a facility layout can avoid and reduce environmental impacts.

- **Use existing infrastructure and disturbed lands and co-locate facilities:** During siting and design, avoid and minimize impacts by:
  - Using existing infrastructure and disturbed lands, including roads, parking areas, staging areas, aggregate resources, and electrical and utility infrastructure
  - Co-locating facilities within existing rights-of-way or easements
  - Considering limitations of existing infrastructure, such as water and energy resources

  ***Rationale*:** Using existing infrastructure and disturbed lands and co-locating facilities reduces impacts to resources that would otherwise result from new ground disturbance and placement of facilities in previously undisturbed areas.

- **Conduct studies and surveys early:** Conduct studies and surveys early in the process and at the appropriate time of year to gather data to inform siting and design. Examples include the following:
  - Geotechnical study
  - Habitat and vegetation study
  - Cultural resource survey
  - Wetland delineation

  ***Rationale*:** Conducting studies and surveys early in the process and at the appropriate time of year provides data to inform siting and design choices that avoid and reduce impacts. This can reduce the overall timeline as well by providing information to agencies as part of a complete application for environmental reviews and permits.

- **Restoration and decommissioning:** Implement a Site Restoration Plan for interim reclamation following temporary construction and operations disturbance. Implement a Decommissioning Plan for site reclamation at the end of a project. Coordinate with state and local authorities, such as the Washington Department of Fish and Wildlife, county extension services, weed boards, or land management agencies on soil and revegetation measures, including approved seed mixes. Such plans address:
  - Documentation of pre-construction conditions and as-built construction drawings
  - Measures to salvage topsoil and revegetate disturbed areas with native and pollinator-supporting plants
  - Management of hazardous and solid wastes
  - Timelines for restoration and decommissioning actions
  - Monitoring of restoration actions
  - Adaptive management measures

  ***Rationale*:** Restoration and decommissioning actions return disturbed areas to pre-construction conditions, promote soil health and revegetation of native plants, remove project infrastructure from the landscape, and ensure that project components are disposed of or recycled in compliance with all applicable laws and regulations.

- **Cumulative impact assessment:** Assess cumulative impacts on resources based on reasonably foreseeable past, present, and future projects. Identify measures to avoid, reduce, and mitigate cumulative impacts. Consider local studies and plans, such as comprehensive plans.

  Rationale**:** Cumulative impacts can result from incremental, but collectively significant, actions that occur over time. The purpose of the cumulative impacts analysis is to make sure that decision-makers consider the full range of consequences under anticipated future conditions.

3.4.3.2 Recommended measures for siting and design s

- If siting is proposed on or near areas of high-fire risk, coordinate with the local fire district, emergency management departments, U.S. Forest Service, and/or DNR during siting and design and throughout the life cycle of the project to identify and address fire response needs.
- Complete a communication interference report to evaluate interference in and around the project area for microwave signals, fixed station radio frequency facilities, land mobile/public safety radio transmitter stations, satellites, television broadcast facilities, and aircraft navigation.
- Design the facility to avoid communications interference in coordination with emergency response providers and emergency management districts. Examples of measures include selecting facility equipment with a frequency spectrum for electrical noise that does not interfere with communications systems and emergency response alerts.
- To minimize potential hazardous solid waste disposal during decommissioning, select nontoxic and/or recyclable turbine blades.

3.4.3.3 Required measures

- Construction and development permits (e.g., road access, grading, building, mechanical, lights, signage) (local agency)
- Electrical permits (Washington State Department of Labor and Industries)
- FCC filing
- Land use permits (e.g., comprehensive plan amendments, conditional use permit/special use permit, or zoning amendments) (local agency)
- Local utility connection permits/approvals (local utility)
- Right-of-way or lease (federal, state, or local agency)
- Water Right Authorization (Ecology)
- DoD Clearance for Radar Interference
- Conform to all applicable building and fire code requirements pertaining to setback distances for public safety related to turbine failure or blade throw.

- In coordination with relevant authorities, develop plans and procedures to reduce risks specific to the project and regional conditions, including the following:
  - Fire Prevention and Response Plan, where required
  - Hazardous Materials and Waste Management Plan
  - Spill Prevention, Control, and Countermeasure Plan
  - Site Security Plan
  - Emergency Response Plan, including medical response procedures
- Implement measures to reduce utility service interruptions and conflicts, including, but not limited to, the following:
  - Mark and locate all underground utilities within the construction footprint prior to ground-disturbing construction activities.
  - Consult and coordinate with utility providers on design standards for utility connections and specify the extent and timing of proposed construction activities.
  - Ensure advance notification to residents and businesses where service interruptions may occur because of construction.

3.4.3.4 Recommended measures for construction, operation, and decommissioning

- Recycle all components of a facility that have the potential to be used as raw materials in commercial or industrial applications.

3.4.3.5 Mitigation measures for potential significant impacts

- Include a turbine blade end-of-life stewardship plan as part of the Decommissioning Plan. The plan would include the following:
  - Expected quantities and types of solid waste the onshore wind energy facility would generate, including but not limited to turbine blade waste
  - Expected destinations for waste
  - Specialized procedures for handling, transporting, management, and disposal of potentially hazardous materials

  ***Rationale*:** It is uncertain whether regulations will come into effect to require stewardship and takeback for turbine blades in future years within the decommissioning time frame for the onshore wind energy facilities. Developing an end-of-life stewardship plan would reduce the overall quantities of potentially hazardous solid waste associated with onshore wind energy components.

- Coordinate with local fire departments and emergency management departments to provide specialized training and equipment caches during project operations.

  ***Rationale*:** Coordination can reduce risk and improve emergency response actions.

- Maintain at least one water truck with sprayers for each 1 to 2 miles of access road for construction during the fire season. Install fire station boxes with shovels, water tank sprayers, and other firefighting equipment at multiple locations along roadways during the fire season.

Rationale**:** Maintaining firefighting equipment at multiple locations at the facility site bolsters the firefighting resources available to emergency responders in remote locations with limited response capabilities or if there are other unique aspects of a facility site.

- Where not already required, develop a site-specific Fire Prevention and Response Plan.

  Rationale**:** A Fire Prevention and Response Plan can mitigate fire risks at a facility.

- Coordinate with local emergency responders to fund training and equipment to address fire risks.

  Rationale**:** Funding training and equipment to address fire risks can help local emergency responders in locations with limited response capabilities better prepare for and respond to a large fire.

3.4.4 Unavoidable significant adverse impacts

Construction, operation, and decommissioning of utility-scale onshore wind facilities may result in a **potentially significant and unavoidable adverse impact** if activities require a large fire response in remote locations with limited response capabilities or if there are other unique aspects of a project site that affect fire response. Determining if mitigation options would reduce or eliminate impacts below significance would be dependent on the specific project and site.

3.5 Onshore wind facilities with co-located battery energy storage systems

3.5.1 Impacts from construction, operation, and decommissioning

Facilities with BESSs would include the same systems as those considered in Section 3.4, with the addition of one or two co-located BESSs, each capable of storing up to 500 MW of energy. The site characterization, construction, operation, and decommissioning of a facility co-located with a BESS is anticipated to include the same impacts on public services and utilities as those described for facilities without BESSs.

Co-location of BESSs introduces additional fire management, emergency response, and solid waste considerations. For detailed discussion regarding public health and safety related to BESSs, refer to the *Environmental Health and Safety Technical Resource Report*.

3.5.1.1 Emergency response

Co-location of the BESS(s) introduces an additional fire risk management and emergency response consideration. The types of BESSs evaluated in this PEIS rarely start fires if properly installed and maintained. Flow batteries and zinc-bromide batteries are generally not flammable. BESSs come equipped with remote alarms for operations personnel and emergency response teams. Other protective measures include ventilation, overcurrent protection, battery controls to operate the batteries within designated parameters, temperature and humidity controls, smoke detection, and maintenance in accordance with manufacturers' guidelines. Some battery types contain hazardous materials that pose potential risks for environmental release if not handled correctly, and lithium-ion batteries, in particular, could introduce hazards for first responders. BESS facilities could create extreme hazards for firefighters and emergency responders with the possibility of explosions, flammable gases, toxic fumes, water-reactive materials, electrical shock, corrosives, and chemical burns. Utility-scale energy storage requires specialized and reliable equipment to perform firefighting operations safely and effectively to the Washington Fire Code, National Fire Protection Association (NFPA), OSHA, and Underwriters Laboratories codes and standards, as discussed in the *Environmental Health and Safety Technical Resource Report*, as well as the applicable county fire protection district codes and standards.

Specialized advanced planning and procedures for enhanced fire response training would be required to ensure that the onshore wind energy facilities and co-located BESSs do not generate hazards that could interfere or exceed emergency response capabilities. For additional details regarding emergency response for BESSs, see Attachment 1, the *First Responders Guide to Lithium-Ion Battery Energy Storage System Incidents* (ACP 2023b). The recommended approach from the American Clean Power guidance for firefighting is not to use water but allow the battery to burn in a controlled manner. This would result in air emissions that could be hazardous to emergency responders and would require protective gear.

Impacts to public services and utilities would be similar to findings for utility-scale onshore wind facilities, with additional fire response considerations for BESSs.

A facility would result in **potentially significant adverse impacts** to fire response if activities required a large fire response in remote locations with limited response capabilities, or if there are other unique aspects of a facility site.

3.5.1.2 Solid waste and recycling

Lithium-ion, zinc-hybrid, and flow batteries have lifespans that are shorter than a typical onshore wind energy facility. Lithium-ion batteries typically last 5 to 15 years (NREL 2025), and because their performance gradually degrades over time, a facility operator may choose to change them sooner than 5 years after installation. Batteries can be recycled but are often disposed of as hazardous waste due to a lack of recycling service providers for batteries. Lithium-ion batteries are considered universal waste.[3] The operator would need to coordinate

[3] Universal waste is a category of dangerous waste that allows businesses to handle several common types of dangerous waste under the Universal Waste Rule (WAC 173-303-573; Ecology 2024).

with a universal waste transporter to transport old lithium-ion batteries to a treatment, storage, and disposal facility or a recycling facility (Ecology 2023).

Because of the growing use of lithium-ion batteries for energy storage and other purposes, the U.S. Environmental Protection Agency (USEPA) has proposed rules to establish waste management regulations specific to the batteries. The Washington State Legislature has directed Ecology to assess and recommend options for collection and end-of-life management of large batteries, such as those used in BESSs.

Zinc-hybrid batteries last almost 20 years with periodic replacement of some components. Zinc-hybrid batteries are nontoxic. The operator or decommissioner would need to confirm with local solid waste providers to determine whether they can recycle zinc-hybrid batteries and, if not, what guidelines need to be followed for disposal.

Flow batteries tend to last 10 to 20 years and do not degrade over time. Flow batteries can be recycled. The operator would need to coordinate with local disposal sites to determine whether they can recycle flow batteries or not.

Through compliance with laws and permits and with the implementation of measures to avoid and reduce impacts, impacts to solid waste and recycling from facilities with co-located BESSs would be **less than significant**.

3.5.2 Measures to avoid, reduce, and mitigate impacts

Available measures to avoid, reduce, and mitigate impacts would be the same as those identified in Section 3.4.3, with additions noted below.

3.5.2.1 Required measures

- When a battery reaches its end of life, follow Ecology's guidance for managing universal waste, which includes the following:
  - Sending the battery off site for recycling. Disposal is prohibited.
  - Storing lithium-ion batteries properly to prevent breakage and release of toxics to the environment.
  - Labeling waste containers.
  - Tracking accumulation start dates, as universal waste cannot be stored on site for more than 1 year.
  - Training employees in proper handling and emergency procedures.
  - Meeting the large-quantity handler requirements if the site accumulates 11,000 pounds or more of universal waste at any time. This will depend on the size of the BESS.
- Incorporate BESS considerations into the project's Fire Prevention and Response Plan.

3.5.3 Unavoidable significant adverse impacts

Construction, operation, and decommissioning of utility-scale onshore wind facilities with BESSs may result in a **potentially significant and unavoidable adverse impact** if activities require a large fire response in remote locations with limited response capabilities or if there are other unique aspects of a facility site that affect fire response. Determining if mitigation options would reduce or eliminate impacts below significance would be dependent on the specific project and site.

3.6 Onshore wind facilities that include agricultural uses

3.6.1 Impacts from construction, operation, and decommissioning

For a facility that includes agricultural land uses, any existing agricultural lands would be maintained, or new agricultural use could be co-located with the utility-scale onshore wind facility. Facilities may entail a different fencing system to potentially accommodate grazing or other agricultural activities. Therefore, there could be access limitations to portions of the site, presenting challenges for first responders. The scale of onshore wind energy facilities with co-located agricultural uses are assumed to be similar to facilities without agricultural use; therefore, most potential impacts on public services and utilities would be similar. Construction, operation, and decommissioning of a facility with co-located agricultural land use is anticipated to include generally the same impacts to most public services (law enforcement, public schools, and healthcare) and utilities (gas and electric, and water and wastewater) as those described for the facilities without agricultural uses. For solid waste and recycling, there could be a similar range of impacts as described for large facilities without agricultural use, from **less than significant** to **potentially significant adverse impacts** associated with solid waste and recycling capacity during decommissioning and repowering.

Additional considerations for fire protection and emergency response are discussed below.

3.6.1.1 Fire protection and emergency response

Because these projects would include active management of the vegetative landscape (e.g., grazing, crop production, pollinator habitat) and provide a beneficial cooling effect to the land, it is assumed that fire risk for the agricultural energy sites could generally be reduced compared to facilities without agricultural use. Emergency fire response demand may correspondingly decrease due to this type of land management.

Co-located agricultural uses could entail a different fencing design to potentially accommodate grazing or other agricultural activities, which could pose challenges for first responders if they were to need to access portions of a facility site that are fenced.

Through compliance with laws and permits and with the implementation of measures to avoid and reduce impacts, most construction, operation, and decommissioning activities would likely result in **less than significant impacts** on public services and utilities.

A facility would result in **potentially significant adverse impacts** to fire response, if activities required a large fire response in remote locations with limited response capabilities, or if there are other unique aspects of a facility site.

3.6.2 Measures to avoid, reduce, and mitigate impact

The measures to avoid, reduce, and mitigate impacts would be the same as those identified in Section 3.4.3. As noted in Section 3.4.2, there are standard operating procedures to enhance training for emergency responders, which would also proactively reduce impacts for onshore wind facilities with agricultural use.

3.6.1 Unavoidable significant adverse impacts

Construction, operation, and decommissioning of facilities with agricultural uses may result in a **potentially significant and unavoidable adverse impact** if activities require a large fire response in remote locations with limited response capabilities or if there are other unique aspects of a facility site that affect fire response. Determining if mitigation options would reduce or eliminate impacts below significance would be dependent on the specific project and site.

3.7 No Action Alternative

Under the No Action Alternative, agencies would continue to conduct environmental review and permitting for onshore wind energy facilities under existing state and local laws on a project-by-project basis. The potential impacts would be similar to the impacts for the types of facilities described above for construction, operations, and decommissioning, depending on project size and design, and would likely range from **less than significant** to **potentially significant adverse impacts**.

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Appendix P, Attachment 1. First Responders Guide to Lithium-Ion Battery Energy Storage System Incidents

First Responders Guide to Lithium-Ion Battery Energy Storage System Incidents

1 Introduction

This document provides guidance to first responders for incidents involving energy storage systems (ESS). The guidance is specific to ESS with lithium-ion (Li-ion) batteries, but some elements may apply to other technologies also. Hazards addressed include fire, explosion, arc flash, shock, and toxic chemicals. For the purposes of this guide, a facility is assumed to be subject to the 2023 revision of NFPA 855 [B8][1] and to have a battery housed in a number of outdoor enclosures with total energy exceeding 600 kWh, thus triggering requirements for a hazard mitigation analysis (HMA), fire and explosion testing in accordance with UL 9540A [B14], emergency planning, and annual training. (The 2021 International Fire Code (IFC) [B2] has language that has been largely harmonized with NFPA 855, so the requirements are similar.)

This guide provides recommendations for pre-incident planning and incident response. Additional tutorial content is provided for each of the hazard categories. The Bibliography provides references to applicable codes and standards, and other documents of interest.

2 Abbreviations and acronyms

AHJ	authority having jurisdiction
BMS	battery management system
ERP	emergency response plan (designated in NFPA 855 as ‘emergency operations plan’)
ESS	energy storage system
HMA	hazard mitigation analysis
IDLH	immediately dangerous to life and health
LEL	lower explosive limit
LFL	lower flammable limit
LFP	lithium iron phosphate battery
Li-ion	lithium-ion
NCA	lithium nickel-cobalt-aluminum oxide
NFPA	National Fire Protection Association
NMC	lithium nickel-manganese-cobalt oxide
PPE	personal protective equipment
SCBA	self-contained breathing apparatus
SDS	safety data sheet
SME	subject-matter expert
UFL	upper flammable limit
UL	Underwriters Laboratories

[1] References in square brackets are to the Bibliography at the end of this guide.

3 Pre-incident planning

3.1 General

The pre-incident plan is used by first responders in effectively managing emergencies. It is required to be available to the incident commander during an event. The plan should be in accordance with the newly released NFPA 1660 [B9]. From the front matter of this new document: "The 2024 edition of NFPA 1660 integrates NFPA 1600, NFPA 1616, and NFPA 1620 into a single standard that establishes a common set of criteria for emergency management and business continuity programs; mass evacuation, sheltering, and re-entry programs; and the development of pre-incident plans for emergency response personnel." Pre-incident planning, formerly in NFPA 1620, is in Chapters 17 through 23.

Additional ESS-specific guidance is provided in the NFPA Energy Storage Systems Safety Fact Sheet [B10]. NFPA 855 requires several submittals to the authority having jurisdiction (AHJ), all of which should be available to the pre-incident plan developer. These include:

- Results of fire and explosion testing conducted in accordance with UL 9540A
- Hazard mitigation analysis (HMA)
- Emergency response plan (ERP)

While the main document for development of the pre-incident plan is the ERP, the UL 9540A test results and HMA may provide useful additional information for the plan and associated training.

3.2 UL 9540A test results

Testing to UL 9540A provides information at a level of detail that may not be included in the ERP (see 3.4). Cell-level testing provides a breakdown of the composition of vented gas from cells in thermal runaway, including flammable gases and vapors. Potentially significant concentrations of highly toxic hydrogen fluoride may also be produced. Video recordings are made of testing at unit (rack) and installation levels (if the latter is performed). These test results and videos can be used in first-responder training (see 3.6) since they provide insight into system behavior in a thermal runaway event that cannot be gained from outside the enclosure.

3.3 HMA

While testing to UL 9540A is valuable, it involves initiation of thermal runaway in a limited number of cells. This method does not address larger-scale failures that could occur, for example, with a loss of insulation and subsequent arcing, or with mechanical damage potentially caused by vehicle impacts or flying debris. Such failures could result in a fire that consumes the entire enclosure. The HMA should address such an occurrence and should assess, at least by simulation or calculation, the maximum temperature rise of cells in adjacent enclosures. This information is used to justify limited spacing between enclosures and can also be used to determine whether first responders should intervene.

3.4 ERP

The ERP forms the basis for pre-incident planning. Among other information, the ERP should include details on the following:

- Site overview and ESS nameplate information
- Potential hazards
- Fire protection and safety systems
- Emergency response recommendations

- Emergency contacts, including subject-matter expert (SME)
- Safety data sheets (SDS)
- PPE

The firefighting philosophy should be outlined, whether that be to suppress the fire using built-in systems or to let it burn out safely (and in some cases, to make it burn. See 5.1.)

3.5 Availability of battery management system data

Access to battery management system (BMS) data is critical for informed incident response. Depending on the severity of the incident, it may be possible to observe the current conditions within the enclosure where the incident began, such as module temperatures and readings for any gas sensing systems that may be installed. If a fire is in progress, it is important to monitor module temperatures in adjacent enclosures, to determine whether additional actions should be taken.

BMS access may be direct, such as using a first responder's computer to access the local human-machine interface or a remote digital twin, or it may be indirect, such as through a voice connection to a network operations center or SME. Data may also be available on a screen local to each enclosure, but this should not be accessed if there is any danger of fire, explosion, or toxic emissions.

3.6 Training

NFPA 855 mandates initial and annual refresher training for facility staff (see section 4.3.2.2). First responders should be included in such training, either in person or via video recordings of the training sessions. Trainees should be familiar with the site layout, installed equipment, SDS contents, and emergency response recommendations of the ERP.

4 Incident response

4.1 General

An incident command system should be established immediately on arrival, and an appropriate incident command individual should have access to BMS data (see 3.5). Working with facility personnel, the scene should be assessed, and potential hazards should be communicated to all responders.

4.2 Personal protective equipment (PPE)

Full firefighter protective gear should be worn where there is any possibility of fire or explosion, including proper use of self-contained breathing apparatus (SCBA). If there is no risk of fire or explosion per the project incident command, protective clothing for arc-flash and shock hazards should be worn by anyone operating within the arc-flash boundary (see 4.5). Jewelry and other metallic items should be removed.

4.3 Fire

If a fire is in progress, flammable gases will be consumed as they are released, and an explosion is unlikely. The safest approach is to allow the enclosure to burn in a controlled manner, so that all fuel is consumed and the possibility of reignition is minimized. BMS data from adjacent enclosures should be monitored to verify that module temperatures remain at safe levels (typically up to around 80 °C/180 °F). Application of water should be limited to cooling and protecting nearby exposures (and adjacent enclosures if module temperatures are above thresholds identified in the ERP).

Once the fire has self-extinguished, there may be ongoing releases of flammable or toxic gases. Full protective gear and SCBA should continue to be used until releases (such as carbon monoxide) are measured to be at a safe level.

If an earlier fire has been extinguished by the enclosure's fire suppression system, there is a potential for ongoing release of flammable gases, with a corresponding explosion risk (see 4.4). See 5.1 for additional discussion of fire hazards.

4.4 Explosion

If system sensors (temperature, smoke, heat, and/or flammable gas) indicate that a thermal runaway event occurred, but there is no sign of fire, it should be assumed that an explosion risk is present. Personnel should be stationed outside the potential blast radius, at an angle to the doors, and upwind of the enclosure. The enclosure should be inspected from a distance using BMS data to determine the status of the system, including module temperatures, gas sensing, and ventilation systems for gas exhaust. If the BMS is not functioning because of system damage, thermal scanning may provide an indication of ongoing thermal issues. However, responders should be aware that enclosure insulation may make it difficult to make an accurate assessment of internal temperature.

If the enclosure has been vented by automatic door or panel opening and there is no indication of high temperatures, the enclosure may be approached by responders using continuous gas monitoring to warn of any residual atmospheric risk.

If the enclosure appears to be sealed – for example, if gas venting is accomplished through a magnetic flap or if there is no provision for gas venting – BMS data and external visual assessment should be reviewed with the SME before attempting to open the enclosure.

See 5.2 for additional discussion of explosion hazards.

4.5 Arc flash and electric shock

Even when disconnected from external circuits, batteries retain their stored energy and should be considered to be energized. A battery may be partially destroyed by fire yet retain stranded energy at hazardous levels. All batteries, whatever their visual condition, should be treated as fully charged with respect to arc flash and electric shock hazards.

Appropriate PPE should be worn by properly trained individuals when working within the arc flash boundary. See 5.3 for additional discussion of arc flash and shock hazards.

4.6 Toxic chemicals

Toxic chemicals, including hydrogen fluoride, hydrogen chloride, hydrogen cyanide, and carbon monoxide, may be released during an incident. Spraying water on smoke or vapor released from the battery, whether burning or not, may cause skin or lung irritation and contaminated run-off similar to plastic fires [B1]. This is one additional reason for allowing the battery to burn in a controlled manner. The site perimeter should be entered only by trained firefighters wearing full protective gear and using SCBA. See 5.4 for additional discussion of toxic chemical hazards.

5 Discussion of Li-ion hazards

5.1 Fire

There is ongoing debate in the energy storage industry over the merits of fire suppression in outdoor battery enclosures. On one hand, successful deployment of clean-agent fire suppression in response to a limited event (for example, an electrical fire or single-cell thermal runaway with no propagation) can limit damage to the system, which can then be expeditiously returned to service. On the other hand, actuation of the same system in response to a large event, such as a multicell arcing fault, may knock out or prevent a fire but allow ongoing release of flammable gases, thus creating an explosion hazard.

Some ESS designs employ a ‘make it burn’ strategy, in which a sparker ignites flammable gas when the lower flammable limit (LFL) is exceeded but before the lower explosive limit (LEL) is reached. Such designs do not include fire suppression, on the basis that the loss of an enclosure through controlled burning is preferable to increasing the risk of an explosion. This strategy can be effective for Li-ion technologies based on transition metal oxides, such as lithium nickel-cobalt-aluminum oxide (NCA) and lithium nickel-manganese-cobalt oxide (NMC) materials, which release oxygen during thermal runaway, thus maintaining a flammable gas mixture. The same arrangement would potentially be less effective for batteries using lithium iron phosphate (LFP) material, as discussed in 5.2.

There are pros and cons to each of the common fire-suppression media in use today, including clean agents, inert gases, aerosols, and water.

- Clean agents, such as Novec 1230®, and inert gases, such as nitrogen, will extinguish small fires without causing extensive damage within the enclosure; they also have a cooling effect, which can assist in limiting thermal runaway propagation. In a larger-scale event, such as a multi-cell arcing fault, their effect may be temporary and may result in ongoing propagation with the risk of reignition or explosion. Also, inert gases are oxygen-depleting and cannot be used in structures where personnel may be present.
- Aerosol devices, such as Stat-X®, can be self-actuating, releasing based on elevated temperature without the need for control systems. They are effective on small fires and can help to limit initiation of thermal runaway. The aerosol itself is typically alkaline and may damage BMS and other electronic components in the enclosure. These devices are unlikely to be effective in larger-scale events or when thermal runaway is freely propagating between cells or modules.
- Water is the most efficient medium for cooling cells below the level at which thermal runaway can occur. However, to be effective, the water must be able to reach cells that may be otherwise shielded within closely spaced modules. This means that directed spray across the top of each module is more likely to achieve full extinguishing and arresting of propagation than can be realized with ceiling-mounted sprinklers, and this precise coverage may not always be feasible to achieve. Liberal use of water may also serve as the initiator for electrical arcing that may cause thermal runaway in otherwise unaffected modules. Additionally, the combination of water and highly energized battery systems could electrolytically generate more explosive hydrogen gas. Finally, similar to plastics fires [B1] use of water for directly targeting a fire will also create contaminated run-off [B11], which must be contained and removed for treatment.

5.2 Explosion

Venting of all Li-ion cells results in the release of a gas mixture with high levels of hydrogen, carbon monoxide, and carbon dioxide. Depending on the circumstances, there may also be a fog of unreacted flammable organic compounds, and hydrogen fluoride (normally in trace amounts, but can be higher). The volume of gas released is typically orders of magnitude greater than the cell volume. In the absence of fire, this gas mixture poses an explosion risk.

NFPA 855 requires design provisions for either explosion prevention in compliance with NFPA 69 [B5], or explosion management according to NFPA 68 [B4]. However, systems only complying with NFPA 68 can present explosion hazards to first responders if the following conditions are met: 1) the atmosphere in the enclosure is above the upper flammable limit (UFL), 2) the system has no remote means to ventilate its contents, 3) and a door is opened. Caution and deliberation with the project SME should be taken in situations where gas has accumulated, and automatic ventilation is either not present or not functioning.

The ’**make** it burn’ strategy for explosion prevention is discussed in 5.1. This approach may be less effective for batteries using LFP technology, from which minimal amounts of oxygen are released during thermal runaway. In a multi-cell arcing fault and in the absence of emergency ventilation with outside air, the available oxygen in the enclosure would be quickly consumed. Further cell venting would drive the gas concentration above the UFL, creating the same hazard described in the previous paragraph.

Ventilation for explosion prevention may be accomplished by the automatic opening of doors or other panels. While this measure is unlikely to meet the requirements of NFPA 69, it addresses the intent of the standard and can be important for protecting first responders. It should be noted that this procedure will reduce the effectiveness of airborne fire suppressants and is more compatible with a ‘let it burn’ philosophy.

5.3 Arc flash and shock

Battery strings in an enclosure involved in an incident should have been tripped by the BMS, but as detailed in 4.5, they can continue to present arc-flash and shock hazards. Many ESS designs now operate at dc voltages up to 1500 V, representing a significant risk to untrained personnel. At the time of preparing this guide, there is ongoing work on characterization of dc arc-flash hazards, and it is likely that this work will inform future changes to NFPA 70E [B7].

5.4 Toxic chemicals

Recommendations for first responders are detailed in 4.6. Emissions from battery fires vary by battery chemistry and state of charge. Toxicity issues are discussed at length in [B1], where it is stated that hydrogen chloride is the chemical that reaches its IDLH (immediately dangerous to life and health) value fastest. In terms of 30-minute average release rates as a function of IDLH, the greatest concern is with hydrogen fluoride, followed by hydrogen cyanide, hydrogen chloride, and carbon monoxide.

6 Bibliography

The following documents are discussed in this guide:

[B1] DNV-GL, Considerations for ESS Fire Safety, Report for Consolidated Edison and NYSERDA, 2017

[B2] International Fire Code (IFC), 2021, International Code Council, Inc.

[B3] NFPA 1, Fire Code, 2021

[B4] NFPA 68, Standard on Explosion Protection by Deflagration Venting, 2018

[B5] NFPA 69, Standard on Explosion Prevention Systems, 2019

[B6] NFPA 70, National Electrical Code, 2023

[B7] NFPA 70E, Standard for Electrical Safety in the Workplace, 2021

[B8] NFPA 855, Standard for the Installation of Stationary Energy Storage Systems, 2023

[B9] NFPA 1660, Standard for Emergency, Continuity, and Crisis Management: Preparedness, Response, and Recovery, 2024

[B10] NFPA Energy Storage Systems Safety Fact Sheet, available from the NFPA website

[B11] Quant, M., Willstrand, O., Mallin, T., Hynynen, J., Ecotoxicity Evaluation of Fire-Extinguishing Water from Large-Scale Battery and Battery Electric Vehicle Fire Tests. *Environ. Sci. Technol.* https://doi.org/10.1021/acs.est.2c08581

[B12] UL 1973 Ed. 3, ANSI/CAN/UL Batteries for Use in Stationary and Motive Auxiliary Power Applications, 2022

[B13] UL 9540 Ed. 2, Energy Storage Systems and Equipment, 2020

[B14] UL 9540A Ed. 4, ANSI/CAN/UL Standard for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems, 2019