CITY OF SUMNER WASHINGTON

STUDY SESSION
City Hall – 1104 Maple Street
January 13, 2025 6:00 PM

The city is conducting this public meeting using a hybrid model. The public is welcome to attend tonight's meeting in-person at City Hall (Council Chambers), or virtually by using the meeting access link below.
https://sumnerwa-gov.zoom.us/j/86825227093
Or One tap mobile +12532158782,,86825227093# +12532050468,,86825227093# US
Or Telephone: +1 253 215 8782 +1 253 205 0468 US
Webinar ID: 868 2522 7093

CALL TO ORDER

Roll Call: Bitetto, Bowman, Clerget, Cole, Elfers, Kenna and Reinke

REGULAR BUSINESS

1. Battery Energy Storage Systems (BESS) 2.0
2. Ordinance No. 2916 - Amending Sumner Municipal Code 12.38 (Park Impact Fees)
3. 2025 Comprehensive Plan Annual Amendments

CITY ADMINISTRATOR REPORT

AGENDA SETTING

1. Council Meeting Agenda Calendar
2. Council Committee Meeting Calendar

EXECUTIVE SESSION

ADJOURNMENT

This meeting is accessible to persons with disabilities. For individuals who may require special accommodations, please contact the City Clerk at (253) 299-5590, 24 hours in advance.

STUDY SESSION
DATE: January 13, 2025
AGENDA BILL: 25-4

SUBJECT: Battery Energy Storage Systems (BESS) 2.0 **CATEGORY:** Information Only

BUDGET IMPACT:
Expenditure Required: None Within Budget Allocation: N/A

ATTACHMENTS:
1. Staff Memo BESS 2.0
2. BESS 2.0 presentation
3. Exhibit B. Department of Energy -2024 Energy Storage Strategic Plan
4. Exhibit C. National Fire Protection Agency (NFPA) BESS Fact Sheet

STAFF CONTACT: Chrissanda Walker, Associate Planner

SUMMARY BACKGROUND:
This agenda item is for Council study and discussion on the importance and value of Battery Energy Storage Systems (BESS) in supplementing the electric grid. The Council adopted Ordinance No. 2899 in November 2024 to regulate large-scale BESS facilities that will have the capacity to store a minimum of 200 MW for the sole purpose of deploying stored energy onto the grid by Puget Sound Energy (PSE). PSE will discuss how BESS are an important component of renewable energy, because they enable reliability on the electric grid and serve to provide back-up power. PSE and staff will also present the case for residential scale installations and smaller or mid-scale BESS on commercial sites.

This study session will look more closely at managing fire risks of BESS and hear from East Pierce Fire & Rescue on fire code regulations, firefighting preparedness and response.

The intent of the BESS 2.0 study session includes:

Learn more about why BESS is important to the electric grid and future plans;
Learn about how smaller scale BESS are needed in the future and why they should be permitted; and
Hear from Puget Sound Energy (PSE) and East Pierce Fire & Rescue (EPFR) about BESS operations and risks;

More background is provided in the attached Staff Memo.

COUNCIL COMMITTEE/STUDY SESSION:
MEETING/STUDY SESSION DATE: 1/13/2025
COMMITTEE RECOMMENDATION:

STAFF RECOMMENDATIONS/MOTION:
Review the information, discuss, and provide questions and comments to staff.

1104 MAPLE STREET, SUMNER WA 98390

MEMORANDUM

DATE: January 13, 2025
TO: Mayor Hayden and City Council
FROM: Chrissanda Walker, Associate Planner
RE: **Battery Energy Storage System (BESS) 2.0- Study Session**

I. INTRODUCTION

In November 2024, the City of Sumner adopted Ordinance No. 2899 that would regulate large-scale Battery Energy Storage Systems (BESS) facilities, as a conditional use in the industrial zones subject to performance standards to mitigate impacts. A large-scale BESS project must go through the required SEPA review and a conditional use permit approval that will address other potential impacts to air, water and soil and as well as mitigate general noise and aesthetics impacts. While Council adopted regulations allowing and limiting large-scale BESS (200MW or more) the Zoning Code currently prohibits smaller more distributed BESS systems.

The purpose of this Study Session is to:

1. Learn more about why BESS is important to the electric grid and future plans;
2. Learn about how smaller scale BESS are needed in the future and why they should be permitted; and
3. Hear from Puget Sound Energy (PSE) and East Pierce Fire & Rescue (EPFR) about BESS operations and risks.

II. BACKGROUND

The expansion of BESS is related to meeting today's energy, environmental and economic challenges around clean energy. Large-scale BESS energy storage systems are "enabling technologies"; they do not generate electricity, but they do enable critical advances to modernize and stabilize the electric grid. BESS can be co-located on existing energy generation substations but are largely deployed as standalone systems and can have value at any point on the electric grid. The biggest hazard identified is risk of fire, and the National Fire Protection Agency (NFPA) provides information on the various hazards and failure modes that can occur with BESS (see exhibit C). It is known that certain battery chemistries release toxic particulate emissions. It is vitally important for first responders to be aware of all fire hazards and failures to treat an emergency event. East Pierce Fire & Rescue (EPFR) are up to date with these hazards and continue to train personnel on best firefighting practices.

Understanding the BESS industry and potential impacts is important to Council. At this study session Fire experts will discuss the hazards of fire emissions from a BESS fire, the interaction with the local environment and tactical choices to suppress the fire. EPFR will also discuss their role in approving a fire safety plan. The City's Emergency Management Response Coordinator will present on the elements of an Emergency Response Plan required for a new BESS facility.

Why do we need Battery Energy Storage Systems?
A distinct characteristic of the electric energy sector is that the amount of electricity generated is relatively fixed over short periods of time, while demand ("load") for electricity fluctuates throughout the day. BESS functions to balance microgrids to achieve a good match between generation and load. Battery energy storage devices can provide frequency regulation to maintain the balance between the network's load and power generated. The vast deployment of BESS around the region supports the transition into cleaner energy technology. PSE will share more information on the State's clean energy transformation mandates and the necessary changes in electric grid infrastructure.

PSE will explain how BESS supports electric grid energy reliability and maintain a reliable power supply for high tech industries. Battery energy storage systems hold substantial promise for transforming the electric power industry. However, there are several different use cases to consider, such as residential or fleet EV charging installations, and residential or commercial sites seeking back up power options. A Zoning Code text amendment would be necessary to address small and mid-scale BESS.

What are the impacts
BESS is an emerging technology with a history of fire risk and safety concerns that are driving more stringent codes and standards, leading to evolving system designs. The Department of Energy conducted a strategic safety plan in 2024 (exhibit B) and explains the impact of toxic emissions from battery fires is critical to guide incident response strategies. A summary list of potential impacts related to BESS include:

- Energy burden (energy poverty)
- Fire risk and explosions
- Air quality, and soil or water contamination
- Health
- Jobs/training
- Light and glare, noise, vibrations, etc.

Recognizing that explosion is a much greater hazard to personnel than a fire, a certain energy storage thresholds BESS components undergo a required test method for evaluating thermal runaway fire propagation in order to mitigate that risk. East Pierce Fire & Rescue will share some updated protocols in responding to electric fires, necessary firefighting training and PPE gear management post fire event.

How will the city administer permit review of a BESS project?
The city will rely on the latest codes and tested technology for reviewing and permitting applications for BESS at all scales and will include some or all of the following depending on size:

- Zoning Code and development regulations
- SEPA review (required for large-scale BESS)
- International Fire Code
- National Fire Protection Association (NFPA) 855 standards
- Coordinate with East Pierce Fire& Rescue in reviewing a fire safety plan
- Multi-department Emergency Management Plan review

Where might Battery Energy Storage Systems locate?
BESS facilities will locate in different Zones and facilities depending on size and use case:

- Major utility substations and/or co-location with energy generation sites
- Residential: small-scale energy storage systems, EV chargers
- Commercial: mid-scale or grid-scale BESS, primarily as backup generators
- Industrial: grid-scale BESS, dedicated-buildings energy storage systems, primarily as backup generators
- Hear about the EPFR community hazard platform

III. STAFF RECOMMENDATION

Review the information, discuss any concerns during the study session and provide feedback to staff regarding next steps.

IV. NEXT STEPS

Staff will hold discussions with the Planning Commission in May 2025 and next steps may include the following:

- Continue to study ESS in residential cases
- Research energy storage systems accessory to solar installations
- Research standalone BESS for commercial and industrial sites seeking back-up energy options
- Better understand the range of energy capacity to distinguish between mid-scale from large-scale BESS facilities
- Evaluate a permit review process for different BESS use cases and research and establish adequate fees.

V. EXHIBITS

A. Staff Slide presentation - Battery Energy Storage Systems 2.0
B. U.S. Department of Energy- 2024 Energy Storage Strategic Plan
C. National Fire Protection Agency(NFPA) BESS Fact Sheet

Battery Energy Storage Systems (BESS) – 2.0

City Council Meeting

Study Session meeting

January 13, 2024

Purpose of Study Session

- PSE will present information on the clean energy transformation in the region
- Staff will provide an overview of the updated fire codes and plan review process
- Understand the City’s role in Emergency Management Planning
- Hear from East Pierce Fire & Rescue (EPFR) about safety operations and fire risk/response
- Learn about next steps needed to address different use cases of BESS

Progress Snapshot

1. November 2024 Council approved Ord 2899 (large-scale BESS)
2. January 13, 2025 Council Study Session BESS 2.0
3. May 2025 Begin Planning Commission Discussions
4. Hold Public Hearing with PC on possible new ordinance

WHERE WE ARE

Different Types of BESS Use Cases

Large-Scale BESS Facilities

"Mid-scale" BESS for commercial/industrial

Residential ESS

https://autonomy.paris/battery-storage-the-missing-middle/

https://planning.org/zoningpractice/2024/march/battery-energy-storage-systems/

PSE's Clean Energy Transformation

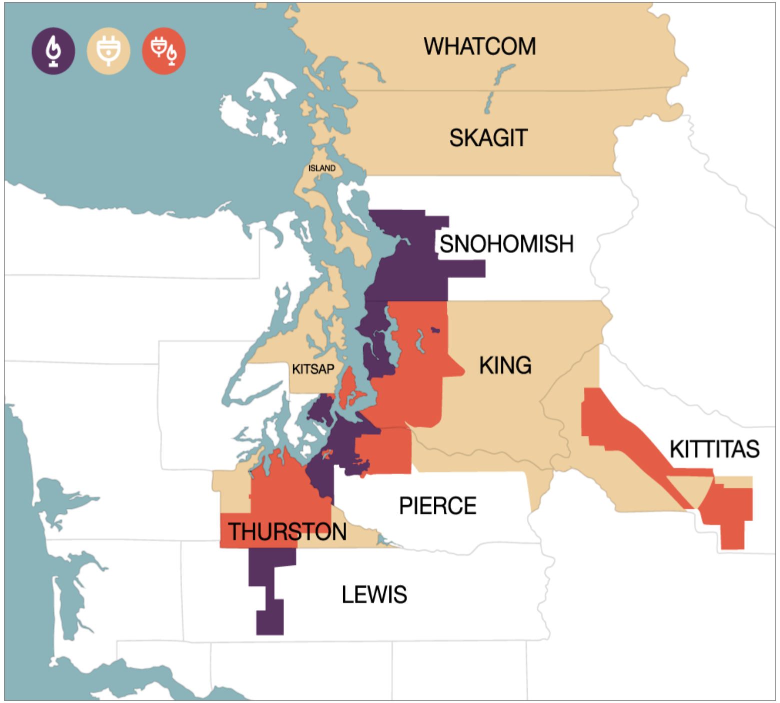
Christine Nhan
January 13th, 2025

PUGET SOUND ENERGY

About Puget Sound Energy

- Washington State's **oldest and largest utility**
- Regulated utility serving approximately **1.2M electric customers and 900K natural gas customers** in 10 counties located in Western Washington
- **Undergoing the most significant transformation in our 150+ year history** as we strive to meet some of the most ambitious clean energy laws in the nation
- Our core mission is to deliver **safe, reliable, and affordable** energy to our customers, under all conditions

Service Territory



PUGET SOUND ENERGY

Washington State Climate Policies

Clean Energy Transformation Act (SB 5116)

Passed in 2019 and commits WA state to a carbon-neutral electric supply by 2030 and 100% clean electricity by 2045

Clean Buildings Act (HB 1257)

Passed in 2019 and adopts a new energy performance standard for existing commercial buildings over 50,000 sq. ft.

Climate Commitment Act (SB 5126 – "Cap and Invest")

Passed in 2021 and establishes a program aimed at capping and reducing GHGs from the largest emitting sources and industries, to work towards the state's greenhouse gas limits set in state law

Clean Fuel Standard (HB 1091)

Passed in 2021 to curb pollution from the transportation sector, which accounts for almost 45% of state GHG emissions

Decarbonization bill (HB 1589)

Passed in 2024, it streamlines planning processes, supporting the future energy choices of our customers in alignment with the state's clean energy goals

Clean Energy Transformation Act Milestones

2025

Coal-free electricity

- PSE will eliminate coal-fired resources from PSE's allocation of electricity to Washington retail electric customers by 2025, **740 MW total capacity removed**

2030

Carbon-neutral electric supply

- PSE is committed to achieving a **net zero carbon emissions** electric supply for our customers by 2030, consistent with Washington State's CETA

2045

100% clean electricity supply

- PSE is committed to achieving a **100% non-emitting electric supply** by 2045, consistent with Washington State's CETA

Battery Energy Storage Systems (BESS)

- Battery storage systems allow us to get the **most value from existing renewables** and **offset the need** to build **additional generation resources** that are used only at times of high demand.
- We estimate we will need approximately **1,500 MW of storage by 2030** (DER, hybrid, utility scale combined).
- We're exploring a mix of **PSE and developer-owned agreements for** battery storage projects.

PSE PUGET SOUND ENERGY

Distributed Energy Resources (DERs)

- Customer adoption of **DERs** (rooftop solar panels, batteries, EVs and other smart appliances) is **growing rapidly**.
- DERs promote **two-way flows of energy** and offer opportunities for utilities and customers to **work together** and innovate to meet rising demand.
- PSE's envisions its role in this new landscape as a **"conductor"** within the energy ecosystem, empowering customer choice and flexibility, enhancing controls and automation, and optimizing interactions to achieve our clean energy targets.

Battery Demonstration Projects

PSE installed a solar array and battery at the Samish Island Fire Station in 2023.

The Glacier battery storage project.

PUGET SOUND ENERGY

Safety Measures for BESS

Fire Plans Review

BESS components must comply with all codes and standards relevant to the operation and installation of energy storage equipment. The 2021 IFC adds new section 12.07 to address energy storage systems.
Covered during City Permit Review.

International Fire & Building codes

- **IFC:** Chapter 12.07
- NFPA 855
- NFPA 68/69
- **IRC:** section R328

Electrical Codes

- NFPA 70
- IEEE 1547

Battery cells, modules and systems

- UL 1642
- UL 9540
- UL 9540A
- UL 1741

Emergency Management Plan

Will require multiple agency coordination and multi-department review

BESS that exceed 600 kWh of energy storage are required to complete hazard mitigation analysis, utilize fire suppression designs, and develop emergency management plans.

https://www.energy-storage.news/fire-hits-construction-of-300mw-victorian-big-battery-in-australia/

Emergency Management Plan contents:

- Strategic Communications
- Tactical responses
- Evacuation protocols
- Medical emergencies and security incidents
- Hazardous materials incident reporting
- O&M continuous monitoring

The Fire District's Role

Fire Safety Plan review (site specific)

Pre-incident planning and training

Variables: heat release rate, ignition heat flux of exposed structure, weather

Protocols:
30 feet baseline recommendation

Post-incident

Fire Response: EV vs ESS

https://www.carexpert.com.au/car-news/firefighters-still-struggle-to-defeat-ev-fires-effectively

BESS Use Cases

Residential ESS:

DER's, "Tesla Powerwalls"

Commercial Mid-Scale BESS:

-Hybrid systems or accessory to a site

-Standalone utility asset

https://planning.org/zoningpractice/2024/march/battery-energy-storage-systems/

Next steps and things to consider

- Distinguish in the code mid-scale vs large-scale BESS
- Residential ESS–specify as allowed through IRC permit review

1. Continue research on model ordinances and hold discussions with Planning Commission on different use cases
2. Fire permit applications and associated permit fees
3. EPFR hazard notification process
4. Performance standards for zoning accessory BESS/mid-scale

Thank you, City Council

- Contact Staff below for any follow up questions

Chrissanda Walker, Associate Planner email: **chrissandaw@sumnerwa.gov**

- Websites and Resources

Market research:

https://www.marketsandmarkets.com/ResearchInsight/battery-energy-storage-system.asp

Planning Research:

https://planning.org/zoningpractice/2024/march/battery-energy-storage-systems/

Department of Energy – Energy Storage Strategic Plan document

NFPA : https://www.nfpa.org/news-blogs-and-articles/blogs/2021/12/03/battery-energy-storage-hazards-and-failure-modes

U.S. DEPARTMENT OF ENERGY

ENERGY STORAGE SAFETY STRATEGIC PLAN

U.S. Department of Energy
Office of Electricity Delivery and Energy Reliability
April, 2024

Disclaimer

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Acknowledgments

The Department of Energy Office of Electricity Delivery and Energy Reliability Energy Storage Program would like to acknowledge the external advisory board that contributed to the topic identification, outlining, and drafting of this report: Lakshmi Srinivasan and Dirk Long (EPRI), LaTanya Schwalb and Laurie Florence (UL Solutions), Jim McDowall and Chris Searles (IEEE), Brian O'Connor (NFPA), Jody Leber (CSA Group), Benjamin Ditch (FM Global), Samuel Madden (Exponent), Carrie Kaplan (DNV), and Matt Koenig (LS Energy Solutions). Their generous efforts ensured that the content of this report is relevant across stakeholders in the energy storage industry.

The Office would like to acknowledge additional authorship contributions from: Waylon Clark, Reed Wittman, Ramesh Koripella, Oindrilla Dutta, Erik D. Spoerke, Loraine Torres-Castro, and Alex Bates (Sandia National Laboratories), Jeremy Twitchell (Pacific Northwest National Laboratory), and Brian G. Onieal (New Jersey Office of Homeland Security and Preparedness).

The Office would also like to acknowledge those who participated in the breakout sessions on (1) Research and Development, (2) Codes and Standards, and (3) Incident Response and Outreach during the 2023 DOE OE Energy Storage Systems Safety and Reliability Forum in Albuquerque, New Mexico. This feedback significantly informed the priorities highlighted in the Gaps section of this report.

The Office appreciates the efforts of Yuliya Preger (Sandia National Laboratories) and Matthew Paiss (Pacific Northwest National Laboratory) in coordinating the drafting of this document.

This report was prepared for the DOE Energy Storage Program under the guidance of Dr. Imre Gyuk, Dr. Caitlin Callaghan, Dr. Mohamed Kamaludeen, Dr. Nyla Khan, Vinod Siberry, and Benjamin Shrager.

Acronyms

AHJ	Authorities Having Jurisdiction
ASSB	All-solid-state Battery
BESS	Battery Energy Storage System
BMS	Battery Management System
Br	Bromine
BTM	Behind-the-meter
CAES	Compressed Air Energy Storage
CSA	Canadian Standards Association
CSR	Codes, Standards, and Regulations
DOD	Depth of Discharge
EOL	End-of-life
EPRI	Electric Power Research Institute
ERP	Emergency Response Plan
ESS	Energy Storage System
EV	Electric Vehicle
FACP	Fire Alarm Control Panel
FEMA	Federal Emergency Management Agency
FMEA	Failure Mode and Effects Analysis
GADS	Generator Availability Data System
GW/GWh	Gigawatt/Gigawatt Hour
HMA	Hazard Mitigation Analysis
HVAC	Heating, Ventilation, and Air Conditioning
IAFC	International Association of Fire Chiefs
ICC	International Code Council
IEC	International Electrical and Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
kW/kWh	Kilowatt/Kilowatt Hour
LCO	LiCoO2
LFP	$LiFePO_4$
Li	Lithium
LMFP	$LiMn_xFe_{1-x}PO_4$
LMO	$LiMn_2O_4$
MW/MWh	Megawatt/Megawatt Hour
NaS	Sodium-sulfur
NCA	$LiNi_xCo_yAl_{1-x-y}O_2$
NEC	National Electric Code
NERC	North American Electric Reliability Corporation
NERIS	National Emergency Response Information System

NFIRS	National Fire Incident Reporting System
NFPA	National Fire Protection Association
Ni	Nickel
NMC	$LiNi_xMn_yCo_{1-x-y}O_2$
O&M	Operations and Maintenance
Pb	Lead
PCS	Power Conversion System
PNNL	Pacific Northwest National Laboratory
PPE	Personal Protective Equipment
RFB	Redox Flow Battery
RFP	Request for Proposal
SDO	Standard Development Organization
SEI	Solid Electrolyte Interphase
SNL	Sandia National Laboratories
SOP	Standard Operating Procedure
SSB	Solid-state Battery
TW/TWh	Terawatt/Terawatt Hour
UL	Underwriters Labs
UPS	Uninterruptible Power Supply
V	Volt
VLA	Vented lead-acid
VRLA	Valve-regulated lead-acid
Zn	Zinc

Executive Summary

Energy storage has emerged as an integral component of a resilient and efficient electric grid, with a diverse array of applications. The widespread deployment of energy storage requires confidence across stakeholder groups (e.g., manufacturers, regulators, insurers, and consumers) in the safety and reliability of the technology. Since the publication of the first Energy Storage Safety Strategic Plan in 2014, there have been introductions of new technologies, new use cases, and new codes, standards, regulations, and testing methods. Additionally, failures in deployed energy storage systems (ESS) have led to new emergency response best practices. The goal of this revision is to review the current state of energy storage safety and identify priorities to advance the field.

The report begins with an overview of the status and known safety concerns associated with major electrochemical and non-electrochemical energy storage technologies. Then, we highlight safety considerations during energy storage deployment in the US, spanning codes and standards, permitting, insurance, and all phases of project execution.

Lithium-ion (Li-ion) batteries currently form the bulk of new energy storage deployments, and they will likely retain this position for the next several years. Thus, this report emphasizes advances in incident response and safety research and development for Li-ion batteries. A framework is provided for evaluating issues in emerging electrochemical energy storage technologies.

The report concludes with the identification of priorities for advancement of the three pillars of energy storage safety: 1) science-based safety validation, 2) incident preparedness and response, 3) codes and standards.

Priorities for science-based safety validation include improved: containment of Li-ion cell failure, operations and maintenance guidance, end-of-life guidance for Li-ion systems, system-level fire modeling of Li-ion, identification of safety and degradation issues for non-Li technologies, assessment of risks of energy storage in new applications, and standardization of testing and reporting.

Priorities for advancement of incident response and preparedness include improved: inclusion of energy storage data in responder guidebooks, emergency response coordination, incident data reporting, physical status indicators, assessment of the impact of toxic emissions, guidance for decommissioning and dealing with stranded energy, and tools for the fire service.

Priorities for codes and standards include addition of guidance for: electrical worker safety, grounding, electrical retesting of a system over time, explosion protection, toxic emissions, and performance and reliability data collection.

1. Introduction

Grid energy storage systems are "enabling technologies"; they do not generate electricity, but they do enable critical advances to modernize and stabilize the electric grid. Numerous studies have highlighted the value of grid energy storage for supporting the integration of variable renewable resources, demand charge management, mitigating losses from outages, improving power quality, transmission and distribution upgrade deferral, and off-grid applications. The variety of deployment environments and application spaces, and the increasing variety in storage technologies, has increased the challenge of developing a single set of protocols for evaluating and improving the safety of grid storage technologies.

Much has changed since the first Energy Storage Safety Strategic Plan was published in 2014. In 2013, the cumulative energy storage deployment in the US was 24.6 GW, with pumped hydro representing 95% of deployments.[1] Utility-scale battery storage was about 200 MW at the end of 2013, about 9 GW at the end of 2022, and is expected to reach 30 GW by the end of 2025 (Figure 1).[2] Most new energy storage deployments are now Li-ion batteries. However, there is an increasing call for other technologies given the broad need for energy storage (especially long duration energy storage), the competition for Li-ion batteries from the electric vehicle (EV) sector, and safety concerns with Li-ion batteries.

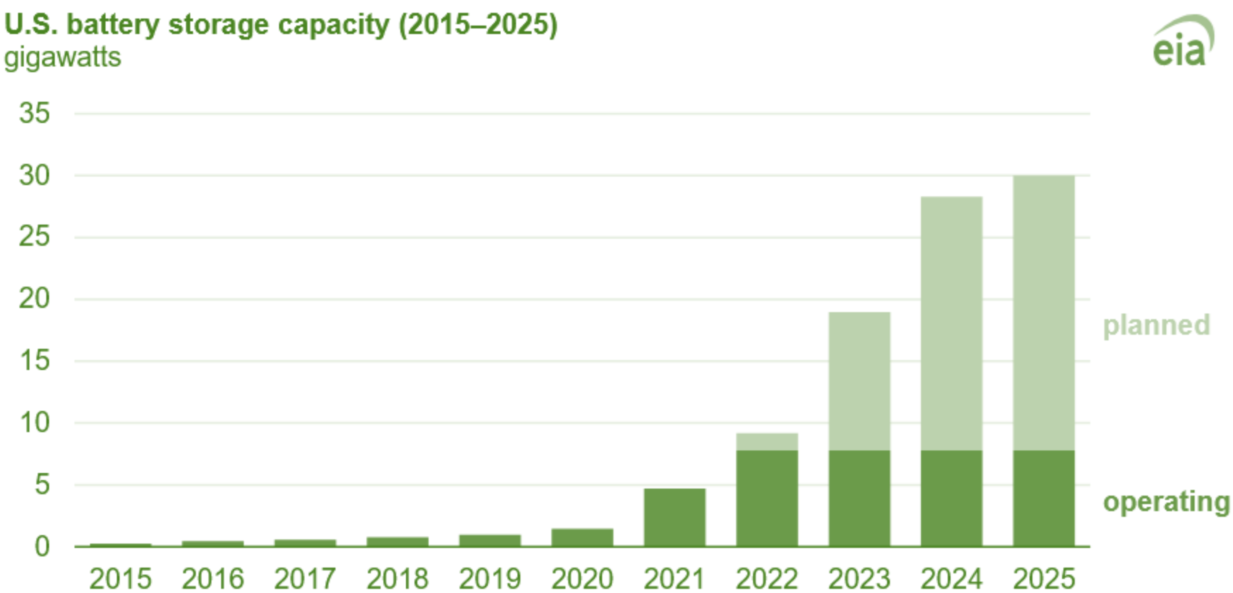

Figure 1. U.S. battery storage capacity through 2025. Source: U.S. Energy Information Administration.

Major advances in safety codes & standards since 2014 include the development of an installation standard for stationary ESS by the National Fire Protection Association (NFPA 855) as well as a product safety standard in UL 9540. Both of these will be discussed in Chapter 4. With the rapid deployment of ESS in the US, there have been a number of opportunities to learn from system failures and incorporate those lessons learned into updates to the codes & standards. While the lithium-ion family of chemistries

[1] https://www.energy.gov/sites/prod/files/2013/12/f5/Grid%20Energy%20Storage%20December%202013.pdf

[2] https://www.eia.gov/todayinenergy/detail.php?id=54939

remains the primary technology being deployed, there have been significant advancements in Li-ion anode and cathode materials as well as flow battery, Zinc, and Sodium-based technologies. These new batteries are setting the stage for more flexibility in cost, supply chain resources, and applications.

The discussion within this document explores the current landscape of energy storage deployments and technologies, with an emphasis on Li-ion batteries. At the end, we identify general gaps and outstanding questions for energy storage safety, focusing on the three pillars of energy storage safety previously mentioned: 1) science-based safety validation, 2) incident preparedness and response, 3) codes and standards. These three areas are all equally important for instilling confidence in the community of stakeholders who interact with energy storage technologies. Ultimately, it is the goal of this strategic plan to lay the groundwork necessary to ensure that safety concerns do not serve as a barrier to deployment of grid energy storage to support an efficient, reliable, and resilient electric grid.

2. Current State of Grid-Scale Electrochemical Energy Storage

Electrochemical energy storage includes various types of batteries that convert chemical energy into electrical energy by reversible oxidation-reduction reactions. Batteries are currently the most common form of new energy storage deployed because they are modular and scalable across diverse applications and geographic locations. This section covers Li-ion, lead acid, flow, Zn-based, and high temperature batteries. Li-ion and lead acid batteries are considered commercially mature technologies. The other listed battery technologies are being explored by academia and industry as alternatives to Li-ion due to concerns about safety, cost, and material availability. Table 1 summarizes the primary safety concerns and upcoming developments for each technology.

Table 1. Summary of electrochemical energy storage deployments.

TECHNOLOGY	MATURITY	PRIMARY SAFETY CONCERNS	FUTURE DEVELOPMENTS
Li-ion batteries	Nearly 10 GW ESS deployed	Thermal runaway leading to fire or explosion	- More stringent codes & standards - Materials: Emphasis on LFP, solid electrolyte, Na-ion
Lead-acid batteries	Decades of use in standby applications	- Thermal runaway less common and severe than Li-ion - Vented lead acid cell spills	- Increased cycle volume and DOD with activated carbon - Bipolar plate to increase cycle count/reduce footprint
Flow batteries	< 1 GW deployed	- H2 gas (or toxic gas) generation - Strong acid/base electrolyte spill if containment breach	- Redox active materials other than vanadium
Zn batteries	< 100 MW deployed	- H2 gas generation - Spill of acidic/basic electrolyte if breached	- Making alkaline batteries rechargeable - Few major deployments, focus on increasing cycling lifetime
High-temperature batteries (e.g., NaS, NaNiCl2, liquid metal)	~700 MW deployed globally	- NaS: exothermic reaction of molten sodium	- Demonstrating new liquid metal technologies (e.g., Ca-based) - Reducing operating temperatures
Hybrid systems	Few deployed projects	- Known issues associated with the individual technologies - Mismanagement of controls for the different technologies	- Developing standard procedures for integrating and controlling different entities

2.1 Li-ion Batteries

Li-ion batteries are the dominant electrochemical grid energy storage technology. Characteristics such as high energy density, high power, high efficiency, and low self-discharge have made them attractive for many grid applications. The ability to significantly modify materials properties of the electrodes and electrolytes has made it possible to tailor Li-ion batteries for many different operating conditions and applications.

Li-ion batteries are most often distinguished by their positive electrodes, or cathodes. The classification of cathodes is based on the crystal structure of the compound: layered, spinel, and olivine. Cathodes with a layered structure, such as LCO ($LiCoO_2$), NCA ($LiNi_xCo_yAl_{1-x-y}O_2$), and NMC ($LiNi_xMn_yCo_{1-x-y}O_2$), have been the most popular material for Li-ion batteries since the commercialization of LCO in the early 1990s. This structure has a good energy density and a sloping voltage profile which makes assessment of battery state-of-charge easier. Spinel electrodes such as LMO ($LiMn_2O_4$) are of interest due to their high average potential and specific energy, but their low theoretical capacity and material instability currently prevent them from being used independently. LMO is often used in a blended cathode with the layered NMC and olivines. The most common olivine electrode, LFP ($LiFePO_4$), has a lower average potential than other popular commercial cathodes, and a correspondingly lower energy density. This initially limited the use of LFP in EV applications, where energy density is prioritized. However, low cost and good thermal stability have fueled its broad adoption in grid energy storage applications.

The primary safety concern for Li-ion batteries is thermal runaway, a phenomenon wherein an accelerating release of heat inside a cell, due to a series of exothermic reactions, manifests as an exponential, uncontrollable, increase in cell temperature. Thermal runaway can be initiated when a battery experiences electrical, mechanical, or thermal abuse; a Li-ion battery possesses all the components required for combustion or even explosion once thermal runaway occurs—fuel (liquid electrolyte), oxygen (released from metal oxide cathodes), and an ignition source (heat from the thermal runaway reactions). LFP is more thermally stable because the phosphorus-oxygen bond is stronger than the metal-oxide bond in most other positive electrodes.

Nearly 10 GW of Li-based utility-scale energy storage is currently deployed in the US, from Alaska to Puerto Rico, for power and energy applications including frequency regulation, peak shaving, load management, and backup power.[3] Li-ion batteries will likely dominate the electrochemical energy storage market for the next several years, despite safety concerns from recent system fires. These safety concerns are encouraging more stringent codes and standards, leading to evolving system designs. However, batteries are likely to retain the same fundamental characteristics with materials modifications to achieve higher lifetime, energy density, and safety.

All solid-state batteries (ASSBs) are an emerging type of Li-ion technology that holds the promise of increased energy density and safety. In an ASSB, the liquid electrolyte and polymer separator is replaced with a solid electrolyte. The liquid electrolyte typically contains a volatile and flammable solvent that, in the event of failure, is largely responsible for the buildup of internal pressure and, especially when aerosolized on venting from the cell, deflagration events. A solid-state battery (SSB) still uses a solid electrolyte, but a small amount of liquid is added to the cathode to minimize interfacial resistance. It is expected that a solid electrolyte will enable the use of a Li-metal anode, which is key to achieving high energy densities. Many existing electric vehicle companies are investing millions into ASSB and SSB start-ups, although none have yet produced commercial products. Target dates as aggressive as 2027 have been announced for mass production of SSBs and implementation into EV battery packs. It is possible that this technology will eventually be implemented in grid-scale systems, but likely not until the end of the decade.

2.2 Lead-acid Batteries

Lead-acid batteries are one of the oldest and safest battery technologies available for use in both stationary standby and regularly cycling energy storage applications. There are two fundamental types of lead-acid batteries: vented lead-acid (VLA) cells and valve regulated lead-acid (VRLA) cells. The VLA

[3] https://www.eia.gov/todayinenergy/detail.php?id=54939

cells can be classified as lead-antimony, lead-calcium, or lead-selenium/low-antimony cells. There are two types of VRLA cells: an absorbed glass mat cell that utilizes a “starved electrolyte” topology and a gelled electrolyte that is more of a hybrid VLA/VRLA topology.[4]

The primary advantages of a lead-acid cell are: its long history of use with over a million batteries installed worldwide (enjoying a now accepted safe history); its relative ease of installation with simple infrastructure requirements; its environmental sustainability – the lead-acid battery is >98% recyclable and the spent lead can be processed and reused comfortably. The two major disadvantages of a Pb battery are (1) its lower power density, i.e., its weight and footprint requirements, and (2) the need for complete recharging on a regular basis when used in partial charge/discharge applications. Ideally, the lead-acid battery needs to function in the discharge range of 10% to 50% depth of discharge (DOD) when used in a cycling energy storage application. This does impact round-trip efficiency and capacity. However, for traditional UPS (uninterruptible power supply) and other standby backup applications, the lead-acid battery is an extremely reliable and cost-effective alternative.

Thermal runaway was first observed in VRLA batteries, due to uncontrolled recombination of charge gas (hydrogen and oxygen), deforming the primary containment and even causing fires. However, these events are typically less severe than in Li-ion batteries. There have been successful efforts to reduce the likelihood of thermal runaway in VRLA batteries, for example, by temperature compensation of the battery charger output and by incorporating a catalyst device in the headspace of larger cells.

For VLA cells with liquid electrolyte visible, safety mitigation efforts include following proper maintenance (watering) procedures and incorporating spill containment.

There are several advances being made with advanced lead-acid batteries. These include improvements in the grid structure with the use of black and/or activated carbon, barium sulfate and lignocellulose expander materials. This aids in increasing cycle volume and enlarging the DOD range. Improvements to 3,000 to 5,000 cycle counts at 80% DOD have been reported. The recent ability to utilize a bipolar plate is showing promise of major cycle count improvement, while reducing footprint requirements.

2.3 Flow Batteries

Redox-flow batteries (RFBs) are a system that operates by dissolving active species into electrolytes which are then stored in containers away from the cell’s electrodes. During operation electrolyte is moved from the storage tanks to a cell stack where charge and discharge can occur.

The dominant flow battery chemistries are currently all vanadium and hybrid Zn-Br batteries. There are several companies that have been developing these chemistries for over a decade. Their prospects have improved over the last few years with the need for long duration energy storage for grid resilience. Other types of flow batteries that are being considered are Fe-flow, slurry flow, and various systems with organic charge carriers. In 2020, the total deployed capacity of RFBs globally was estimated to be 340 MW/1200 MWh. In September 2022, the largest flow battery in the world commenced operation, with a capacity of 100 MW/400 MWh (to be expanded to 200 MW/800 MWh in the future).[5]

Gas generation is a ubiquitous issue in aqueous redox flow batteries. The stable voltage window of water is a relatively small 1.2 V that shifts with pH. Outside of this window, H_2 and O_2 can evolve along with toxic gases depending on the system chemistry. Since a system’s power scales directly with increased

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[4] Thomas B. Reddy. Linden's Handbook of Batteries, Fourth Edition. Fourth. McGraw-Hill Education.
[5] https://www.pv-magazine.com/2022/09/29/china-connects-worlds-largest-redox-flow-battery-system-to-grid/, Accessed August 1, 2023.

nominal voltage, batteries typically operate at or just outside of the voltage window where gas can be generated. Often, the generated oxygen and hydrogen can be recombined into water to refill the battery or simply vented via an engineered exhaust system. For toxic gases, other mitigation and prevention efforts may be required to address the hazard adequately.

Additionally, RFB electrolytes are often strong acids and bases carrying high concentrations of metal ions. Hazard mitigation typically involves additional containment for any electrolyte that spills out of the primary system containment.

2.4 Zinc Batteries

Zinc-based batteries have a long history in a variety of applications on smaller scales. Single use Zn-MnO_2 alkaline systems with low relative energy and power density are used in consumer electronics, Zn-air batteries are used in hearing aids, and Ni-Zn systems have been used in UPS applications. Recently, several firms have been working on developing Zn-based batteries for different applications on the grid. Several are working on Zn-air systems for long duration energy storage on the grid (100 h discharge). Others are working on updating the Zn-MnO_2 system to make it rechargeable, more energy dense and able to work in mobility applications and daily operation in front of and behind-the-meter (BTM). Finally, companies are developing Zn intercalation cells that could significantly increase the energy density and power of the cell. These companies are all at different stages of production, some with commercial products and others in the prototype phase.

19 MW/300 MWh of Zn-based systems are currently used in grid operations, although there are many Zn-based deployments planned in the near future. These deployments range from a 20 MWh system in California to residential deployments in 200,000 planned homes via a partnership with a sustainable home builder.[6]

Emerging Zn-based batteries are roughly the same size as lead-acid batteries and have similar safety concerns (H_2 gas generation and spill of basic/acidic electrolyte).

2.5 High-temperature Batteries

High temperature batteries, which we define here as having a *target* operating temperature significantly above ambient temperatures and typically above 250 °C, are emerging as potentially effective energy storage systems, particularly for stationary storage. At present, there are three technologies that are in significant commercial development and deployment: Sodium-Sulfur (NaS), Sodium-Nickel Chloride Molten Salt, and Liquid Metal (Molten Calcium) Batteries. These batteries employ highly durable inorganic components that lead to long expected lifetimes. They are fully-sealed with no emissions, and they require significantly less operational maintenance (little to none for the sealed cells) compared with other batteries. The high temperature design and operation of these batteries makes them much less sensitive to external ambient temperature variability, allowing for operation in both cold and hot environments. They are, however, designed and insulated to be cycled regularly, as heat generated during cycling (for example, from resistive heating) provides sufficient energy to maintain the battery at high temperature. When batteries are left dormant for extended periods of time, the absence of this internal heating requires an additional source of heat, which decreases the overall storage/cost-benefit of the storage system.

NaS and Liquid Metal batteries are primarily developed for stationary applications. NaS batteries have been deployed in over 250 projects globally (700 MW/4.9 GWh), including very large installations, such

[6] https://www.powermag.com/zinc-batteries-power-stationary-energy-storage/, Accessed July 23, 2023.

as a 108 MW/648 MWh system in 2022. With 6 hours of storage at rated power, they are used to support microgrids, BTM locations, and ancillary grid services. Early use cases for liquid metal batteries include data center support and renewables integration (including a 300 MW/1.2 GWh system to be installed in 2024). Na-$NiCl_2$ batteries support utility grid services, telecom (backup, power stabilization), oil and gas (onshore/offshore power), BTM, and renewables integration.

Of the three battery chemistries, only NaS has an inherent chemical safety concern during operation, as molten sodium combined directly with molten sulfur can lead to a highly exothermic, toxic fire. Modern manufacturing of NaS, however, has developed solutions to this challenge, employing measures such as sand filling to extinguish fire and absorb leaked active materials, thermal fuses to prevent short-circuits, hermetical cell seals, and a mechanically isolating thermal enclosure to protect against external shock or internal leakage. With GWh' of deployments in over 200 locations globally, no accidents have been reported since 2011, when a 2MW system in Tsukuba, Japan started a fire leading to a redesign of the system.

2.6 Hybrid Systems

Utility grid services encompass diverse operations that have widely varying requirements for operating time, responsiveness, ramp rate, annual cycling, energy density, and power rating. For instance, congestion relief requires 1-4 hours of discharge with approximately 100 cycles/year, whereas voltage regulation requires up to half an hour of support resulting in shallow intermittent cycling of the battery. The operating time required for frequency recovery ranges from less than a second to an hour, whereas time-shift services can span from an hour to six hours. In addition, recent climatic incidents point to the need for longer duration electric supply. For example, wildfires, hurricanes, and flooding events can require up to 24 hours or more of backup energy storage. A single storage technology fails to perform optimally in all the different aspects of generation, transmission, and distribution. This has paved the way for hybrid energy storage, where technologies with disparate energy density and power ratings can be integrated.

Technologies that are complementary in terms of energy and power density are often combined to leverage the benefits of fast charging/discharging with long duration energy storage. Some relevant demonstration and deployment projects include integrating batteries with supercapacitors or flywheels. These find applications in ancillary services, frequency stabilization, voltage regulation, PV/Wind power plants, and microgrids.

Another method of developing hybrid storage systems is to combine batteries with different chemistries. Such hybrid systems are particularly promising for long duration energy storage in grid applications. Pb-acid batteries are extensively used for their low capital cost and wide availability. However, they are heavier, with lower energy density, and their cycle life ranges from 300-1500 cycles if allowed to reach an 80% DOD. Li-ion batteries have high efficiency, energy, and power densities. However, they are expensive, and can degrade quickly if utilized at a high depth of discharge or are improperly charged. NaS batteries have excellent pulse-power capability but are expensive and have high operating temperatures. Redox flow batteries can provide long-duration storage services but are slow to ramp up, or are inefficient under small loads due to the parasitic losses of the mechanical pumps in the system. Thus, the benefits of the various battery technologies can be leveraged by creating a hybrid storage system.

While the potential of hybrid storage systems in supporting the grid is widely acknowledged, deployment projects are still scarce. One of the primary reasons behind this is the lack of a standardized procedure in integrating and controlling the different entities. There are still open questions on how various BESS technologies will safely work together or in concert with other hybrid devices over a long-term installation.

3. Current State of Non-Electrochemical Grid-Scale Energy Storage

This section describes methods of mechanical (e.g., pumped hydro storage, flywheels, gravity, and compressed air), thermal, and chemical (hydrogen) energy storage. Pumped hydro storage is commercially mature, with decades of implementation, but the other methods are under development without significant commercial deployments. Table 2 summarizes the primary safety concerns and upcoming developments for each technology.

Table 2. Summary of non-electrochemical energy storage deployments.

TECHNOLOGY	MATURITY	PRIMARY SAFETY CONCERNS	FUTURE DEVELOPMENTS
Pumped hydro storage	Nearly a century of application, 1.6 TWh deployed	Isolated maintenance issues led to electrical fires and dam failures	- Closed loop systems that don't rely on specific geologic formations - Improved turbines and motors
Flywheels	Several deployments < 20 MW	- Rotor cracking and expulsion	- Identification of new applications (e.g., fast EV charging)
Gravity storage	Pilot demonstrations	- Large falling masses	- Many options being explored, currently no consensus
Thermal energy storage (sensible energy, latent energy, chemical reaction)	- Sensible energy approach used in commercial concentrating solar plants	- Burns and heat-related injuries - Toxic/corrosive molten salt materials	- Sensible energy storage at > 600C - Demonstration of latent energy and thermo-chemical energy storage approaches
CAES	Several MW-scale demonstrations	- Containment of high pressure, pressure vessel integrity - Capturing heat safely during compression	- Different vessels for storing the compressed air (e.g., water tanks and wells)
Hydrogen	No major deployments	- Flammability	- DOE awarded billions for development of "hydrogen hubs" across the US

3.1 Pumped Hydro Storage

Pumped hydro storage plants store and generate energy by moving water between two reservoirs at different elevations. Water is pumped into an upper reservoir for charging and then released through pipes into turbines for discharging. The first use of pumped storage was in the early 1900s and in 2020, it accounted for over 90% of active storage installations worldwide, with a capacity of 1.6 TWh. The main drawback is that the technology is geographically limited and involves more permitting requirements because of the large size. Given its long history, the reliability of this technology is well established.

3.2 Flywheels

Flywheels store kinetic energy in a spinning mass called a rotor. During charging, the electrical energy is converted into kinetic energy using a motor to accelerate the rotor. Kinetic energy is stored in the spinning mass of the rotor. During discharge, the motor operates as a generator that decelerates the rotor, returning electrical power to the application. The rotor spins at very high speeds (>100 m/s), and it is usually enclosed in a rigid container for safety and performance. The rotors operate in a vacuum or a low pressure He gas atmosphere to reduce friction and minimize energy losses.

Flywheels respond quickly to charge and discharge commands. Because of their quick response time, they are good for frequency regulation services, or in UPSs to span generator ramp-up lag times. Today's flywheel systems are shorter energy duration systems, typically less than 10 kWh. The energy storage system can be scaled up by adding more flywheels. Flywheels are not generally attractive for large-scale grid support services that require many kWh or MWh of energy storage because of the cost, safety, and space requirements.

The most prominent safety issue in flywheels is failure of the rotor while it is rotating. In large rotors, such as those made of steel, failure typically results from the propagation of cracks, causing large pieces of the flywheel to break off during rotation. Unless the wheel is properly contained, this type of failure can cause damage to surrounding equipment and injury to people in the vicinity. Containment systems should be designed to prevent high-speed fragments from causing damage in the event of failure. Because of the heavy mass and/or high speeds, practical containment of even a relatively small 5 kWh rotor failure is expensive, requiring a containment structure many times larger than the rotor itself.

Flywheel technology has been demonstrated in several small deployments, the largest of which was 20 MW. Due to a drop in revenue models, the market saw a decline in flywheel installations. However, recently a few startup companies have started looking at fast EV charging market applications.

3.3 Gravity Storage

Several types of gravity-based solutions are under development for long duration energy storage. One approach involves lifting large concrete (or polymer/low-cost earth material composite) blocks to different heights with cranes to store energy as potential energy. This potential energy is then converted into kinetic energy by dropping the blocks. Kinetic energy is converted into electrical energy through a spinning rotor. In another approach, railway cars filled with concrete blocks or similar heavy loads are moved up an incline during charging and released under gravity for discharge. Currently, only a few pilot demonstrations are in progress.

Any failures of these systems during uncontrolled descent can be significant due to the large mass falling under gravity. The area around the storage system needs to be secured and offer protection to the people and property outside the periphery.

3.4 Thermal Energy Storage

Thermal energy storage involves storing heat in a medium (e.g., liquid, solid) that can be used to power a heat engine (e.g., steam turbine) for electricity production, or to provide industrial process heat. Thermal energy can be stored in three forms—sensible energy, latent energy, and chemical reaction.

Sensible energy involves heating or cooling a liquid or storage medium (e.g., water, sand, molten salts, rocks) without any phase change. It is the dominant thermal storage method used for large grid-scale applications. For example, molten nitrate salt ($NaNO_3$-KNO_3) is used in commercial concentrating solar plants, operating in a temperature range of 300-600 °C. Higher temperature operation, in the range of 600-1000 °C, has also been proposed using porous rock, ceramic, or graphite blocks, however, there have been no major commercial deployments.

Latent heat involves a phase change process at a constant temperature and offers a slightly higher energy density. Phase change can be solid-gas, solid-liquid or liquid-gas, the most common being solid-liquid (using inorganic fluoride, nitrate, carbonate or chloride salt mixtures). The operating temperature range is 200-600 °C. These systems are also mostly in the demonstration stage with no major commercial deployments.

Thermo-chemical heat storage involves a reversible exothermic/endothermic chemical reaction with thermo-chemical materials. There are also no major commercial deployments with this technology.

The main safety concerns with thermal energy storage are all heat-related. Good thermal insulation is needed to reduce heat losses as well as to prevent burns and other heat-related injuries. Molten salt storage requires consideration of the toxicity of the materials and difficulty of handling corrosive fluids.

3.5 Compressed Air Energy Storage (CAES)

CAES systems use off-peak electricity to compress air and store it in a reservoir, either in an underground cavern or depleted oil wells, or aboveground in pipes or vessels. When electricity is needed, the compressed air is heated, expanded, and directed through an expander or conventional turbine-generator to produce electricity. CAES can store a large amount of energy, however, the energy and power density are low, so a larger storage volume is needed.

The main safety issues associated with CAES are: containment of high pressure, pressure vessel integrity, and capturing heat safely during compression. The heater and turbines used to generate electrical power are very similar to commercial gas turbine power plants.

Since it is a multistage process, CAES cannot respond quickly and is not suitable for power quality, voltage, and frequency regulation applications. A few companies are exploring newer designs of CAES, including storing compressed air in water tanks (the water head maintains the pressure to hold compressed air) and water wells. There have been a few small demonstrations of CAES concepts (several MW), but no major deployments completed yet.

3.6 Hydrogen Storage

Hydrogen storage is attractive for very long duration energy storage and for seasonal storage. Excess energy from renewables can be used to generate hydrogen by electrolysis and it can be stored for later use in fuel cells or combustion engines to generate electricity. Hydrogen can be compressed in underground salt caverns or stored in aboveground tanks in the gaseous or liquid form. Hydrogen storage in metal hydrides and metal organic frameworks is not yet attractive at large volumes due to the cost and low energy density. Hydrogen can also be used to make ammonia. Liquified ammonia is easier to transport than liquified hydrogen and the chemical can also be used as a fertilizer.

Because hydrogen is a very flammable gas there are several safety precautions that need to be taken during handling. Installations need to be leak-tight, which can be challenging. There has been discussion of transporting hydrogen using existing pipelines, but natural gas pipelines are known to leak methane.[7] Hydrogen disperses quickly in the open air, however, precautions must be taken to avoid accumulation in closed rooms. Even a very small spark can ignite hydrogen, so it is important to avoid ignition sources near hydrogen.

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[7] Weller et al., "A National Estimate of Methane Leakage from Pipeline Mains in Natural Gas Local Distribution Systems," *Environ. Sci. Technol*. **2020**, *14*, 8958.

There is no major commercial hydrogen storage yet, however, it is likely to pick up given the new funding from the Department of Energy for so-called hydrogen hubs. One of the largest proposed hydrogen storage projects is in the Utah salt domes for 1000 MW (currently at the preliminary small-scale drilling phase).

4. Safety Considerations During Energy Storage Project Deployment in the US

This section describes general considerations for safely deploying energy storage in the US, including the development of safety codes and standards, the process for project execution, permitting and zoning requirements, and insurance. While there are a number of technologies and chemistries being deployed, the bulk of the content in this section describes practices that were developed for Li-ion batteries (the most broadly deployed technology). Guidance for emerging technologies is provided in Section 7.

4.1 Codes and Standards

A project should begin with consideration of the existing codes and standards (the minimum requirements) especially as applicable and adopted for the local area in which the project is intended. In areas where no local codes and standards apply, special efforts should be made to design and plan to the most current published codes and standards and work with local officials, as outlined further in Section 4.2.

For energy storage applications there are three categories of codes or standards that are of critical importance: (1) fire protection codes, (2) building codes, and (3) electrical codes. There is a technical difference between a safety code and a standard, even though the terms are often used synonymously:

- A code is a model, a set of rules that knowledgeable people recommend for others to follow. It is not a law although it can be adopted into law when adopted by an Authority Having Jurisdiction (AH. (i.e., the 'what' that needs to be followed)

- A standard tends to be a more detailed elaboration (i.e., the nuts and bolts of meeting a code; 'how' to accomplish it). A standard becomes a part of regulatory law when the code which references it is adopted into law, or in some cases if adopted directly by the regulatory authority.

There are two major fire codes accepted within the United States and some of its 'territories.' The International Fire Code (IFC) published by the International Code Council (ICC) is the model fire code in 42 states, the District of Columbia, Puerto Rico, and the US Virgin Islands. NFPA 1, published by the National Fire Protection Association (NFPA), is the model fire code in the remaining 8 states and certain federal government agencies. Those two codes reference many standards from various sources, but fundamental as a bellwether standard for ESS projects is NFPA 855, *Standard for the Installation of Stationary Energy Storage Systems.*

The major electrical code adopted in all 50 states within the USA is NFPA 70, more commonly known as the National Electrical Code (NEC). Two articles within it deal with energy storage, including stationary standby power applications. The NEC and its corollary standards (NFPA 70A, 70B, and 70E) detail regulatory requirements for electrical installation, maintenance of electrical components and systems, and electrical worker and workplace safety.

The key building codes are the International Building Code published by the ICC and NFPA 5000, published by NFPA. There are a number of other standards and reference documents published by reputable standards development organizations (SDOs), but they are often guidance documents as opposed to the mandatory requirements of the NFPA or ICC codes in North America.

A byproduct of the codes described above are the inspection, testing, and maintenance standards published by organizations such as UL Standards and Engagement (ULSE), the Canadian Standards Association (CSA), and the International Electrical and Electrotechnical Commission (IEC). The standard will outline the product testing and verifications the product must pass to be approved for installation. Nationally recognized testing laboratories (NRTLs) such as UL, TUV Rheinland, ETL, FM, and CSA can all test to that standard. For example, a standard published by ULSE, such as UL 9540 - *Standard for Stationary Energy Storage Systems and Equipment*, may be used by NRTLs for testing even though they did not publish the standard themselves.

Development of product safety and installation standards as well as fire codes is accomplished through a consensus-based collaborative process through organizations known as Standards Development Organizations (SDOs). Both codes and standards are developed by volunteer technical committees representing various stakeholder groups and updated on either regular cycles, or as needed. The two major fire codes in the US are part of a triennial revision process and are enforced via legal adoption of the code at either a state or local level. Public input and comments are part of the process to support a consensus process and to comply with ANSI requirements.

One of the most common issues facing safety codes is the time it takes for new codes to be adopted at the state or local level. As a result, the technology can quickly outpace the adopted standards. At any one time across the US, states can be on up to three different editions of the IFC. Additionally, the most current edition may not be adopted for another two to six years in most states.

A further challenge is the fact that reputable manufacturers design their products to comply with the codes and standards in effect at the time of their design. Since energy storage is in a fluid state of progress, changes in these codes and standards may require manufacturers to redesign their products and retest them to the new standard. This can involve significant financial investment and time resources, potentially forcing delays in bringing the new or enhanced product to market.

It is recommended that a manufacturer or design engineering firm stay aware of the major ESS safety codes and standards. Most of the major SDOs publish upcoming meetings on their websites, and the majority are open to guest participation although becoming an active member of a working codes/standards committee is not an easy process in most cases. An alternative is to assign an in-house regulatory specialist who stays abreast of developments as they occur within this space.

Table 3 summarizes the most relevant codes and standards for an energy storage system. A more detailed listing of the relevant codes and standards can be found in a recent report to Congress.[8] Figure 2 indicates the portions of an energy storage system to which each code or standard applies.

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Paiss, M. D., Franks, R. J., Searles, C. G., Twitchell, J. B., Vartanian, C. K., Ropp, M., and Sprenkle, V. L. *Study of Codes & Standards for Energy Storage Systems: A Report to Congress*. United States: N. p., 2022. Web. doi:10.2172/1985701.

Table 3. Key standards for energy storage systems.

STANDARD	NAME	KEY DETAILS
IEEE 1547	Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces	Standard for interconnection of distributed energy resources (DER) with electric power systems. DER as defined in IEEE 1547 includes energy storage systems capable of exchanging real power (kW, MW) with the local distribution utility grid. IEEE 1547 also defines the performance requirements that are the basis for UL 1741 listing. IEEE 1547.9 provides guidance on the application of IEEE 1547 to energy storage distributed energy resources.
IEEE 2800	IEEE Standard for Interconnection and Interoperability of Inverter-Based Resources (IBRs) Interconnecting with Associated Transmission Electric Power Systems	Included in this standard are performance requirements for reliable integration of inverter-based resources into the bulk power system, including, but not limited to: voltage and frequency ride-through, active power control, reactive power control, dynamic active power support under abnormal frequency conditions, dynamic voltage support under abnormal voltage conditions, power quality, negative sequence current injection, and system protection.
NFPA 70	National Electric Code	Adopted in all 50 states, considered the benchmark for safe electrical design, installation and inspection to protect both people and property from electrical hazards. Article 706 applies to energy storage systems while Article 480 remains applicable to batteries as used in standard stationary backup power applications.
NFPA 855	Standard for the Installation of Stationary Energy Storage Systems	Key standard for the safe design, installation, operation, and emergency response for stationary ESS.
UL 9540	Safety Standard for Energy Storage Systems and Equipment	Key N. American product safety standard for factory certification of an energy storage system. Includes requirements for the battery, PCS, enclosure, thermal management, functional safety, and explosion control.
IFC	International Fire Code	Chapter 12 addresses ESS and harmonizes fairly closely with NPFA 855.

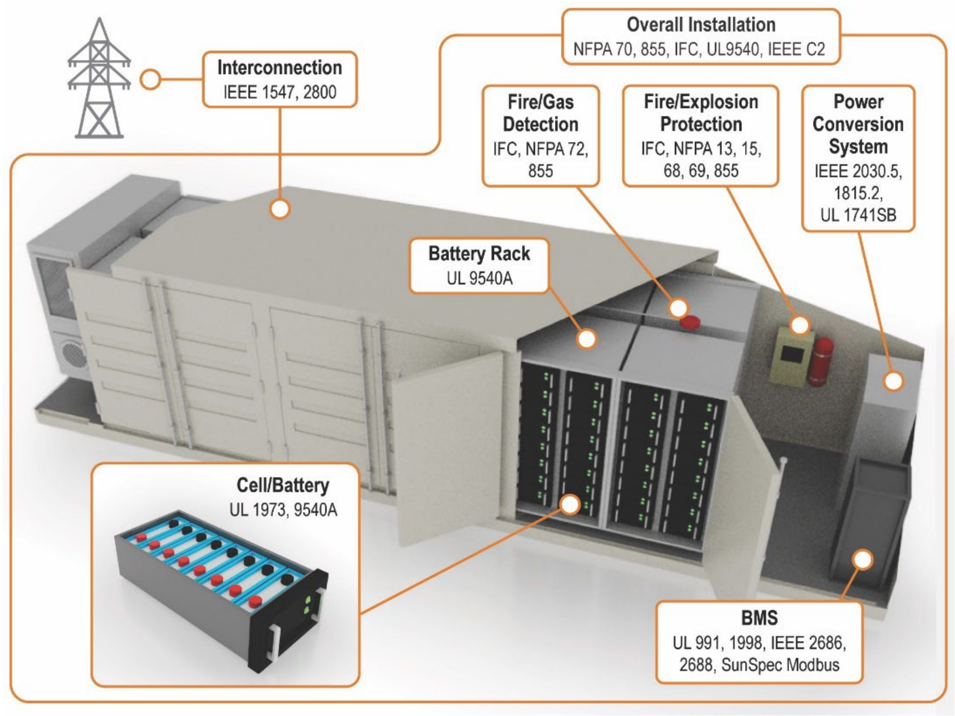

Figure 2. Applicability of codes and standards to different elements of an ESS

4.2 Project Execution

A typical energy storage deployment will consist of multiple project phases, including (1) planning (project initiation, development, and design activities), (2) procurement, (3) construction, (4) acceptance testing (i.e., commissioning), (5) operations and maintenance, and (6) decommissioning. Each of these activities involves decisions that will have an impact on safety during the installation of the system as well as during its operational lifetime. Figure 3 summarizes key safety considerations during each phase of energy storage project execution.

4.2.1 Planning

Development and design activities undertaken during this phase will result in preliminary specifications for the size (in power - kW and energy - kWh) of the system and the potential installation location. The size and where to physically locate the system have implications due to installation Codes/Standards requirements that must be considered. These considerations will drive the final engineering design and the acceptance testing schedule as the need for specialty contractors or equipment must be determined and planned for. Most importantly, it is in the planning phase that the local AHJ and first responders should be made aware, and their input actively sought on the project. These conversations will serve as the foundation for the final emergency response plan (ERP) for the system. Often, first responders are the last to know of the existence of an energy storage installation. This can lead to a lack of preparedness and potentially increased response times to a failure event. Overall safety and project support is compromised when AHJs and first responders are not part of the project process from the beginning.

4.2.2 Procurement

The predominant area of focus during the procurement phase should be the Request for Proposal (RFP) development. The RFP is the document that will determine what exactly the winning bid respondent (the 'vendor') will deliver to the system owner. This delivery involves not only the physical equipment that comprises a BESS but the plans, documentation, and installation practices that begin to lay the foundation of safety for the entire lifecycle of a BESS. There are typically several items that are often not specified in enough detail or even at all in the RFP that will impact subsequent project phases. The first gap is specifying the appropriate codes/standards to which the BESS should be designed, tested, and installed. Examples include requiring that the BESS be listed to UL9540 or its listed equivalent and be installed in accordance with the most recent version of either the IFC or NFPA 1 and NFPA 855. These standards are covered in more detail in section 4.1. Next, simply requiring these codes/standards without context can lead to unacceptably long delays in project delivery unless additional detail is provided in the RFP. Depending on the BESS chemistry there is a need to call out certain requirements within the installation codes/standards that are often misunderstood or not considered by the system vendor. Some examples of additional context include requirements for the system vendor to provide test data from large scale fire testing (see UL9540A), a Hazard Mitigation Analysis (HMA), potential design and installation of explosion mitigation methods (see NFPA 68 and NFPA 69), and a commissioning plan that clearly identifies roles and responsibilities (NFPA 855). Additional details of fire alarm design are also critical at the RFP stage to ensure proper communications are managed as expected by the AHJ.

4.2.3 Construction

The activities that take place during this phase will mostly fall under the category of monitoring. Monitoring refers to oversight of the construction and installation activities with respect to site safety and of project scope, schedule, and budget. Site safety during construction activities is critical as safety issues not only have the potential to result in worker injuries but also have the potential to shut down and cause serious delays to a project. Monitoring for project scope, schedule, and budget are all interrelated items that need oversight for changes that can impact construction activities or acceptance testing schedules. Another monitoring function is to track any design changes such as installation location, i.e., same general area but adjusted just enough to now be within a Code/Standard boundary that initiates additional installation requirements.

4.2.4 Acceptance Testing/Commissioning

Acceptance tests provide a baseline for how the BESS is expected to function when placed in operation. Acceptance testing can also identify malfunctioning components that could have created a safety issue if left unchecked. Although the primary vendor is responsible for providing the initial acceptance testing plan it is in the best interest of the commissioning process team to use BESS-specific commissioning guides to understand the tests being performed and expected results. It is essential to catalog and archive results from the BESS system components and sub-components acceptance tests.

Unfortunately, commissioning tasks are often only partially performed or disregarded completely. Successful completion of this project phase provides the basis for a smooth handover of a project to the operations and maintenance (O&M) team, often a different set of personnel. Finally, and just prior to commencing full-scale operations, it is best practice to schedule training for local first responders. A classroom training session that includes battery safety awareness that is tailored to the specific BESS chemistry plus a site tour of the installation and location closes the loop on the project side with first responders. Including the O&M personnel in this training allows for introduction of those operating the BESS to those who would be responding to an upset condition at the BESS.

4.2.5 Operations and Maintenance

The O&M phase constitutes the majority of the BESS lifecycle and safe operations during this period are critically dependent on how well the entire project was executed. The energy storage asset owner may manage maintenance of a system themselves or they may outsource it to a third-party company (especially for geographically distributed sites). Recommended preventive maintenance actions include semi-annual visual inspections of the system and regular updates to the ESS software control and communications, as well as testing of the alarms and other safety systems. Additionally, there should be annual refresher training for individuals who have responsibilities under the emergency response plan, including first responders. In general, there is limited standard guidance on best practices for maintenance. Beyond preventive maintenance, there is a growing industry focused on BESS predictive maintenance – analyzing streaming data to identify early signs of malfunctioning components.

4.2.6 Decommissioning

A decommissioning plan will describe how: (1) a system will be shut down and removed from service; (2) components of the system will be disassembled, removed, and transported; (3) components of the system will be disposed, reused, or recycled; and (4) the site will be restored and remediated. Decommissioning can be a planned or unplanned event. A planned event is where the asset has met its expected life span based on normal degradation, while an unplanned event is due to a failure, and can involve a significant time delay depending on the failure event. There have been relatively few examples of energy storage decommissioning efforts due to the nascence of the industry. Key considerations for decommissioning include identifying under what circumstances the system will be decommissioned (e.g., component degradation, return on investment, etc.), who is responsible for system removal and costs, and how to ensure safety during decommissioning. Most jurisdictions are requiring decommissioning plans to be presented to the AHJ during the initial project permitting process, or prior to any decommissioning work beginning.

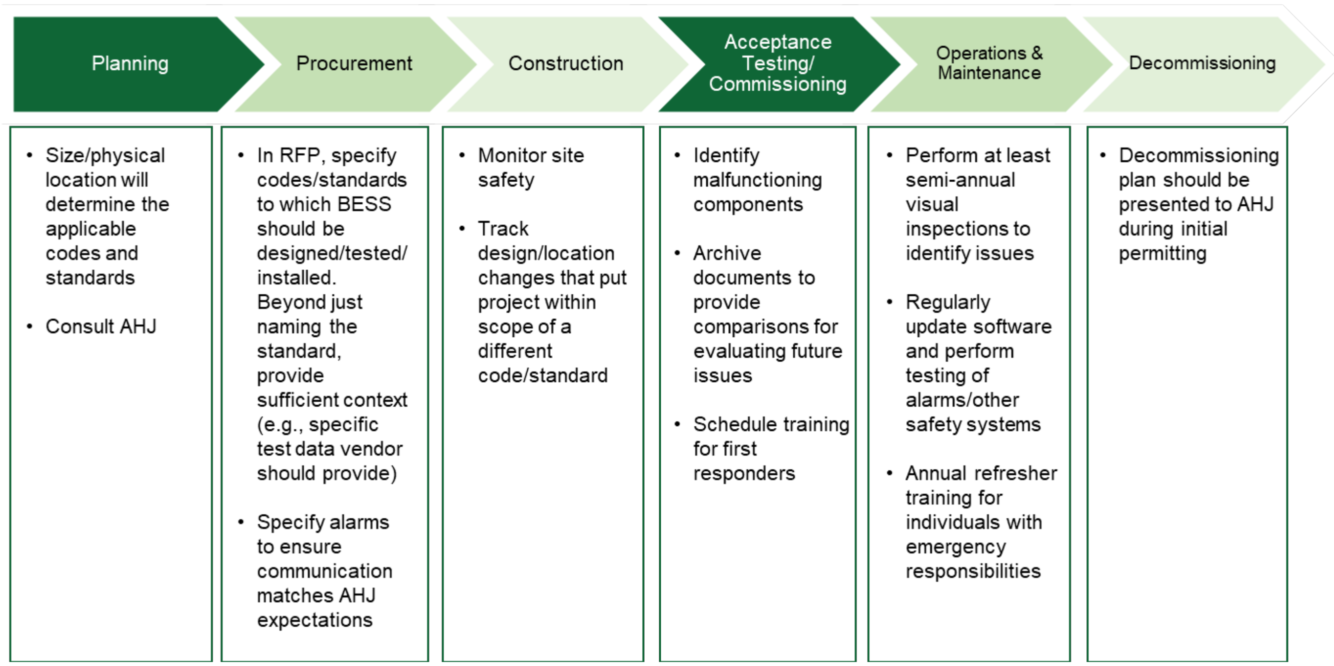

Figure 3. Key safety considerations throughout project execution.

4.3 Permitting and Zoning

Since 2015, the amount of utility-scale energy storage installed in the U.S. has grown at an average rate of 75 percent per year. Since 2020, the annual growth rate is 134 percent (including planned installations for 2023). As storage projects proliferate in the U.S., the potential for them to come into conflict with other land uses increases. Local zoning officials at the municipal and county levels are responsible for determining appropriate land uses and mitigating any impacts of a proposed project on nearby uses. Local planners, however, face two significant challenges in responding to proposed storage projects: 1) uncertain jurisdictional lines between state energy siting agencies and local planners; and 2) lack of familiarity with storage technologies and their potential impacts.

A large majority of municipalities and counties in the U.S. have not defined how storage fits into their zoning ordinances. Table 4 highlights the different ways that energy storage has appeared in local zoning ordinances. If a developer wants to install an energy storage project in a jurisdiction that has not defined where storage is allowed, the developer is responsible for identifying a potential site and petitioning the jurisdiction to issue a conditional use permit or rezone the site to enable the project. Such proceedings are subject to public hearing, which provides neighboring property owners an opportunity to express concerns. Communities are typically focused on understanding the physical impacts of energy storage: safety risks, environmental impacts, visual impacts, noise, odors, etc. Community opposition to storage projects is usually rooted in concern over safety and environmental risks, and public hearings tend to focus on the few, high-profile incidents of battery fires. These community impacts can be mitigated through local zoning requirements and conditional use permits, but doing so requires an awareness of energy storage characteristics that local planning officials and community members may not have.

Table 4. Energy storage in local zoning ordinances. Adapted from [9].

DESCRIPTION	NUMBER OF ORDINANCES FOUND	EXAMPLES
Ordinances written to regulate solar installations that also include storage. These ordinances generally only regulate storage systems when co-located with solar generation, and generally apply all solar PV regulations to storage components.	37	• *Plumsted, New Jersey* requires all equipment for a solar energy system, "including ... structures for batteries or storage cells" to "be completely enclosed by a minimum 12 foot high fence," and prohibits all systems from being located in a "front, side, or rear yard setback." *(Township of Plumsted, NJ Code § 15-5.21)* • *Boulder, Colorado*'s zoning ordinances define a "solar energy system" as "a system ... which may include an energy storage facility," and then defines permitting requirements and zoning districts eligible for installation of these systems. *(Boulder County Land Use Code Article 18, 18-199)*
Local adoption of fire or building codes that include standards for energy storage systems. County and municipalities have adopted fire and/or building codes that include explicit safety, labeling, and siting guidance for energy storage, such as the 2018 IFC, 2020 NEC, or NFPA 855.	12	• *Yarmouth, Maine* has locally adopted NFPA 855, "Standard for the Installation of Stationary Energy Storage," into its municipal fire and safety code. *(Town of Yarmouth, Maine Code Chapter 319: Fire Prevention and Life Safety Ordinance, 2021)* • *Several states have amended their Fire Codes (based on the IFC) to include language that allows the AHJ to enforce provisions in NFPA 855. (Michigan PUC Act No. 233, and WA State Building Code 2021 Edition §1201.1)*
Ordinances specifically targeted at energy storage technologies. These regulations include labeling standards, permitting requirements, setbacks, height standards, and visibility requirements. These ordinances may contain standards like those in standard fire or building codes and may be adopted in addition to these codes to add additional guidance. Alternatively, they may be adopted by local governments unable to exceed state code requirements.	12	• *King George County, Virginia* requires battery energy storage facilities to have access to water, provide access to the county fire department, have decommissioning plans, be labeled with NFPA 704 placards, and to not be visible from "any adjacent street, use or building." *(King George County, Virginia Code of Ordinances § 4.19)* • *Madison, Maine* requires battery storage systems to be enclosed by a minimum eight-foot fence with a locking gate and feature a visible sign to warn of potential voltage hazards. *(Town of Madison, Maine Code of Ordinances § 484-41)*
Ordinances that incent or encourage energy storage development. Some municipal ordinances protect the right to install energy storage systems or use local building codes to add incentives for storage.	5	• *Lancaster, California* ensures that all residents and businesses are "permitted to construct and operate stand-alone electric energy systems," including "fuel cell systems [and] battery systems." *(City of Lancaster, California, Ordinance No. 1067)* • *Wilton Manors, Florida*'s "Green Building Design Option" system, written into its code of ordinances, requires new buildings to earn a minimum number of green building "points," and allows on-site solar and storage systems to contribute to their total. *(Wilton Manors, Florida Code of Ordinances § 170-050)*.

4.4 Insurance

Property insurance is fundamental to the long-term sustainability of industrial facilities. Any failure of an energy storage system poses the potential for significant financial loss. At the utility scale, ESSs are most often multi-megawatt-sized systems that consist of thousands or millions of individual Li-ion battery cells. Thermal runaway or, more importantly, the propagation of thermal runaway events, can result in damage that extends well beyond the initial failure point. Nearby supporting systems or critical infrastructure could also be damaged and lead to extended outages or reductions in power capacity.

Property insurance is about protecting the value associated with a facility. Ideally this is accomplished by preventing the loss from happening. However, when failures occur, it is important to mitigate the event to the least cost and disruption to the insured client. Insurance companies typically separate sources of

[9] Twitchell, J.B., Powell D.W., and Paiss, M.D. 2023. **Energy Storage in Local Zoning Ordinances,** Richland, WA: Pacific Northwest National Laboratory.

financial losses into two categories, property damage and business interruption. Property damage relates to physical damage that requires repair or replacement. Business interruption addresses longer-term financial losses that occur while the property is unavailable, such as lost revenue or extra expenses incurred to maintain business operations. In some cases, the upfront property damage may be the leading loss cost; however, the accumulation of business interruption costs is often the dominant factor.

Loss prevention strategies focus on minimizing the two components of financial risk: frequency and severity. Current approaches to reduce loss frequency largely rely on manufacturers or integrators to implement good manufacturing practices and product design. A battery management system, for example, is an integral part of early abuse detection and intervention but can have limited impact once thermal runaway occurs. Thus, a layered protection strategy is recommended in guidance documents, such as FM Global Property Loss Prevention Data Sheet 5-33, *Electrical Energy Storage System*[10], to limit the severity of a loss. While not all protection options are available in every case, the general goals are to protect critical indoor equipment with automatic protection systems and to separate units from other ESS and buildings or other critical equipment to limit the damage area.

While there is beneficial alignment with installation standards, such as NFPA 855[11], achieving meaningful loss prevention often requires additional considerations. Regardless of the protection strategy, production of smoke, water runoff from fire protection efforts, and buildup of flammable gases can occur. Since fire generates smoke and sprinkler water damages electronics, any equipment near the origin of the fire would likely be lost in any case. This highlights the importance of continued development of high quality, robust and abuse tolerant battery systems and protection strategies to prevent an event from spreading beyond the initial point of failure.

[10] FM Global Property Loss Prevention Data Sheet 5-33, Electrical Energy Storage Systems, Interim Revision, August 2023.
[11] NFPA 855, Standard for the Installation of Stationary Energy Storage Systems, 2023.

5. Developments in Validated ESS Safety for Li-ion Batteries

Li-ion batteries are currently the most common form of newly deployed energy storage due to their high production volumes, proven commercial performance, and desirable technical characteristics such as high energy density, high power, high efficiency, and low self-discharge. The key safety concern for Li-ion batteries is thermal runaway, which can be triggered by abuse or manufacturing defects. Propagation of thermal runaway can lead to major system fires or explosions. Thus, this section focuses on avoiding or mitigating the consequences of thermal runaway in Li-ion batteries, including current validation techniques, safety considerations for materials, engineering controls, and system design.

5.1 Current Validation Techniques

The rapid growth in energy storage deployments, along with a growing number of high-profile events involving fires and explosions, have resulted in ESS validation techniques diverging from those of the electric vehicle community. The accompanying evolution of ESS-specific codes and standards has given a clearer picture for battery manufacturers and integrators to validate their designs to meet the latest requirements.

However, codes and standards for ESS must be written to cover an extremely wide range of systems, from a few kilowatts and kilowatt-hours to hundreds of megawatts and more than a gigawatt-hour, and from 48-volt residential ESS to 1,500-volt grid-scale units. These diverse systems have widely varying validation needs. Residential systems represent the lowest level of absolute hazard but the highest risk for life safety, often consigning them to outdoor installations where they may be subject to widely varying ambient temperatures. Larger-scale ESS are normally temperature-controlled but are subject to other hazards; for example, a loss of isolation in a 1,500-volt battery can cause a multicell thermal runaway event with elevated risk of fire or explosion.

A major trend in the ESS industry is away from very large 40-foot and 53-foot ISO containers that must be assembled on-site, to smaller modular cabinets that can be shipped fully assembled. For optimum land utilization, these cabinets must be installed with minimal spacing, so avoiding propagation of thermal runaway becomes critical. Not only is it important to limit cell-to-cell propagation within modules, but the cabinet design must be validated to ensure that complete combustion of a single cabinet will not result in an explosion, or cause propagation to adjacent units.

At least some of the ESS incidents involving fire or explosion in recent years have occurred because integrators did not fully understand the failure modes and severity of hazards associated with Li-ion batteries. Lessons learned from these events have resulted in rapid evolution of codes and standards and improved understanding on the part of integrators. Large-scale fire and explosion testing has become a standard requirement for an increasing range of system sizes, and the significant cost of that testing may represent a barrier to some integrators entering the market.

Current validation techniques are generally adequate for today's Li-ion chemistries, but there is ongoing work on emerging technologies, such as solid-state lithium and sodium-ion batteries. Both of these families of battery chemistries offer the hope of improved safety, but their failure modes and potential hazards must be more comprehensively understood. This understanding will inform the possible need for additional codes and standards and validation techniques.

5.2 Safety Considerations for Li-ion Battery Materials

Thermal runaway of Li-ion batteries, a process wherein the battery exhibits an accelerating heat release due to a series of uncontrollable exothermic reactions, is fueled by the interaction of component materials. Thus, there have been numerous efforts to develop 'safe by design' batteries by modifying the composition and architecture of the battery's anode, cathode, electrolyte, and their respective interfaces. However, it is important to note that safety is still typically evaluated at the whole-product (or cell) level after initial development of the battery to meet performance goals.

5.2.1 Anode (Negative Electrode)

Graphite is a well-established anode material in commercial Li-ion batteries. In Li-ion batteries with graphite electrodes, lithium ions react with the electrolyte during the initial cycles to form a passivation layer called the solid-electrolyte interphase (SEI). Further SEI growth is suppressed by the inability of electrolyte molecules to penetrate the established SEI layer, which in turn inhibits parasitic reactions at the anode.

The structure of the graphite creates limitations in charge rate, causing lithium plating on the outer surface of the negative electrode.[12] Li can plate in various morphologies, including tree-like crystals known as dendrites that can penetrate the separator and cause a short circuit. Attempts to modify graphite structures as 3D architectures have shown promise in increasing surface area and preventing lithium plating and dendrites during high charging rates. In addition, at a system level, to prevent lithium deposition, the battery management system (BMS) must limit charge currents to safe levels.

5.2.2 Cathode (Positive Electrode)

Many modern Li-ion batteries contain an NMC cathode with varying compositions of nickel, manganese, and cobalt. Recent research has focused on reducing the cost and ethical concerns of the NMC cathode by eliminating as much cobalt as possible. This has led to high nickel cathodes (e.g., NMC811). However, high nickel content can lead to challenges in fabrication and poor structural and thermal stability, which can affect safety. Many early grid-scale systems used an NMC cathode, and some BTM home storage systems continue to do so.

Recent grid-scale installations have used an LFP cathode due to its lower cost, better cycle life, and increased thermal stability (safety). Safety concerns are a significant driver due to BESS incidents that have harmed first responders and were widely covered in the media. However, it is important to note that LFP is not a silver bullet and incidents have occurred even in LFP-based systems (when LFP is experiencing thermal runaway, a greater volume of hydrogen gas is produced, leading to increased explosion risks). The drawback to LFP is its lower operating potential and hence, reduced energy density. A successor to the LFP chemistry may be $LiMn_xFe_{1-x}PO_4$ (LMFP). The inclusion of manganese in LFP can offer a >20% increase in energy density and high operating potential,[13] while maintaining the benefits of safety and cyclability. While some products could appear with pure LMFP as the cathode, it is likely that the trend toward blending cathodes will continue, with some manufacturers mixing LMFP and NMC.

5.2.3 Electrolytes

Commercial Li-ion batteries generally use an electrolyte solution composed of organic solvents, typically dimethyl carbonate (DMC) and diethyl carbonate (DEC), enhanced with lithium salts, such as $LiPF_6$, for ionic conductivity, and reinforced with ethylene carbonate (EC) to increase electrical resistivity. Organic electrolytes are more attractive for Li-ion batteries because of their wide electrochemical stability window

[12] Janakiraman et al. "Review – Lithium Plating Detection Methods in Li-ion Batteries," *J. Electrochem. Soc.* **2020**, *167*, 160552.

[13] Yang et al. "Olivine $LiMn_xFe_{1-x}PO_4$ cathode materials for lithium ion batteries: restricted factors of rate perfromances," *J. Mater. Chem. A*, **2021**, *9*, 14214.

compared to aqueous electrolytes, which undergo water decomposition at relatively low potentials (1.23V vs. H/H^+). A major drawback of the commonly used organic electrolyte is its high volatility and flammability when operated outside of normal conditions. Operation at high voltage or high temperature can lead to the decomposition of the electrolyte constituents and further chemical reactions with the electrodes. Usually, these reactions are exothermic and self-sustaining, with aggressive gas release and flames. Flame retardant additives are under investigation to increase battery safety. Various additives based on phosphates and phosphazenes have been studied for this purpose, but their chemical stability, reactivity with other battery components, and the concentration required for them to be effective while still negligible to the overall weight of the cell is still under significant development.

5.2.4 Development of New Materials

The earlier sections described research on conventional, commercial Li-ion battery materials; this section describes the development of new materials.

Lithium metal anodes are theoretically capable of providing 10x higher gravimetric capacity than graphite. Electrolyte design improvements are constantly being made that may enable Li metal to replace conventional graphite electrodes. The development of electrolytes is focused on alternative salts, high salt concentrations, and/or alternative solvents that improve coulombic efficiency and morphological control. Because Li metal suffers from reactivity with liquid electrolytes and has traditionally exhibited poor morphological control, solid electrolytes are being developed and touted as the safer alternative to organic liquids.

Solid electrolytes are claimed to enable Li metal anodes and corresponding energy density gains by physically blocking dendrites and minimizing reactivity between the electrolyte and Li metal. Despite this common claim, the literature shows that Li dendrites readily form and grow through ceramic solid electrolytes.[14] Polymer electrolytes may more effectively block dendrites if they are engineered to exhibit sufficient shear modulus, but they are often still flammable like liquid electrolytes (with some exceptions). Recent research has indicated that solid-state batteries may be less safe than Li-ion batteries under short circuit failure because their higher energy density means that the same amount of heat is released in a smaller mass and volume, leading to higher temperatures. Solid-state batteries still need to undergo thorough modeling and experimental safety analysis prior to commercialization.

Another emerging technology is sodium-ion batteries, many of which use the same working principles and cell construction as Li-ion batteries. Sodium-ion batteries have received significant attention due to the natural abundance of sodium and the opportunity to avoid using metals such as cobalt, copper, and nickel. Limitations of sodium-ion batteries include lower energy density and cycling lifetime. Several companies have recently announced the production of sodium-ion battery packs for electric vehicles, however, there have not yet been major deployments. The safety of sodium-ion batteries has not yet been systematically studied, although this is changing as more commercial products are becoming available for testing. [15]

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[14] Barai et al. "Mechanical Stress Induced Current Focusing and Fracture in Grain Boundaries," *J. Electrochem. Soc.*, **2019**, *166*, A1752.
[15] https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/2023-04/DOT-SIB-Testing-Report-Web-Version.pdf, Accessed August 1, 2023.

5.3 Engineering Controls and System Design

The following section covers common practices and emerging guidance in the design of systems containing Li-ion cells. Table 5 summarizes engineering controls and system design approaches to enhance safety.

5.3.1 Module Design

The smallest replaceable unit in a Li-ion battery is typically the module, comprising multiple cells in series (and sometimes in parallel, depending on cell size) and BMS components for voltage sensing, temperature sensing, and cell balancing. The module design is integrated with the thermal management system, which may include air or liquid circulation. In air-cooled systems, the module may also include a BMS-controlled fan. While system cooling is important for maintaining the battery at a safe operating temperature, prevention of thermal runaway propagation should not normally be contingent on coolant circulation since this would require redundancy in the powering scheme and fans or pumps.

Module designs should include barriers between cells to provide passive protection against thermal runaway propagation. Examples of such barriers are air gaps, dielectric liquids, aerogels, and phase-change media. A typical arrangement has thermal barriers between cells and a cooling plate below them.

5.3.2 Enclosure Design

While some ESSs are still installed in buildings, codes and standards have evolved to the point where compliance is more onerous due to the proximity to people. Similarly, earlier containerized designs were mostly walk-in units, which are now treated like buildings from the perspective of fire codes. These issues have pushed designers towards cabinets that are serviced from the outside and only the technician's arms cross the threshold of the enclosure. Such enclosures also allow for much higher energy density and reduced facility area.

In past years, many integrators standardized their designs on 40-foot and 53-foot ISO containers, and some still offer these units. The weight of these systems is such that they cannot be transported fully assembled, so it is necessary to install modules in the field. Furthermore, the requirements for product listing have led some integrators to adopt smaller cabinet-type units to modularize ESS project designs. These units, typically 10'-20', can be shipped fully assembled, and, in the event of a fire, losses are reduced, and cabinets can be easily replaced. The cabinets are heavily insulated to allow them to be installed with very little spacing, while still preventing propagation of fire between units.

5.3.3 System Integration

Some earlier safety events resulted from poor integration of ESS components, particularly relating to electromagnetic compatibility and interoperability. The BMS should be resistant to any electromagnetic interference from the PCS (power conversion system) and must be able to cope with current ripple without nuisance warnings and alarms. Interoperability is achieved between the BMS, PCS controller, and energy storage management system with proper integration of communications. The *de facto* standard in this area is provided by the SunSpec Energy Storage Models. The SunSpec models are included in a draft IEEE recommended practice for BMSs, expected to be published in 2024. Another failure mode experienced in the field involves poor cell balancing across a string of cells as they degrade at different rates, which can lead to overcharging in higher SOC (state of charge) cells.

Table 5. Possible engineering controls and system design elements to enhance safety.

LEVEL	POSSIBLE FEATURES IN DEPLOYED SYSTEMS
Module	- Barriers between cells to minimize thermal runaway propagation - Integration of thermal management
System	- Cabinet/modular systems: 1) serviced from the outside to enhance technician safety; 2) reduced losses compared to larger container - BMS: 1) resistant to EM interference; 2) communications redundancy - Proper integration between BMS/PCS/EMS - Explosion control: deflagration panels, sparkers, etc.

5.3.4 Fire Versus Explosion Philosophy

When abused, Li-ion cells vent a flammable mixture of gases containing hydrogen, carbon monoxide, carbon dioxide, and organic compounds. If allowed to accumulate in the confines of an enclosure, this gas can quickly surpass the lower explosive limit and pose a risk of deflagration to first responders. Industry trends towards larger format cells and greatly reduced free air volume in enclosures can mean that a single cell venting could present an explosion risk.

In ESS designs where cell-to-cell thermal runaway propagation is possible, or in the event of a multi-cell arcing fault, suppressing a fire may knock down the visible flames but may not cool cells sufficiently to prevent propagation. In an enclosed space, continued cell venting can drive the gas concentration above the upper explosive limit, posing an extreme risk to first responders who may open the enclosure door, allow oxygen to enter, and then trigger an explosion. This is exactly what happened in McMicken, Arizona in April 2019, where four firefighters were injured.

Recognizing that explosion is a much greater hazard to personnel than fire, the codes require explosion control to mitigate the risk. Many integrators now employ venting strategies to flush flammable gases out of enclosures. Provisions for venting may be as simple as opening doors or roof vents, or may involve emergency fan operation. For the latter case, it is important to provide reliable power to the fans, possibly with an uninterruptible power system or generator, since the battery may have been tripped offline in response to the event.

Venting of flammable gases is likely to reduce the effectiveness of fire suppression, so some integrators have opted to eliminate fire suppression from their designs. This ‘let it burn’, or defensive, strategy has a benefit in that, if the enclosure is burning, flammable gases are consumed as they are generated, reducing the risk of explosion. For this reason, some integrators have extended the ‘let it burn’ concept to a ‘make it burn’ strategy, using sparkers to ignite vent gases. Allowing the fire to burn out also avoids problems with stranded energy and reignition.

Although it has been widely acknowledged that water is the most effective medium for cooling cells and arresting propagation, to be effective the water must be properly directed to contact all cells. Ceiling-mounted sprinklers and hose-directed water from firefighters are unlikely to achieve this close contact, potentially resulting in partial extinguishing while creating contaminated run-off, or requiring significant amounts of water. Additionally, water is conductive and large losses have occurred to previously unaffected battery racks. Where a defensive strategy is adopted, firefighters are trained to use water only to protect nearby exposures.

5.3.5 Event Detection

Detecting an ESS safety event and alerting the necessary personnel represents the first step in incident response. All ESS facilities are required to prepare an emergency response plan for submission to the AHJ, and this plan should be triggered by the initial detection.

The BMS may detect the early stages of an event through temperature measurements, evaluating temperature differences both between module sensors and between those sensors and the ambient. However, most BMS designs do not include temperature sensing for each individual cell, and a certain number of sensors per module are allowed to fail before string tripping, to maintain availability. Thus, the BMS capability to detect the beginnings of thermal runaway depends on the proximity of the faulty cell to the nearest sensor.

Another aspect of BMS design is communications redundancy. The internal BMS communications and communication to the system controller should be supplemented by a trip circuit activated by a dry contact. This circuit may be activated in a single string during normal operation as a result of a performance anomaly, or an external sensor or system may trip all strings in the enclosure when a safety event is detected. While BMSs are routinely used for isolating a battery from charging and discharging, they are not typically used for high-level emergency alert notifications, primarily due to the lack of a BMS standard addressing this use.

NFPA 855 (2023) requires the ESS area to have smoke detection or radiant heat sensors. Many designs go beyond this minimum requirement, installing both smoke and heat sensors and often additional detection. This additional detection typically senses one or more components of cell vent gas, such as volatile organic compounds, hydrogen, carbon monoxide, and carbon dioxide. Cell venting normally occurs some time before full-blown thermal runaway and may not be detected by smoke or heat sensors, so these vent-gas sensors can provide early warning of an event.

Communication to emergency responders typically occurs through the use of a FACP (Fire Alarm Control Panel) which receives alarm signals from any of the above sensors and transmits the alarm signal via central dispatch protocols.

6. Incident Response for Li-ion Batteries

This section covers lessons learned from recent incidents, translating knowledge and data gained from incidents to codes and standards, and how notable incidents have led to significant policy changes in the energy storage community.

6.1 Lessons Learned From Recent Events

Emergency services utilize a system to organize resources, assess risks, develop strategy, and implement the plan in the form of tactics. This may take the form of Standard Operating Procedures (SOPs) for well-defined incidents such as Hazardous Material Incidents (HAZMAT), structure fires, or vehicle rescues.

One of the best tools to utilize in planning any response is past experience from similar events. These are often formulated into what is commonly known as Best Practices. In the realm of ESS incidents, experience has shown that extinguishment of Li-ion BESSs is challenging, often ineffective, or even detrimental to saving property or protecting the environment. As a result, a best practice that is being validated on more and more events is the defensive (let it burn) strategy while protecting exposures. This is challenging for the fire service based on their deeply ingrained culture of taking personal risk to save lives and property and putting all fires out. However, as with wildland firefighting, where the fire is allowed to assist in the task of removing fuel and protecting high value exposures, a defensive strategy can actually be considered a part of the HMA. Allowing a BESS to burn, as long as no exposures are threatened, may actually result in an overall shorter incident duration, with less HAZMAT concerns with water run-off. Recent incidents with sprinkler system activations have actually led to significantly increased damage to previously unaffected modules and racks, not to mention millions of gallons of water use. The ‘let it burn’ approach has been challenged as more BESSs have been placed in populated areas (e.g., near homes, schools, or businesses). Clearly this defensive strategy is also not possible for indoor installations of BESS.

6.2 From Incidents to Codes and Standards

Codes and standards are often called “reactionary” but the reality is they should be based on data, and previous incidents provide valuable data to identify gaps or modifications to the codes. The best practices described above are only enforceable when they are codified. Additionally, with the model fire, electrical, and building codes being updated on a triennial cycle, it is critical to incorporate these lessons learned and resulting Best Practices into the code without delay to keep up with the fast pace of technological innovation. One example of code changes based on lessons learned is the requirement for explosion control in all enclosures. Another is allowing some exceptions for providing sprinkler suppression systems given the limited effectiveness from incidents. In fact, water has in some cases led to greater battery involvement and loss in several incidents.

6.3 Deflagration Prevention Challenges

Great care must be taken to prevent explosions, which have already led to several notable injuries and fatalities during BESS incident response. The highly unpredictable nature of thermal runaway with the potential for propagation into a large-scale ESS fire can make designing explosion control systems quite challenging. For example, while the characteristics of a single cell failure are predictable, failure does not always scale predictably at the system level. The rapid evolution of a mixture of flammable gases presents challenges for sensors and for designing systems with the level of reliability required to ensure an explosion does not occur.

While passive controls such as pressure relief vents are common in other industrial processes, the presence of passive-only devices on a BESS enclosure will not prevent the potential for an explosion, nor exhaust the gases. In fact, it can present great risk to anyone that will have to open a door at some point. It is critical to remove the flammable gases to avoid the potential for any explosion.

6.4 Suppression Options

There is a growing field of research focusing on identifying effective fire suppression for Li-ion fires, but the results have not yet pointed to a universally effective agent or method of application to suppress a thermal runaway fire in lithium-based incidents. Traditional fire suppression agents include water-based agents, gaseous clean agents, and aerosolized powders.

6.4.1 Water-based Agents

Water-based agents include foams which are typically used for fires in Class A (common combustibles) as well as Class B (hydrocarbon and alcohol-based liquid fuels) materials. Water is used in automatic sprinkler systems that can use temperature-fused heads, or in a system where all heads are open and the piping is dry (empty) until either an automatic valve delivers the water, or firefighters make an external connection on a standpipe.

One challenge with water application is getting the water directly to the source of the fire in a very dense rack of modules. Another challenge is the conductive quality of water creating short circuits and extending the damage. Some manufacturers have experimented with direct injection of water into each module. While this has shown effective results in UL9540A fire testing, it has also resulted in large scale damage to the ESS when inadvertently discharged, as well as challenges in preventing further equipment or environmental damage from the flowing water.

6.4.2 Gaseous Agents

In the gaseous-clean agent category, common systems include Novec 1230 and FM200. These agents are common in the protection of sensitive electronics and act by either cooling or displacing oxygen. Challenges in the suppression of ESS fires include limited effectiveness due to the extreme heat generated during the thermal runaway process, as well as the duration of the incident. Additional challenges are the need to have a sealed environment to achieve the designed concentration of the agent for long enough to extinguish flame. This is the key issue that actually creates an unintended risk. The elimination of visible flame does not stop the thermal runaway process and the continued production of flammable gas now creates an explosion risk as the gases are allowed to build in the sealed enclosure.

Some manufacturers are experimenting with direct injection of the liquid clean agent. One area of considerable interest is immersion cooling in a dielectric liquid (as opposed to submersion after an incident). Several manufacturers have presented early data on these designs but have limited field data to validate the concept.

6.4.3 Aerosol Agents

Aerosol agents are powders that are designed to be discharged into the enclosure or room to disrupt the chemical chain reaction and extinguish flames. These powders, like gaseous clean agents, are well established in other sensitive electronics protections, however, they are not effective for lithium battery fires due to their limitations in cooling as well as the need for a sealed environment to maintain agent concentration. This creates a similar conflict as gaseous agents with the need to prevent the build-up of flammable gases with rapid exhausting.

6.5 Firefighting Priorities

The tactics employed in responding to an ESS incident will take the same approach as described in the Lessons Learned section. With the priority of protecting exposures, any decision for a defensive versus offensive strategy is dependent on the incident and location. Considerations of smoke plume direction as well as runoff containment should be part of the incident management decisions. HAZMAT monitoring of runoff and airborne emissions may be required, so resources should be requested early in the incident to support these efforts.

The location of the battery will determine the exposures and direct the strategy for any incident. Water may only be used to protect nearby equipment or other structures. Indoor installations have more strict fire and life-safety code requirements, which will make the system more complex and costly. Luckily the number of incidents in this category remain very low, however, expectations are that as the cost of residential ESS is driven downward, quality and safety may suffer. ESS technologies that emit toxic or flammable gasses during failure should be placed outdoors or in garages.

6.6 Status of Training

Training for emergency responders is a code requirement for non-residential installations. This will typically include awareness of failure modes, hazards, system operation, and recommended response actions. As ESSs become more common, fire departments may require less training, but at this early stage in the electrification of our society more information is critical for successful adoption. When communities raise safety concerns about applications for ESS installations, planning commissions will reach out to local fire officials to obtain information on the safety topics. If the fire department has not received any training, very often these projects will experience delays up to and including moratoriums on development. Experience has shown that in communities where the local fire department has received training by independent experts, ESS projects encounter fewer concerns from the fire service in the community.

6.7 Resources

Training and education in emergency response for an ESS development should be driven by the developer or manufacturer as there may be site- or installation-specific concerns. However, a number of national organizations are also developing and delivering training for the fire service. For example, the NFPA as well as the International Association of Fire Chiefs (IAFC) have online training available.

An example incident response guidance document is given in Appendix B.

7. Evaluating Emerging Electrochemical Technologies

While ESS safety assessments tend to focus on Li-ion, the failure modes and risks of other chemistries still need to be considered during development. Not doing so can lead to significant delays in commercialization of new technologies and harm people and the environment.

One of the major challenges facing SDOs in developing meaningful safety codes or standards with a new technology is the lack of credible data to validate the safety and reliability of that new, emerging technology. In one respect, standards development organizations are like the railroad operator. Once a significant accident occurs at a railroad crossing, that operator puts up red lights and safety crossing gates. However, evaluation of the failure modes of a new technology needs to be done at all stages of development and deployment (Figure 4). This process begins during the development of small-scale systems in the lab. At this point, it is important to consider all potential hazards, regardless of how significant they may appear at the small scale. The data collected at the lab scale (e.g., gas generation) should be used to make rough projections of how the risk scales with system size. This allows for the development of mitigation strategies and identification of appropriate sensors for monitoring of expected failure modes in the commercial-scale product.

Lab-scale testing should simulate real-world operating conditions as much as possible to determine how factors such as temperature impact degradation and failure. Additionally, any safety assessments (i.e., response of the battery to thermal, electrical, or mechanical abuse) should be completed both on fresh and cycle/calendar-aged cells. One gap in current safety assessments is that validation tests are performed on new products under laboratory conditions, and do not reflect changes that can occur in service or as the product ages.

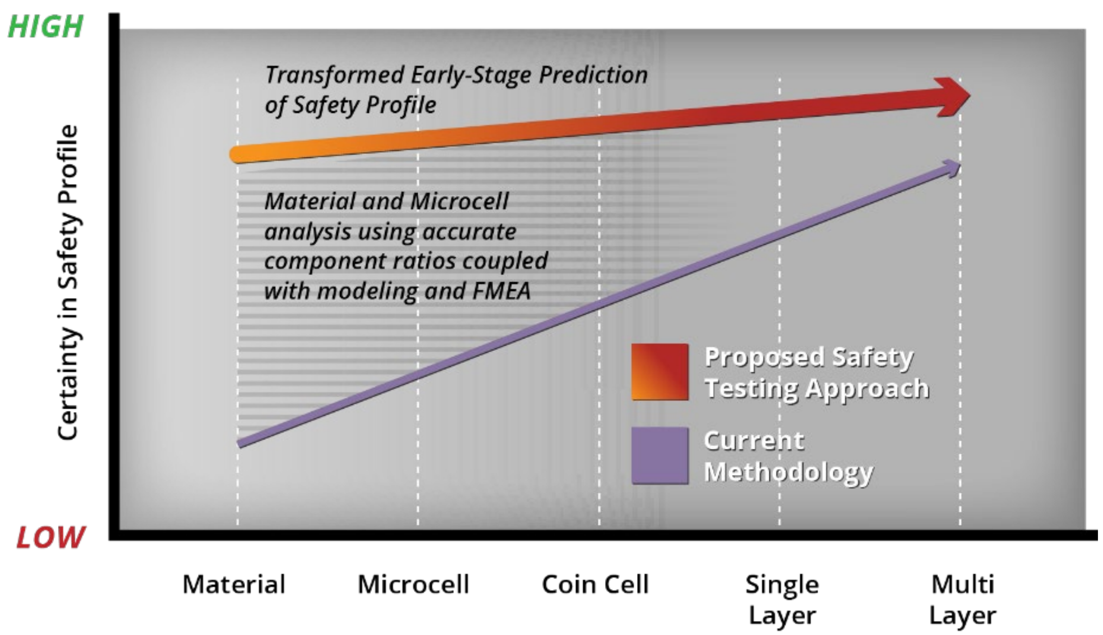

Figure 4. Increasing safety certainty earlier in the energy storage development cycle.

8. Summary of Gaps

Safety of any new technology can be broadly viewed as having three linked components: 1) a system must be engineered and validated to the highest safety level possible, 2) techniques and processes must be developed for responding to incidents if and when they do occur; 3) the best practices and system requirements must then be reflected in standardized safety determinations in the form of codes, standards, and regulations so there is uniform, written guidance for the community to follow when designing, building, testing, and deploying the system. The following section describes remaining gaps in each of these three areas based on the current state of ESS safety and reliability outlined earlier in this document and feedback solicited during the 2023 Energy Storage Systems Safety and Reliability Forum Breakout Sessions on these topics. Table 6 compares these gaps to those identified in the first version of the DOE Energy Storage Safety Strategic Plan published in 2014.

Table 6. Energy storage safety gaps identified in 2014 and 2023.

	2014	2023
Validated Safety and Reliability	• Materials science R&D – research into all device components • Engineering controls and system design • Modeling, cell to system • System testing and analysis • Commissioning and field system safety research	• Containment of Li-ion cell failure • O & M Guidance • End-of-life for Li-ion systems • System level fire modeling for Li-ion • Safety and degradation of beyond-Li-ion technology • Risks of energy storage in new applications • Standardized testing and reporting
Incident Response and Training	• First responder awareness and response practices • Fire suppression and protection system selection • Verification and control of stored energy • Post-incident response and recovery guidance • Battery-specific commodity classification for sprinklers	• Inclusion of energy storage data in guidebooks • Incident reporting • Decommissioning and stranded energy • Emergency response coordination • Physical status indicators • Impact of toxic emissions • Development of new tools for the fire service • Incident response during shipping and transportation

Codes, Standards, and Regulations	• Develop plan to assess existing CSR to identify gaps	• **Electrical**
		  • ESS-specific guidance for worker health & safety
		  • Grounding ESS
		  • Retesting a system over its lifetime
		• **Fire**
		  • Continue updating UL9540A (e.g., better module tests, impact of aged batteries, ignition of vent gases)
		  • ESS-specific guidance for minimizing explosions (NFPA69 generic)
		  • Acceptable emissions + spill containment
		• **Reliability**
		  • Data monitoring and reporting requirements
		• **Permitting**
		  • Uncertain jurisdictions of state agency vs. local planner
		  • Local planners lack of familiarity with storage

8.1 Validated Safety and Reliability

Several gap areas were identified for validated safety and reliability, with an emphasis on Li-ion system design and operation but a recognition that significant research is needed to identify the risks of emerging technologies.

1. **Containment of Li-ion cell failure**: Based on current Li-ion cell manufacturing processes, we expect the internal short-circuit failure of a certain number of fielded Li-ion cells. There have been no recent public examinations of these failure statistics, but studies in the 2010s of batteries in consumer electronics estimated the failure rate at less than one in one million.[16] This number may have decreased over time for established manufacturers, but the failure rate may be different for the many new battery cell manufacturers that are entering the industry due to growing demand for electric vehicles and energy storage. Energy storage developers must design systems that can contain these inevitable cell failures and prevent propagation to additional cells.

2. Operations and maintenance guidance: Currently, the certification process for BESS ensures that the overall system design is sound, the factory testing makes certain that the unit was constructed correctly, and the commissioning test confirms that there were no faults created or discovered immediately after the unit was installed at the site. However, there is limited public information on best practices for Day 2 operations and maintenance of Li-ion systems – what component failures should we be looking for (e.g., HVAC breakdown, rusting due to humidity, etc.), what are the most useful data points to track, and so on. One notable area of research is early detection of thermal runaway. Current devices and practices (e.g., gas sensors) aim to detect thermal runaway in a single cell before it occurs, leaving only enough time for a response that damages the system, such as a water deluge, or aerosol agent discharge. Identification of failure markers a week or at least a few days ahead of time would enable proactive maintenance of the affected area, such as replacing a faulty module. BMS analytics of battery degradation provide a possible avenue for failure detection.

3. End-of-life for Li-ion systems: There is currently limited guidance for end-of-life (EOL) management of Li-ion BESS because few systems have reached EOL, but this is a topic that merits research before more systems come offline in the next few years. There are currently detailed guides for BESS commissioning which may be used to inform the development of commissioning plans[17]; similarly detailed guidance is needed for system decommissioning. Current fire codes require a decommissioning plan, but there is currently limited documentation of best practices and advances in this area (including guidance for planned decommissioning based on system degradation and unplanned decommissioning due to a significant system failure). Tools to assess the health or stability of a battery for decommissioning or repurposing are critical. Additional questions include how to safely deenergize, disassemble, transport, and recycle batteries. Fires during transport and at recycling facilities have become a notable concern for consumer electronics and EV batteries.

4. System-level fire modeling for Li-ion: System-level experimental fire tests are an important tool for understanding the worst-case failure scenario for a BESS. However, they are expensive and may be difficult to support for emerging developers. Accurate system-level fire modeling including explosion control design would complement large-scale fire testing by evaluating many failure scenarios ahead of time and enabling the identification of issues and design of better systems prior to final testing. Additionally, this modeling would inform siting decisions, especially for large systems. There is a lack of

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[16] https://www.nrc.gov/docs/ML1719/ML17191A294.pdf, Accessed August 1, 2023.
[17] EPRI ESIC Energy Storage Commissioning Guide https://www.epri.com/research/products/000000003002013972, Accessed August 1, 2023.

guidance on clearances and setbacks required from critical grid infrastructure, such as substations or transmission lines. Current modeling tools primarily focus on cell-level failure and module-level propagation.

5. Safety and degradation of beyond-Li-ion technology: Many emerging energy storage technologies are presented as 'safer' alternatives to Li-ion systems. Full, rigorous FMEAs still need to be completed for these new technologies to understand their unique safety and degradation profiles. These FMEAs can then inform the development of new, technology-appropriate performance and safety testing protocols. Passing safety tests designed specifically for Li-ion batteries is not sufficient.

6. Risks of energy storage in new applications: Codes, standards, and testing protocols for energy storage systems tend to focus on grid-scale deployments. However, energy storage is increasingly being used in new applications such as support for EV charging stations and home back-up systems. Additionally, many jurisdictions are seeing increasing use of EVs and mobile energy storage systems which are moved around to be used as a temporary source of power. <u>It would be beneficial to understand the performance and degradation of energy storage systems under these new duty profiles. These new applications also merit their own guidance for safe system design and emergency response protocols.</u> A residential energy storage system will have different emergency response protocols from a utility-scale system.

7. Standardized testing and reporting: Many Li-ion battery safety and performance testing protocols are being developed, but tests are often executed in slightly different ways (e.g., different thermal runaway initiation methods) making it difficult to compare results across tests. Even when two labs try to strictly follow the same test procedure, the outcomes can still be slightly different. There should be an effort to make testing protocols descriptive enough to increase reproducibility. Standardized testing protocols should be complemented with standardized reporting protocols. Additionally, new safety tests can be informed by specific incidents in fielded systems (e.g., ARC flash between modules). Where possible, safety and performance tests should mimic conditions encountered in the field to yield the most accurate expectation of real outcomes; however, this can be challenging due to insufficient reporting of details and root causes in fielded system incidents.

8.2 Incident Response and Training

The gap areas identified for incident response generally fall into three categories: increasing knowledge about ESS safety prior to an incident, increasing situational awareness during an incident, and managing the aftermath of an incident.

1. Inclusion of energy storage data in guidebooks: Firefighters use the Department of Transportation Emergency Response Guidebook, or ERG, to find data on the properties of materials they might interact with during HAZMAT transportation accidents. Appropriate data on different battery chemistries should be incorporated into this manual and similar guides so that emergency responders have an easy, standard reference.

2. Emergency response coordination: Larger jurisdictions with significant experience with ESS have started coordinating emergency response plans. However, there is still no standard template to guide system owners through the development of a plan with all key elements (e.g., identifying all relevant stakeholders, all data to consider during an incident, etc.). Such a template would be especially useful in jurisdictions with volunteer fire departments.

3. Incident reporting: Incident reporting for emergency responders is commonly done via an electronic system called the National Fire Incident Reporting System (NFIRS) managed by FEMA. This is a system used by over 22,000 fire departments to log all emergency responses. One of the gaps in this system is the ability to track emerging risks such as newer technologies. More accurate incident reporting to capture these incidents is needed to understand the impact on fire departments, as well as incidents themselves. The US Fire Administration is launching a modernization effort to deploy a new reporting system called the National Emergency Response Information System (NERIS). NERIS will provide capabilities for documenting and introducing community risk reduction efforts, offering insight into vulnerability gaps where resources can be used to harden communities and minimize future emergency and disaster events.

Additionally, the nation would benefit from the public release of detailed reports on ESS incidents so that lessons learned can be shared and issues mitigated in other systems.

4. Physical status indicators: Emergency responders need stationary ESS to report out more data during incidents to support them in providing an appropriate response. Examples of physical status indicators include BMS data to help identify trending temperatures and gas-levels inside the enclosures. Gas levels are particularly important to understand the explosion risk and if gas sensors are utilized as part of the explosion control system, they should be able to report concentrations for the duration of an incident. Emergency responders should be able to access these physical status indicators outside of a suitable exclusion zone from the system. Outside of live data reporting, all BESS should have standardized hazard markings (e.g., “keep out” areas), signage, placards, and ground labeling so that emergency responders immediately know what they are approaching.

5. Impact of toxic emissions: The impact of toxic emissions from battery fires is critical to guide incident response strategies as well as to be able to provide better data-driven guidance for public safety protections. Early studies are considering the impact of heavy metals in both particulate emissions (air-borne), as well as those found in water run-off. Additional work is needed to identify toxicity impacts to firefighting PPE (personal protective equipment), as well as appropriate cleaning of the PPE. Some early studies are looking at SOC and chemistry impacts on emissions, as well as plume studies for airborne particulates. As current best practices are trending towards a defensive strategy on outdoor battery incidents, greater toxic emissions knowledge is needed to understand the long-term impacts of this approach.

6. Decommissioning and stranded energy: Stranded energy, the energy remaining in damaged batteries (if a fire does not burn everything), can pose a significant fire and shock hazard. Stranded energy impacts when and how batteries can be removed from their original installation, transported, and disposed of. Emergency responders need guidance on how to mitigate the hazards of stranded energy and tools for safely neutralizing batteries. Current areas of research include tools to short circuit batteries and the effectiveness of water submersion.

7. Development of new tools for the fire service: Development of new tools for the fire service to effectively respond to ESS incidents is also an emerging field. Fire suppression tools common in Europe are being evaluated for EV fires where extinguishment is challenging. Piercing nozzles and high-pressure cutting tools are common on fire apparatus in Europe and several studies have evaluated these tools in direct injection of water to damaged EV packs with successful results. Fire suppression tools may be seen as ‘counter’ to the defensive ‘let it burn’ philosophy, but the defensive approach has been challenged as more BESS have been placed in residential areas and near schools).

For stationary ESS, there has also been a call for more physical status indicators, as documented in (5). Outdoor ESSs with automatic door systems for deflagration prevention are increasingly being considered to provide direct visualization from a safe distance; automatic door opening also increases the situational awareness in a way that other data streams can't.

8. Incident response during shipping and transportation: Battery incidents may occur outside of an ESS installation, either during shipping or transport to a site or, more likely, after batteries are removed from a site. The maritime environment presents unique challenges and risks for the transportation of Li-ion batteries, particularly due to the potential for thermal runaway and fires, which can be difficult to manage at sea. To ensure the safe transportation and shipping of Li-ion batteries, several international codes and standards have been established. These include: the International Maritime Organization Dangerous Goods Code and Circulars, IEC 62619 and 62660, and United Nations Recommendations on the Transport of Dangerous Goods. To further enhance the safety of Li-ion battery transportation and shipping in the maritime environment, the following recommendations are proposed. Companies involved in the transportation and shipping of Li-ion batteries should provide regular training and education to their employees on the safe handling, storage, and shipping of these batteries. This includes updates on the latest regulations, guidelines, and best practices. The maritime industry should establish a centralized system for reporting and analyzing incidents related to the transportation and shipping of Li-ion batteries. This system would help to identify trends and patterns, allowing for targeted improvements in safety measures and best practices. Additionally, close collaboration between battery manufacturers and shipping companies can help to ensure that Li-ion batteries are designed and produced with transportation safety in mind.

8.3 Codes, Standards, and Regulations

While progress has been made in the three critical areas of CSR (fire and explosion safety, electrical safety, and worker/workplace safety), ESS applications are still relatively new and gaps still need to be addressed.

8.3.1 Electrical Safety

In the area of electrical codes and standards, the community would benefit from ESS-specific guidance for electrical worker health and safety, for example, on the topics of PPE and lockout tagout procedures. NFPA 70B and NFPA 70E are in the process of being updated to better reflect ESS-related concerns.

Development of an understanding of minimum requirements for grounding an ESS, both for the DC and AC components, would also be helpful. Recent incidents in ESS have involved arcing faults, some even triggered by the water released by emergency sprinkler systems. Understanding the principles of arc flash versus arc burns as they apply to both vdc and vac current flows would be very useful.

Lastly, full electrical testing of a system is normally completed only during factory development or commissioning. Standards for retesting a system over the course of its lifetime would lead to the identification of any changes that are caused by component aging and degradation. [18]

8.3.2 Fire Safety

UL9540A is currently the most common standard for large-scale fire testing of ESS. It should continue to evolve as more data is collected about incidents in fielded systems. Some areas worth addressing include better tests for module-level propagation (propagation is still occasionally observed in packs approved to the standard), the impact of aging on battery safety, and the ignition of vent gases to assess the fire resistance of the system.

[18] IEEE has an active project (P2962) on Li-ion installation, maintenance, and testing. It will include a recommendation for annual testing of systems like ESS that are regularly cycled. Likely publication is in 2024.

Recent incidents in fielded systems have driven interest in the establishment of clear minimum requirements to mitigate the risk of explosions in Li-ion-based BESS (see also 5.3.4 Fire versus explosion philosophy). Currently, developers refer to NFPA 69, a general standard for installing systems for the prevention and control of explosions that contain flammable concentrations of flammable gases, vapors, mists, dusts, or hybrid mixtures. However, there is some concern that this standard does not provide sufficient ESS-specific design context and leaves too much room for interpretation.

Lastly, research on the impact of toxic emissions on beings and the environment, described in the incident response section, should lead to the development of new codes and standards for emergency response. These standards should address topics like exclusion zones, acceptable concentrations of pollutants in the air and water, and spill containment if the fire approach is to let the container burn.

8.3.3 Reliability

Most codes and standards for energy storage systems focus on safe system design and emergency response. There is relatively little guidance on reliability concerns, including what data points should be monitored during operation to enhance insight into the system. Performance reporting has traditionally been mandated by the North American Electric Reliability Corporation (NERC) for the Generator Availability Data System (GADS) for fossil-based, NERC-registered entities. Draft requirements for solar generation systems include energy storage reporting requirements for photovoltaic hybrid systems. Standalone ESS would also benefit from data monitoring and reporting requirements.

While reliability of interconnected power sources is part of the requirements found in the IEEE 1547 family of standards, the industry would also benefit from formal standards for ESS reliability and performance testing. This involves the development of reference performance tests and duty cycles for specific use cases. Information from these standards would enable an apples-to-apples comparison of ESS and make it clear whether an ESS can truly reach a desired metric. PNNL and SNL developed protocols for uniformly measuring and expressing the performance of energy storage systems in the mid-2010s. More recently, the scope of IEC TC 120 has included the “preparation of normative documents dealing with the system aspects of ESS” including “defining unit parameters and testing methods.”

8.3.4 Land Use Permitting

Land use permitting for energy storage faces two significant challenges: 1) Uncertain jurisdictional lines between state energy siting agencies and local planners; 2) Local planners’ lack of familiarity with storage technologies and their potential impacts. For the first challenge, state and local jurisdictions need to come to an agreement on their areas of authority. Actions to address the second challenge include the development of educational materials for local planners that define ESS impacts through a local zoning lens and a best-practices guide in local zoning for storage. A good starting point is a review of past community engagement models, i.e., how have successful projects engaged and won the support of their local community?

9. Conclusion

Since the publication of the first Energy Storage Safety Strategic Plan in 2014, the field has seen the emergence of new technologies, use cases, emergency response procedures, and regulations. This document reviewed the current state of energy storage safety according to three pillars: 1) science-based safety validation, 2) incident preparedness and response, and 3) codes and standards. A key outcome of this review was the identification of gap areas and future research priorities for each of these pillars. These recommendations are intended to ensure that safety concerns do not serve as a barrier to deployment of grid energy storage to support an efficient, reliable, and resilient electric grid.

Appendix A. Relevant Sections for Different Stakeholders

The overall document is intended to provide a broad survey of key issues in energy storage safety in the United States. This appendix is intended to support various stakeholder groups in parsing this document by identifying which sections contain information that is most relevant to them.

A.1 Energy Storage Project Developers

The following sections in the report are most relevant for energy storage developers who are seeking to advance new projects:

- Section 4 “Safety considerations during energy storage deployment” describes general considerations for safely deploying energy storage in the US, including the development of safety codes and standards, the process for project execution, permitting and zoning requirements, and insurance.
- Section 5.3 “Engineering controls and system design” covers common practices and emerging guidance in the design of systems containing Li-ion cells.
- Section 7 “Evaluating emerging electrochemical technologies” highlights the importance and general process for assessing the risks of beyond lithium-ion technologies.

A.2 Codes & Standards Contributors

The following sections in the report are most relevant for individuals who provide input to new codes and standards:

- Section 8.3 “Summary of gaps: codes, standards, and regulations” describes gaps in existing standards identified by a broad cross-section of stakeholders during the 2023 Energy Storage Systems Safety and Reliability Forum. This section touches on gaps in electrical safety, fire safety, system reliability, and land use permitting.

A.3 State and Local Regulatory and Policy Community

The following sections in the report are most relevant for individuals who contribute to the development of regulations and policies at the state and local level:

- Section 4 “Safety considerations during energy storage deployment” describes general considerations for safely deploying energy storage in the US, including the development of safety codes and standards, the process for project execution, permitting and zoning requirements, and insurance.
- Section 8.3.4 “Summary of gaps: land use permitting” describes gaps in existing approaches to land use permitting identified by a broad cross-section of stakeholders during the 2023 Energy Storage Systems Safety and Reliability Forum.

A.4 First Responders

The following sections in the report are most relevant for individuals who are the first line of response whenever there are incidents involving fielded energy storage systems:

- Section 6 “Incident response for Li-ion batteries” covers lessons learned from recent incidents and how notable incidents have led to significant policy changes in the energy storage community.
- Section 8.2 “Summary of gaps: incident response and training” describes gaps in incident response identified by a broad cross-section of stakeholders during the 2023 Energy Storage Systems Safety and Reliability Forum. The gap areas identified for incident response generally fall into three categories: increasing knowledge about ESS safety prior to an incident, increasing situational awareness during an incident, and managing the aftermath of an incident.

Appendix B. Sample Incident Response Guidance

This sample Standard Operating Procedure has been designed to provide an example for agencies to adopt and modify as necessary, as it pertains to responding to incidents involving batteries. The steps in this document represent best practices from field incidents as of the date of this publication.

This document had been developed with a risk-based approach in mind, considering indoor as the highest risk, and then outdoor incidents. Accordingly, separate response procedures are outlined for indoor and outdoor incidents. This approach is not based on type of battery/device (stationary ESS, electric vehicle, micromobility device, etc), rather the overall risk profile of the incident.

Purpose

To establish operational guidelines for effective response, mitigation, and safe operational procedures for battery failures in all formats; personal mobility, electric vehicles (EVs), and stationary storage systems.

Scope

This policy shall apply to all sworn XX Department personnel.

Authority

The fire chief authorizes the information within this policy.

Definitions

Battery Energy Storage System (BESS): Battery Energy Storage Systems, or BESS, are rechargeable batteries that can store energy from different sources and discharge it when needed. BESS consist of one or more batteries.

Personal Mobility Device: Potable electric mobility devices such as e-bikes, e-scooters, and e-unicycles.

Thermal Runaway: Lithium-ion (Li-ion) battery thermal runaway occurs when a cell, or area within the cell, achieves elevated temperatures due to thermal damage, mechanical damage, internal/external short circuiting, or electrochemical abuse. This elevated temperature releases energy which in turn further increases temperature. It is a phenomenon known as a positive feedback loop in which the lithium-ion cell enters an uncontrollable, self-heating state.

Propagation: The spreading of *fire* between *Lithium*-ion battery cells initiated by a thermal runaway.

Policy

A. PPE
    1. Wear self-contained breathing apparatus (SCBA).
    2. Wear structural firefighting gear.

B. Determine if device is located indoors or outdoors.
    1. Devices or systems located indoors may represent a life safety priority and do represent exposure risks to the structure.
    2. Outdoor installations may support a defensive operation where no life safety rescue exist.

C. Signs of possible Battery Failure

1. Visible gas, popping sounds, or suspicious odor emanating from an electrified device can be an indication of an abnormal and hazardous condition.
2. Battery thermal runaway fires are frequently preceded by visible gas vapors.
3. Do not rely on thermal imaging cameras as the sole source of identifying battery failure.
4. The absence of flaming or gases/smoke does not indicate there is no event. Flaming and off-gassing may be intermittent over minutes, hours, or days.

D. Outdoor Incidents.
1. <u>Stage engines upwind of event.</u>
2. Complete area size-up and establish hazmat exclusion zone and water supply.
3. Evacuate the area of all non-emergency personnel and consider evacuation/shelter-in-place for the public.
4. If fire, gas vapors, popping sounds, or suspicious odor is observed emanating from the product at any time, perform the following:
5. If possible, shut off the unit/system. Note: It is not possible to discharge all energy from battery cells. The goal is to isolate the battery from charging/discharging.
6. For stationary BESS incidents determine if any provided exhaust systems are operating.
7. Do not approach the unit and attempt to open any doors. BESS have a variety of safety mechanisms. Some are designed to maintain the doors shut, and some have automatic doors designed to aid in ventilation.
8. For stationary BESS incidents, if not already done, contact the site emergency contact and/or manufacturer.
9. For electric vehicles, identify make, model, and year, and locate Emergency Vehicle Field Guide.
10. There may be periods of during which the thermal runaway propagates from battery modules to battery modules. During such time, the battery may not generate visible signs of thermal event although the event can still be active, and the battery can flare up.
11. If a fire has not developed: be aware of explosion risks and remain up wind of gas cloud.
12. If a fire develops:
    i. Allow the affected unit to consume itself as it is designed to do. Applying water to the burning unit will only slow its eventual combustion.
    ii. If exposure protection is required, use wide-fog stream, at lowest volume possible, to achieve desired cooling of exposures including neighboring battery enclosures. Be cautious of potential for water ingress to result in additional battery damage.
13. Allow the battery pack to cool down (this process may take multiple days) prior to opening of any doors.

E. Indoor Incidents.
1. Identify the presence of any visible gas cloud and recognize the potential for explosion risk. Ventilation is key.
2. Rescue if required.

F. Overhaul

1. Perform search for stray battery cells that could re-ignite during overhaul operations.
2. When packing damaged batteries in noncombustible containers for hazardous material transport ensure damaged batteries are overpacked with an appropriate material.
3. Implement solutions for storage of EVs and personal mobility devices that will allow the battery to be placed in a safe state prior to transport and disposal. Potential options include:
    i. Appropriately sized open top trailer/tank for submersion of EV or mobility device in water.
    ii. Appropriately sized open top trailer/tank for covering EV or mobility device in sand. Procure necessary equipment such as front-end loaders and fork lifts to move equipment and sand. Procure sand in advance or have a vendor ready.
4. Pre-plan for transport of affected battery off-site for disposal. This could include coordinating with transportation vendors with requisite capabilities or procuring appropriate equipment for site use.

FACT SHEET

ENERGY STORAGE SYSTEMS SAFETY FACT SHEET

Growing concerns about the use of fossil fuels and greater demand for a cleaner, more efficient, and more resilient energy grid has led to the use of energy storage systems (ESS), and that use has increased substantially over the past decade. Renewable sources of energy such as solar and wind power are intermittent, so storage becomes a key factor in supplying reliable energy. ESS also help meet energy demands during peak times and can supply backup power during natural disasters and other emergencies. However, the rise in the number of ESS installations requires the need for a heightened understanding of the hazards involved and more extensive measures to reduce the risks.

What Is an ESS?

An ESS is a device or group of devices assembled together, capable of storing energy in order to supply electrical energy at a later time. Battery ESS are the most common type of new installation and are the focus of this fact sheet.

DID YOU KNOW?

Battery storage capacity in the United States is expected to more than double between 2022 and 2025 from 9.4 GW to 20.8 GW, according to the U.S. Energy Information Administration.

Some ESS Advantages

Supplement Renewables

Renewable energies such as solar panels or wind turbines only produce electricity when the sun is out or the wind is blowing. Supplementing these with ESS allows users to take advantage of the electricity that is generated when the renewable energy technologies are not producing electricity.

Peak Shaving

ESS allows a user to shift where their electricity comes from by drawing power from the batteries during the higher-cost daytime hours then recharging during the lower-cost nighttime hours. This practice is referred to as peak shaving.

Load Leveling

When power generation facilities ramp up and ramp down to keep up with the changing demand for electricity, it puts stress on the system. ESS can help flatten out the demand curve by charging when electrical demand is low and discharging when it is high.

Uninterruptible Power Supply

ESS can provide near instantaneous protection from power interruptions and are often used in hospitals, data centers, and homes.

Some ESS Hazards

Thermal Runaway

Thermal runaway is a term used for the rapid uncontrolled release of heat energy from a battery cell; it is a condition when a battery creates more heat than it can effectively dissipate. Thermal runaway in a single cell can result in a chain reaction that heats up neighboring cells. As this process continues, it can result in a battery fire or explosion. This can often be the ignition source for larger battery fires.

Stranded Energy

As with most electrical equipment there is a shock hazard present, but what is unique about ESS is that often, even after being involved in a fire, there is still energy within the ESS. This is difficult to discharge since the terminals are often damaged and presents a hazard to those performing overhaul after a fire. Stranded energy can also cause reignition of the fire hours, days, or even weeks later.

Toxic and Flammable Gases Generated

Most batteries create toxic and flammable gases when they undergo thermal runaway. If the gases do not ignite before the lower explosive limit is reached, it can lead to the creation of an explosive atmosphere inside of the ESS room or container.

Deep Seated Fires

ESS are usually comprised of batteries that are housed in a protective metal or plastic casing within larger cabinets. These layers of protection help prevent damage to the system but can also block water from accessing the seat of the fire. This means that it takes large amounts of water to effectively dissipate the heat generated from ESS fires since cooling the hottest part of the fire is often difficult.

ENERGY STORAGE SYSTEMS SAFETY FACT SHEET *CONTINUED*

Failure Modes

These are ways the batteries can fail, often leading to thermal runaway and subsequent fires or explosions.

Mechanical Abuse	Thermal Abuse	Electrical Abuse	Environmental Impacts
Can happen when a battery is physically compromised by either being dropped, crushed, or penetrated.	Can occur when a battery is exposed to external heat sources.	Can happen when the battery is overcharged, charged too rapidly or at high voltage, or discharged too rapidly.	Can lead to battery failure include seismic activity, rodent damage to wiring, extreme heat, and floods.

Tips to Help Keep People and Property Safe

For the Designer/Installer

Explosion Protection/Prevention
If there are enough batteries in a room to create an explosive atmosphere, then explosion prevention systems or deflagration venting should be installed per NFPA 68, *Standard on Explosion Protection by Deflagration Venting*, and NFPA 69, *Standard on Explosion Prevention Systems*.

Fire Suppression System
Testing has shown water to be the most effective medium for cooling an ESS fire. A sprinkler system that complies with NFPA 13, *Standard for the Installation of Sprinkler Systems,* should be installed in buildings where an ESS is installed.

Battery Management System (BMS)
A BMS is a critical system that should be used in an ESS to monitor, control, and optimize performance of an individual or multiple battery modules in an ESS. It can also control the disconnection of the module(s) from the system in the event of abnormal conditions.

Spacing
ESS units should be grouped into small segments limited to certain kilo-watt hours (kWh) and spaced from other segments and walls to prevent horizontal propagation. The table below, which summarizes information from a 2019 Fire Protection Research Foundation (FPRF) report, "Sprinkler Protection Guidance for Lithium-Ion Based Energy Storage Systems," demonstrates the recommended spacing for the testing for specific chemistries and arrangements.

Recommended Separation of Lithium-Ion Battery Energy Storage Systems

ESS Type & Capacity	Object Combustibility	Sprinklered ft (m)	Nonsprinklered ft (m)
LFP 31 kWh	Non Combustible	-	< 3 ft (< 0.9 m)
	Combustible	-	4 ft (1.2 m)
LFP 83kWh	Non Combustible	3 ft (0.9 m)	4 ft (1.2 m)
	Combustible	5 ft (1.5 m)	6 ft (1.8 m)
LNO/LMO 47 kWh	Non Combustible	-	4 ft (1.2 m)
	Combustible	-	6 ft (1.8 m)
LNO/LMO 125 kWh	Non Combustible	6 ft (1.8 m)	8 ft (2.4 m)
	Combustible	9 ft (2.7 m)	13 ft (4.0 m)

ENERGY STORAGE SYSTEMS SAFETY FACT SHEET *CONTINUED*

For the AHJ

Permitting Checklist

Permits should be issued by and in accordance with the procedures of all authorities having jurisdiction (AHJ) and should bear the name and signature of each AHJ or their designated representative(s). In addition, the permit should indicate the following:

1. Purpose of the ESS for which the permit is issued
2. Type of ESS, size, weight broken down by subcomponents or subsystems, type, and amount of any hazardous materials, general arrangement of the system, and extent of work to be performed
3. Address where the ESS is to be installed and operated
4. Name and address of the permittee
5. Permit number and date of issuance
6. Period of validity of the permit
7. Inspection requirements

For the Fire Service

Pre-Incident Planning

The fire department should develop a pre-incident plan for responding to fires, explosions, and other emergency conditions associated with the ESS installation, and the pre-incident plan should include the following elements:

1. Understanding the procedures included in the facility operation and emergency response plan described
2. Identifying the types of ESS technologies present, the potential hazards associated with the systems, and methods for responding to fires and incidents associated with the particular ESS
3. Identifying the location of all electrical disconnects in the building and understanding that electrical energy stored in ESS equipment cannot always be removed or isolated
4. Understanding the procedures for shutting down and de-energizing or isolating equipment to reduce the risk of fire, electric shock, and personal injury hazards
5. Understanding the procedures for dealing with damaged ESS equipment in a post-fire incident, including the following:
   a. Recognizing that stranded electrical energy in fire-damaged storage batteries and other ESS has the potential for reignition long after initial extinguishment
   b. Contacting personnel qualified to safely remove damaged ESS equipment from the facility (This contact information is included in the facility operation and emergency response plan.)

Emergency Operations Planning

An emergency operations plan should be created and contain elements such as procedures to safely shut down the system, procedures for the removal of damaged ESS, general emergency procedures, and annual staff training.

CASE STUDY

On April 19, 2019, a thermal runaway event followed by an explosion occurred at the McMicken Battery Energy Storage System in Surprise, Arizona. A fire captain, a fire engineer, and two firefighters sustained serious injuries. The walk-in structure housed a 2.16 MWh lithium-ion battery energy storage system. This event highlighted the hazard of a non-flaming thermal runaway event and the need for deflagration prevention and protection.

FAQs

Q: Which NFPA standard covers the installation of ESS?

A: If you are installing ESS for either new construction or a renovation, you should review the requirements of NFPA 855, *Standard for the Installation of Energy Storage Systems.*

Q: What is the best extinguishing agent for a fire in a battery ESS?

A: Testing has shown that water is the most effective agent for cooling for a battery ESS. For this reason, a sprinkler system designed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems,* is required by NFPA 855, *Standard for the Installation of Energy Storage Systems.*

Learn More

- Visit nfpa.org/ess to access more FAQs and the latest ESS-related training, information, research, and reports.
- To view NFPA 855, visit nfpa.org/855, or to access the standard plus expert commentary, visit nfpa.org/LiNK.

CITY OF SUMNER WASHINGTON

STUDY SESSION
DATE: January 13, 2025
AGENDA BILL: 25-1

SUBJECT: Ordinance No. 2916 - Amending Sumner Municipal Code 12.38 (Park Impact Fees)

CATEGORY: Ordinance

BUDGET IMPACT:

Expenditure Required: None

Within Budget Allocation: N/A

ATTACHMENTS:

1. Presentation - Park Impact Fees
2. Park Impact Fee Rate Study - 2025 Update
3. Ordinance No 2916 - Amending Sumner Municipal Code 12.38 (Park Impact Fees)

STAFF CONTACT: Ryan Windish, Community & Economic Development Director

SUMMARY BACKGROUND:

The City Council adopted the *2024-2030 Parks & Trails Plan* update in May 2024 and an updated *Capital Facilities Plan* on January 6th. These new plans set the groundwork for updating the Parks Impact Fee. The state Growth Management Act (GMA) allows impact fees to be charged by a local government on new development to recover a portion of the cost of capital facility improvements needed to serve that new development (i.e., to allow growth to pay for growth). This allows for a transparent and balanced funding system where capital facilities funding responsibilities are shared among all beneficiaries (residents, businesses, and developers).

City staff, working with a consultant, has completed a *Parks Impact Fee Rate Study* which sets forth assumptions and methodology for calculating new impact fees based on state law, parks valuation, and other factors. This has resulted in an updated parks impact fee that is based on number of bedrooms in a residential housing unit for residential development. The fee for commercial/industrial growth is based on building area.

Staff and the consultants will be presenting the information attached in the slide-deck and *Parks Impact Fee Rate Study* and seeking City Council comments and questions.

This item (Ordinance No. 2916) will come before the City Council for action on January 21, 2025.

COUNCIL COMMITTEE/STUDY SESSION:
MEETING/STUDY SESSION DATE: 1/13/2025
COMMITTEE RECOMMENDATION:

STAFF RECOMMENDATIONS/MOTION:

Discuss the proposal and ask questions.

Park Impact Fees Update

City Council Study Session - 1/13/25

Overview

The City needs to update its Park Impact Fees because:

- Trails are now part of the Transportation Impact Fee, so must be removed from the Park Impact Fee
- Recent state and case law have changed requirements
- We have an updated park level of service (in the new Capital Facilities Plan) based on the current rate of parks investment

The consultant team and staff have prepared an updated rate study for park impact fees.

Background

What are park impact fees?

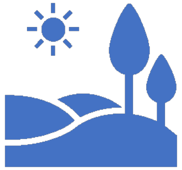
- Fees paid by property developers of residential, commercial, and industrial property to offset the impact of new development on the park system.

What is the history of park impact fees in Sumner?

- The City established a park impact fee in 2018 to support implementation of the City's 2018 Parks and Trails Plan.
- The update to park impact fees aligns with the adoption of the 2024-2030 Parks, Trails and Open Space Plan.

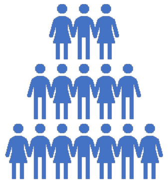
Methodology

- Fees are currently set based on a **per capita investment**.
- Demand for parks and open space is driven by **both residents and workers**.
  - We quantify demand based on relative access to park facilities, or how many hours per week the system is available to each group.
- We incorporate population, employment, and land use projections.
- We adjust the fee based on capital investments funded by other sources.



Value of current park system

/



Number of beneficiaries (residents + workers)

→ Minimum investment per capita → Updated park impact fees

Updates to the Methodology

- There are some proposed changes to the current methodology, in part due to recent changes to case law and state law:
  - **Residential fees are charged based on the number of bedrooms** (more bedrooms = higher fee).
    - There is a new state requirement to have a proportionally lower impact fee for smaller housing units.
  - **Commercial and industrial charges are lower** (residents are more likely to use parks than workers).
  - Accessory dwelling unit fees = **half of single-family home fees based on the number of bedrooms.**
- The new fee calculation also does not include the value of trails, which provide access to employees for recreation and commuting.

Current Fee Structure

- The City has a per unit housing fee for single family and multifamily residential property and a per square foot fee for commercial/ industrial property
- Accessory Dwelling Units (ADUs) are charged 50% of the multifamily fee

Category	2024 Adopted Fee
Residential Single Family	$3,527.43
Residential Multifamily	$3,026.87
Commercial (per 1,000 square feet)	$1,770.07
Industrial (per 1,000 square feet)	$829.27
Accessory Dwelling Unit	$1,513.44

Recommended Fees

- The recommended fee structure includes different fees based on number of bedrooms for residential property.
  - 2025 fees adjust the 2024 calculated fees by inflation.

Category	2024 Adopted Fee	2024 Calculated Fee	2025 Calculated Fee
Residential – no bedroom	--	$1,946.52	$2,021.54
Residential – 1 bedroom	--	$3,244.19	$3,369.24
Residential – 2 or 3 bedrooms	--	$4,055.24	$4,211.55
Residential – 4+ bedrooms	--	$6,488.39	$6,738.48
Residential Single Family	$3,527.43	--	--
Residential Multifamily	$3,026.87	--	--
Commercial (per 1,000 square feet)	$1,770.07	$202.27	$210.07
Industrial (per 1,000 square feet)	$829.27	$112.37	$116.70
Accessory Dwelling Unit	$1,513.44	50% of fee for the number of bedrooms	50% of fee for the number of bedrooms

Estimated Revenue from Fees

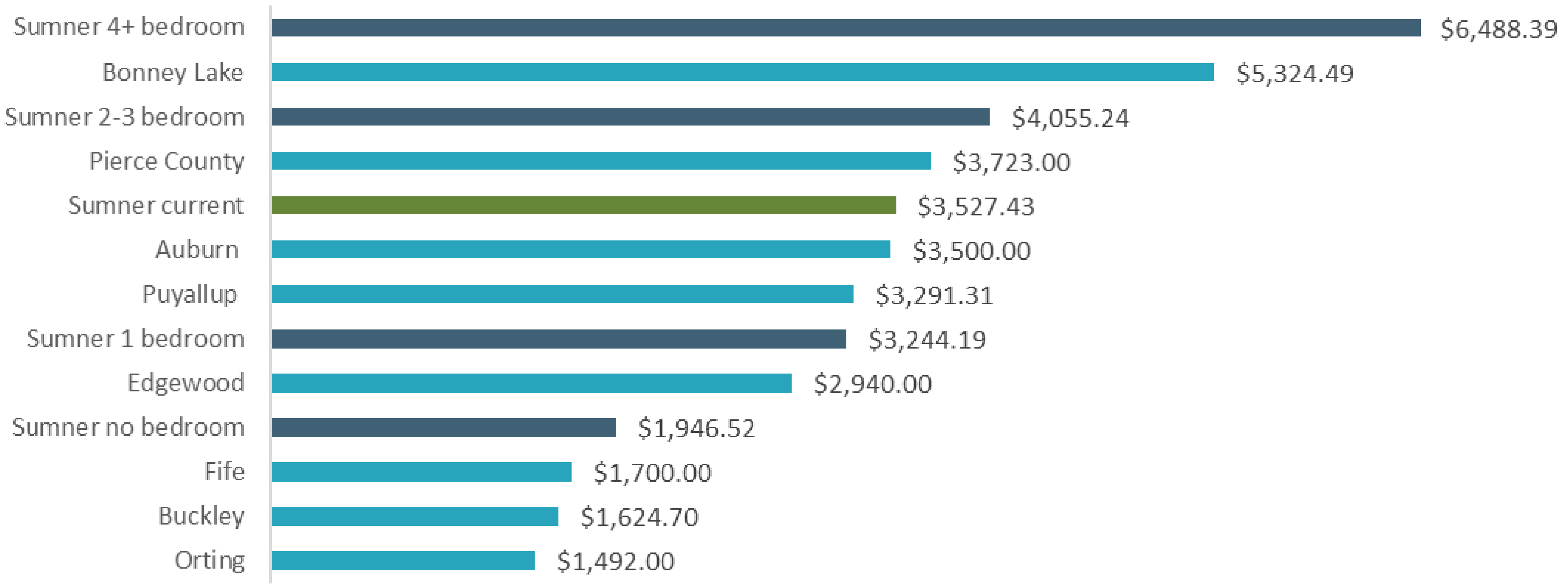
- The estimated revenue that could be collected from park impact fees between 2025 and 2044 is **$7.2-$9.6 million**.
- This estimated range is based on the projected growth in housing units and commercial/industrial square feet, the calculated fees, and estimated inflationary increases to the fees over a 20-year period.
- Actual revenue depends on the amount of growth and when that growth would occur.

Eligible Projects

- Impact fees may be applied to park system improvements that add capacity to serve growth.
- The 2024 Parks and Trails Plan and 2025 Capital Facilities Plan identified **$22.5 million in project costs that are considered "capacity-adding"** or potentially eligible for use of impact fees.
- The City could use other funding sources to offset the gap between estimated revenues and project costs.

Fee Comparisons

- **Single family residential** park impact fees for Sumner and neighboring cities are shown below.
- The proposed **4+ bedroom fee for Sumner is the highest of this group and the proposed 2-3 bedroom fee is near the top of the range**.



Fees represent 2024 calculated fees for Sumner and current fees for other jurisdictions.

Discussion

2024 Sumner Park Impact Fee Rate Study

December 31, 2024

Introduction

GMA impact fees are those fees charged by a local government on new development to recover a portion of the cost of capital facility improvements needed to serve that new development (i.e., to allow growth to pay for growth). This allows for a transparent and balanced funding system for where capital facilities funding responsibilities are shared among all beneficiaries (residents, businesses, and developers). Specifically, the Washington State Legislature outlined the intent of local impact fees in *RCW 82.02.050 Impact fees—Intent—Limitations*:

> *(1) It is the intent of the legislature:*
>
> *(a) To ensure that adequate facilities are available to serve new growth and development;*
>
> *(b) To promote orderly growth and development by establishing standards by which counties, cities, and towns may require, by ordinance, that new growth and development pay a proportionate share of the cost of new facilities needed to serve new growth and development; and*
>
> *(c) To ensure that impact fees are imposed through established procedures and criteria so that specific developments do not pay arbitrary fees or duplicative fees for the same impact.*
>
> *(2) Counties, cities, and towns … are authorized to impose impact fees on development activity as part of the financing for public facilities, provided that the financing for system improvements to serve new development must provide for a balance between impact fees and other sources of public funds and cannot rely solely on impact fees.*

The City of Sumner established a park impact fee in 2018 to support implementation of the City's 2018 Parks and Trails Plan. The City adopted a Parks, Trails and Open Space Plan Update in 2024. The City engaged BERK Consulting to conduct an updated park impact fee analysis, building on the analysis completed in 2018.

Impact Fee Requirements

State law regarding impact fees, as codified in RCW 82.02.050 requires that the impact fees support system improvements related to new development and reasonably benefit the new development. The impact fee should not exceed a proportionate share of the costs of the system improvements needed to support growth.

> *RCW 82.02.050 (4) The impact fees:*
>
> *(a) Shall only be imposed for system improvements that are reasonably related to the new development;*
>
> *(b) Shall not exceed a proportionate share of the costs of system improvements that are reasonably related to the new development; and*
>
> *(c) Shall be used for system improvements that will reasonably benefit the new development.*

The means by which the fee and the proportionate share are calculated is guided by RCW 82.02.060. The jurisdiction's enabling ordinance is to include a schedule of impact fees for each type of development activity that is subject to impact fees. The schedule must be based on a formula or method. (RCW 82.02.060(1)) To determine the proportionate share, the formula is to consider the following:

> *RCW 82.02.060 (1) …In determining proportionate share, the formula or other method of calculating impact fees shall incorporate, among other things, the following:*
>
> *(a) The cost of public facilities necessitated by new development;*
>
> *(b) An adjustment to the cost of the public facilities for past or future payments made or reasonably anticipated to be made by new development to pay for particular system improvements in the form of user fees, debt service payments, taxes, or other payments earmarked for or proratable to the particular system improvement;*
>
> *(c) The availability of other means of funding public facility improvements;*
>
> *(d) The cost of existing public facilities improvements; and*
>
> *(e) The methods by which public facilities improvements were financed;*

According to the provisions of RCW 82.02.060(1), impact fees must be adjusted for other revenue sources that are paid by development, if such payments are earmarked or pro-ratable to particular system improvements.[1] Additionally, impact fees need to account for and be balanced with other sources of public funding. Improving facilities to accommodate a growing population should not solely be funded

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[1] Other provisions of RCW 82.02.050 and 060 include: The City must provide impact fee credit if the developer dedicates land or improvements identified in the City's adopted Capital Facilities Plan and such construction is required as a condition of development approval (RCW 82.02.060 (4). Collected impact fees may only be spent on public facilities identified in a capital facilities plan or to reimburse the government for the unused capacity of existing facilities (RCW 82.02.050(4)). In addition, impact fees may only be spent on capital costs for system improvements.

through impact fees (see balance provision in RCW 82.02.050(2)).

In 2023, the State Legislature amended RCW 82.02.060(1) to require that:

> *The schedule shall reflect the proportionate impact of new housing units, including multifamily and condominium units, based on the square footage, number of bedrooms, or trips generated, in the housing unit in order to produce a proportionally lower impact fee for smaller housing units.*

This memo proposes a per capita investment approach to the fee and level of service, which is the same methodology as the City's established park impact fee program. The method is adapted to the new requirement in RCW 82.02.060(1) to have a proportionally lower impact fee for smaller housing units.

Methodology and Assumptions

Current Population, Employment, and Land use; and Projected Growth

The City of Sumner is responsible for planning to accommodate expected growth. This planning effort includes increasing the capacity of existing City facilities and services, like parks and open space to support a larger population of residents and businesses (including employees). To support this planning, and as obligated by the GMA, the City of Sumner is in the process of adopting a Comprehensive Plan for a 20-year planning horizon, 2024 to 2044. This comprehensive plan establishes base and 20-year population, employment, and housing projections. Current population, employment, and housing estimates were drawn from the Washington State Office of Financial Management's postcensal estimates.

Recognizing that the demand for City of Sumner parks and open space is driven by both residents (population) and people employed in the City (employment), a conversion factor is used to generate a modified per capita projection that quantifies this demand based on relative access to park facilities and creates a "resident equivalency". The "resident equivalency" is a ratio for the demand generated by employees relative to the demand created by population.

To determine the resident equivalency, we first look at population and employment in Sumner. In 2021, 10,700 people lived in Sumner and 19,811 people worked in Sumner; of these, 508 people both lived and worked in Sumner (Exhibit 1).

Exhibit 1: Population and Employment in Sumner, 2021

Category	Living inside Sumner	Living outside Sumner	Total
Working inside Sumner	508	19,303	19,811
Working outside Sumner	4,255		
Not working	5,937		
Total	**10,700**		

Sources: Census Bureau, OnTheMap, 2021; BERK, 2024.

We can estimate the demand by residents and employees based on the hours per week the system is available to each group. For Sumner residents who work inside and outside Sumner, the park system is available to them 58 hours a week. This is determined by the hours the park system is open daily (14), less the hours worked daily (8 hours, five days a week). Those who live in Sumner and do not work can access the system during all open hours. For employees in Sumner, it is assumed they can also use the park system for one hour daily, for a total of five hours a week.

Exhibit 2: Demand Estimates for Residents and Employees

	Living Inside Sumner	Living Outside Sumner
Hours per week of residential demand		
Working inside Sumner	58	
Working outside Sumner	58	
Not working	98	
Hours per week of employment demand		
Working inside Sumner	5	5

Sources: BERK, 2024.

Using the number of residents and number of employees in Exhibit 1 and the demand estimates in Exhibit 2, we can estimate the total hours of demand for residents and employees, shown in Exhibit 3. The demand hours for an employee is approximately 6.2% of the demand hours for a resident. The 6.2% figure is used as the resident equivalent factor in this analysis.

Exhibit 3: Total Hours per Week of Park Demand

	Residential hours	Non-residential hours	Total hours
Working inside Sumner (number of people * hours of demand)	29,464	99,055	128,519
Working outside Sumner (number of people * hours of demand)	246,790		246,790
Not working (number of people * hours of demand)	581,826		581,826
Total	**858,080**	**99,055**	**957,135**
Hours per resident (total hours / number of residents)	80		
Hours per employee (total hours / number of employees)		5	
Employee Hours per Resident Hours (5/80)			**6.2%**

Sources: Census Bureau, OnTheMap, 2021; BERK, 2024.

Future projections for Sumner residents, employees, and modified per capita population based on resident equivalency, are shown in Exhibit 4. The City of Sumner expects a net service population growth of 4,585 between 2024 and 2044, which includes 4,479 residents and 106 resident-equivalent employees, based on the "modified per capita" assumptions.

Exhibit 4. Historical and Projected Population Equivalent Estimates, 2024 to 2044

Estimated Population Equivalent	2024 City	2024 City and UGA	2044 City	2044 City and UGA	Net Change City	Net Change City and UGA
Employees (Excluding Construction)	17,690	17,775	19,396	19,549	1,706	1,774
Employee Resident Equivalent at 6.2%	1,103	1,108	1,209	1,219	106	111
Permanent Resident	11,040	13,067	15,519	22,172	4,479	9,105
Total "Modified per Capita" Service Population	**12,143**	**14,175**	**16,728**	**23,391**	**4,585**	**9,216**

Note: UGA stands for Urban Growth Area.

Sources: City of Sumner, 2024; BERK, 2024.

The City of Sumner expects a net increase of 1,772 housing units between 2024 and 2044 (see Exhibit 5).

Exhibit 5. Historical and Projected Housing Units, 2024 to 2044

Estimated Population Equivalent	2024 City	2024 City and UGA	2044 City	2044 City and UGA	Net Change City	Net Change City and UGA
Housing Units	4,705	5,335	6,477	7,591	1,772	2,256

Note: UGA stands for Urban Growth Area.

Sources: City of Sumner, 2024; BERK, 2024.

To develop a proportionally lower impact fee for smaller housing units, we are using the number of bedrooms in a housing unit. The City has information on single family and multifamily development between 2019 and 2024. The total units developed with number of bedrooms is shown in Exhibit 6. Using the same distribution, the estimated new housing units with number of bedrooms is shown in Exhibit 6. Recent development data is used to estimate the size distribution of new housing units to reflect trends toward multifamily housing or smaller units.

Exhibit 6: New Development Housing Unit Size and Anticipated Housing Growth, 2024 to 2044

Number of Bedrooms	Total Units 2019-2024	Percent of Total	Estimated New Housing Units
No bedroom	34	5.7%	101
1 bedroom	205	34.5%	612
2 or 3 bedrooms	316	53.2%	943
4 or more bedrooms	39	6.6%	116
Total	**594**		**1,772**

Sources: American Community Survey, 2022; BERK, 2024.

The employment estimates can also be used with land use projections for commercial and industrial development to estimate the addition commercial and industrial square footage in the planning horizon, which is necessary for distributing the system value to new residential development. The estimated increase in commercial and industrial jobs and estimated square feet are shown in Exhibit 7. The impact fee is assessed per 1,000 square feet of commercial or industrial property, so the values shown in Exhibit 7 are used later in this analysis.

Exhibit 7: Estimated Commercial and Industrial Development and Resident-equivalents per 1,000 Square Feet, 2044

	Commercial	Industrial
Estimated increase in total jobs 2024 to 2044	1,706	
Share of 2024 jobs	27%	49%
Estimated increase in jobs using 2024 share by sector	465	844
Square Feet per Employee	500	900
Estimated Square Feet Based on Increase in Jobs	232,500	759,600
Estimated Square Feet/1,000	**233**	**760**
Average Employees per 1,000 Square Feet	2.0	1.1
Employee to resident conversion factor	6.2%	6.2%
Estimated resident equivalents per 1,000 square feet	**0.12**	**0.07**

Sources: City of Sumner, 2024; Pierce County Buildable Lands Report, 2021; BERK, 2024.

These population, employment, and land use projections, and the imputed "modified per capita" projection (based on the resident equivalency assumptions) support the analysis presented in the rest of this memo.

Financial Analysis

Financial data is presented as both year of expenditure dollars (YOE$) and inflation-adjusted 2025 dollars (2025$), to support calculation of proportionate share of tax contributions anticipated to also support new growth.

- YOE$, or nominal dollars, present non-inflation adjusted dollars for the actual year – this is essential for actuals, so that figures match the historical record.
- Inflation-adjusted dollars (in this case, 2025$) match the year when the fee change would be effective.

For the purposes of this analysis, we have used the Consumer Price Index – Urban Consumers for the Seattle-Tacoma-Bellevue Metropolitan Area (CPI-U) as our inflation rate assumption. Budget assumptions within this report are based on seven years (2018 to 2024) of financial data provided by the City of Sumner and the City's current financial policies.

Modified Per Capita Investment Approach

Establishing an investment by modified per capita is a method used to establish the total value of the parks and open space system per beneficiary (in this case, residents and employees). Essentially, the total value (generated based on expected replacement value) of a parks system is divided by the total beneficiaries to generate a value of the system per beneficiary. The current investment by modified per capita is then applied to the future beneficiaries (expected growth) to establish an initial (undiscounted) contribution or fee rate.[2]

As a formula, this method is expressed as:

$$\textbf{Investment by beneficiary (modified per capita)} = \frac{\textbf{Assessed value of park land + facilities (Total System Value)}}{\textbf{Number of beneficiaries (modified per capita)}}$$

The value of the City of Sumner's parks and open space system is shown in Attachment A. The total land value is $10.44 million (2024$) and relies primarily on Pierce County Assessor's valuations.[3] The replacement value of improvements is estimated at $9.62 million (2024$). This is based on a mix of data from the Pierce County Assessor's valuations, insurance valuations, and replacement value, as estimated by using a database of cost estimates developed by HBB Landscape Architecture (HBB) and existing park master plans for City parks. The total combined 2024 system value is $20.1 million. A full accounting of the total system valuation is provided in *Appendix A: System Value Estimate*.

In this analysis, the value of trails is not included, which is a change in methodology from the 2018 analysis. The value of trails is included in the calculation of the City's Transportation Impact Fee, effective January 2025.

Based on the 2024 "modified per capita" service population estimates, the share of this value is $1,652.31 per beneficiary, or resident equivalent. The per resident value is the same and the per employee value is $103.02 in line with the resident equivalent percentages in Exhibit 4.

[2] RCW 82.02.050(4) requires cities to determine whether or not there are any existing deficiencies; a city may not charge impact fees to correct existing deficiencies. Because the per capita investment method is based on current assets and the current population there are no existing deficiencies. Similarly, because the per capita approach is based on the existing system as it serves the existing population, there is no reserve capacity (excess capacity designed to serve growth).

[3] For other studies, a market factor is applied to escalate land values to recognize potential differences between the market value and Assessor's value (which is generally lower). It would slightly increase the system value and the resulting per capita value. It is a method that can be applied in revisions to this memo as appropriate.

Exhibit 8: System Value per Beneficiary, Resident, Employee, 2024$

Metric	Beneficiary	Resident	Employee
Total System Value		$20,063,958	
Number of Beneficiaries		12,143	
Resident Equivalent Percent	100%	100%	6.2%
System Value Per	**$1,652.31**	**$1,652.31**	**$103.02**

Sources: City of Sumner, 2024; BERK, 2024.

If adjusted for inflation to 2025$, the year the fee adjustment would take effect, the results would be:

Exhibit 9: System Value per Beneficiary, Resident, Employee, 2025$

Metric	Beneficiary	Resident	Employee
Total System Value		$20,837,319	
Number of Beneficiaries		12,143	
Resident Equivalent Percent	100%	100%	6.2%
System Value Per	**$1,716.00**	**$1,716.00**	**$106.99**

Sources: City of Sumner, 2024; BERK, 2024.

Impact Fee Rate

Unadjusted

To generate an impact fee rate based on per resident and per employee values, we must convert those values to the expected land uses through which they will pay impact fees. For residents, this is residential development. For residential development, we are using the number of bedrooms and the expected growth shown in Exhibit 6. Expected growth for each category is based on local development trends over the past five years. This analysis assumes a number of beneficiaries for each housing unit size, shown below in Exhibit 10. For employees, this is per 1,000 square feet of commercial and industrial development.

The potential investment shown below and in subsequent exhibits is the revenue estimate based on the calculated fee and total number of new units or square feet. Actual revenue will depend on the pace of growth and if the City continues to adjust fees annually by an inflationary factor.

Exhibit 10: Unadjusted Impact Fee Rates (2024$)

Category	Number of Beneficiaries	Metric	System Value Per Metric	Expected Growth (2024-2044)	Potential Investment
Residential – no bedroom	1.2*	Housing unit	$1,982.78	101	$201,108
Residential – 1 bedroom	2	Housing unit	$3,304.63	612	$2,020,941
Residential – 2 or 3 bedrooms	2.5	Housing unit	$4,130.79	943	$3,894,009
Residential – 4+ bedrooms	4	Housing unit	$6,609.26	116	$768,944
Commercial		1,000 sq. ft.	$206.04	233	$47,935
Industrial		1,000 sq. ft.	$114.47	760	$86,942
Total					**$7,019,880**

*Note: *While most no-bedroom units are likely to be occupied by a single resident, some may be occupied by two residents. This method assumes that 1 in every 5 no-bedroom units could be occupied by two residents.*

Sources: City of Sumner, 2024; BERK, 2024.

We can then use inflation to adjust the fee for the expected implementation year, 2025.

Exhibit 11. Unadjusted Impact Fee Rates (2025$)

Category	Number of Beneficiaries	Metric	System Value Per Metric	Expected Growth (2024-2044)	Potential Investment
Residential – no bedroom	1.2	Housing unit	$2,059.20	101	$208,860
Residential – 1 bedroom	2	Housing unit	$3,432.00	612	$2,098,838
Residential – 2 or 3 bedrooms	2.5	Housing unit	$4,290.01	943	$4,044,103
Residential – 4+ bedrooms	4	Housing unit	$6,864.01	116	$798,582
Commercial		1,000 sq. ft.	$213.98	233	$49,783
Industrial		1,000 sq. ft.	$118.88	760	$90,294
Total					**$7,290,460**

Sources: American Community Survey, 2022; City of Sumner, 2024; BERK, 2024.

To maintain the current per capita share of investment, the City's total investment in its parks system would be $7.0 million in current dollars or $7.3 million if adjusted to 2025 dollars. The proportionate share to be contributed by new growth through adjusted park impact fees is estimated below.

Proportionate Share Adjustment

The City has historically used other revenues to pay for capital projects, including real estate excise taxes and grants. We assume that the City will continue to use other revenues to pay for capital projects. The impact fee should be adjusted so that impact fee revenues do not pay the full cost of capital improvements. Exhibit 12 provides parks capital expenditures for capacity projects and revenues collected in the Parks Capital Fund between 2018 and 2024. The capital investment funded by other sources is used to calculate an average per capita investment over this period.

Exhibit 12. Capital Expenditures and Revenues for Parks Capacity Projects, 2018 to 2024 (YOE$)

	2018	2019	2020	2021	2022	2023	2024	Total
Loyalty Park Improvements	--	--	--	$10,587	$123,088	$38,187	--	$171,862
Seibenthaler Park Improvements	--	--	--	$36,874	$2,745	--	--	$39,618
Bennett Park	--	--	--	$82,385	$85,295	$234,303	--	$401,983
Rainier View Covered Court	--	--	--	$1,265	$93,840	$590,373	$1,439,336	$2,124,815
Heritage Park	--	--	--	$158,272	$47,435	$186,428	$393,587	$785,722
Total Capital Costs	**--**	**--**	**--**	**$289,384**	**$352,402**	**$1,075,013**	**$1,866,543**	**$3,583,342**
Park Impact Fees	--	--	--	$203,123	$496,895	$3,058	$492,434	$1,195,509
Capital Costs Funded by Other Sources	**--**	**--**	**--**	**$86,261**	**--**	**$1,046,233**	**$1,340,490**	**$2,328,491**

Note: 2024 revenues and expenditures are through September 3, 2024.

Source: City of Sumner, 2024; BERK, 2024.

The average annual per capita investment funded from other sources over the 2018-2024 period is $29.52 per capita. Amounts from 2018 to 2023 are adjusted for inflation to 2024 dollars.

Exhibit 13: Historic Per Capita Capital Investment from Other Sources, 2018 to 2024 (2024$)

Year	Capital Investment Funded from Other Sources	Residential Equivalent	Per Capita Investment
2018	--	11,058	$0.00
2019	--	11,160	$0.00
2020	--	11,520	$0.00
2021	$103,312	11,765	$8.78
2022	--	11,762	$0.00
2023	$1,086,560	11,766	$92.35
2024	$1,340,490	12,143	$110.39
Average			**$30.22**

Note: 2024 revenues and expenditures are through September 3, 2024.

Sources: City of Sumner, 2024; BERK, 2024.

If this is applied per beneficiary and converted to residents and employees for purposes of the rate calculation, the results are shown in Exhibit 14.

Exhibit 14: Adjustment Calculation

Metric	Beneficiary	Resident	Employee
Average Capital Investment		$30.22	
Number of Beneficiaries		12,143	
Resident Equivalent Percent	100%	100%	6.2%
Capital Investment Per	**$30.22**	**$30.22**	**$1.88**

Sources: City of Sumner, 2024; BERK, 2024.

This value can then be used to generate a proportionate-share adjusted impact fee rate, as shown in Exhibit 15.

Exhibit 15: Proportionate Share Adjusted Impact Fee Rates (2024$)

Category	Metric	Proportionate Share	Adjusted Fee	Expected Growth (2024-2044)	Potential Impact Fee Investment
Residential – no bedroom	Housing unit	$36.26	$1,946.52	101	$197,430
Residential – 1 bedroom	Housing unit	$60.44	$3,244.19	612	$1,983,982
Residential – 2 or 3 bedrooms	Housing unit	$75.54	$4,055.24	943	$3,822,795
Residential – 4+ bedrooms	Housing unit	$120.87	$6,488.39	116	$754,881
Commercial	1,000 sq. ft.	$3.77	$202.27	233	$47,059
Industrial	1,000 sq. ft.	$2.09	$112.37	760	$85,352
Total					**$6,891,501**

Sources: American Community Survey, 2022; City of Sumner, 2024; BERK, 2024.

We can then use inflation to adjust the fee for the expected implementation year, 2025.

Exhibit 16: Proportionate Share Adjusted Impact Fee Rates (2025$)

Category	Metric	Proportionate Share	Adjusted Fee	Expected Growth (2024-2044)	Potential Impact Fee Investment
Residential – no bedroom	Housing unit	$37.66	$2,021.54	101	$250,040
Residential – 1 bedroom	Housing unit	$62.76	$3,369.24	612	$2,060,455
Residential – 2 or 3 bedrooms	Housing unit	$78.46	$4,211.55	943	$3,970,144
Residential – 4+ bedrooms	Housing unit	$125.53	$6,738.48	116	$783,978
Commercial	1,000 sq. ft.	$3.91	$210.07	233	$48,873
Industrial	1,000 sq. ft.	$2.17	$116.70	760	$88,642
Total					**$7,156,132**

Sources: American Community Survey, 2022; City of Sumner, 2024; BERK, 2024.

It should be noted that the proportionate share discount is conservative in that it assumes all of the revenue contribution from the service population would go to capacity projects to serve growth, while in reality a share would go towards capital replacement and maintenance.

Exhibit 17 provides a summary of the impact fees calculated in this analysis compared to the current fee. The proposed residential fee structure is different than the current structure to account for housing unit size. Currently, the City has a residential single family fee and a residential multifamily fee. The fee for smaller housing units, with 0 or 1 bedrooms, is less than the current residential single family fee, while the fee for larger housing units is higher than the current fee. The commercial and industrial fees are lower due to a change in the calculation of resident equivalency from the 2018 analysis. The new fee calculation also does not include the value of trails, which provide access to employees for recreation and commuting. Accessory Dwelling Units (ADU) are currently charged 50% of the fee for a dwelling unit, using the multifamily fee. The new fee calculation would charge an ADU 50% of fee based on the number of bedrooms.

Exhibit 17: Park Impact Fee Summary

Category	2024 Adopted Fee	2024 Calculated Fee	2025 Calculated Fee
Residential – no bedroom	--	$1,946.52	$2,021.54
Residential – 1 bedroom	--	$3,244.19	$3,369.24
Residential – 2 or 3 bedrooms	--	$4,055.24	$4,211.55
Residential – 4+ bedrooms	--	$6,488.39	$6,738.48
Residential Single Family	$3,527.43		
Residential Multifamily	$3,026.87		
Commercial (per 1,000 square feet)	$1,770.07	$202.27	$210.07
Industrial (per 1,000 square feet)	$829.27	$112.37	$116.70
Accessory Dwelling Unit – no bedroom	$1,513.44	50% of fee for the number of bedrooms	50% of fee for the number of bedrooms

Sources: City of Sumner, 2024; BERK, 2024.

Capital Improvements Eligible for Impact Fees

Impact fees may be applied to park system improvements that add capacity to serve growth and that are addressed by a capital facilities plan element of a comprehensive land use plan adopted pursuant to the Growth Management Act. As part of the Parks, Trails, and Open Space Plan Update, amendments to the City's Capital Facilities Plan are proposed. Facilities identified in Appendix B would add capacity and serve growth.

See the Parks, Trails, and Open Space Plan Update for different packages of improvements that could occur in the 2024-2030 six-year period, as well as facilities that could occur through 2044 and beyond. The Capital Facilities Plan addresses the six-year period and demonstrates an ability to serve the 2044 planning horizon. The City may collect impact fees and spend them on eligible improvements over a 10-year period.

Appendix A: System Value Estimate 2024 (Land and Facilities)

Park	Address	Total Land Value (2024)	Total Improvements Value (2024)	Total Value (2024)
Rhubarb Alley	between 1011 and 1101 Main Street	$107,471	$235,311	$342,782
Dining Parklet	1012 Main St	$-	$10,996	$10,996
Pocket Park off 45th St	xxx Tacoma Ave	$8,900	$15,978	$24,878
Hops Alley	915 Kincaid and 922 Alder	$704,100	$7,100	$711,200
WWTF mowed area	13114 63rd St E	$430,645	$-	$430,645
The Shops mowed area	4711 142nd Ave E	$574,194	$-	$574,194
Current library mowed area	1116 Fryar Ave	$430,645	$-	$430,645
North St Parking Lots (used for some events)	Multiple locations on North Street	$1,282,900	$-	$1,282,900
Rainier View Park	15603 Meade McCumber Rd	$396,700	$2,671,068	$3,067,768
Loyalty Park	1300 Park St	$502,700	$650,662	$1,153,362
Reuben A. Knoblauch Heritage Park	916 Kincaid Ave	$863,600	$187,358	$1,050,958
Lucy V. Ryan Park	1228 Main St	$756,400	$2,250,804	$3,007,204
Bill Heath Sports Complex	5604 Graham Ave	$3,217,300	$2,580,543	$5,797,843
Seibenthaler Park	1602 Bonney Ave	$748,600	$632,086	$1,380,686
Bennett Property	4811 East Valley Hwy	$399,100	$-	$399,100
Qunell Family Park	14324 72nd St E	$16,300	$-	$16,300
Sumner Link Trail*	N/A	$-	$382,497	$382,497
TOTAL		**$10,439,555**	**$9,624,404**	**$20,063,958**

**Note: Valuation for the Sumner Link Trail does not include land value or the value of the trail itself, only the improvements value of the restroom and parking areas. The land and improvement value for the trail itself is part of the analysis underlying the City's 2025 Transportation Impact Fee.*

Appendix B: Parks & Trails Capital Facility Plan 2024-2030

The following table includes updated cost estimates for the projects listed in the 2024 Parks and Trails Plan and the amount of these projects that are considered "capacity-adding" or potentially eligible for use of impact fees. Impact fees must be spent on projects that serve new demand as the city grows.

Project	Park	Updated Estimate (2024$)	Amount Potentially Eligible for Impact Fees
Covered Court (Funded)	Rainier View	$937,000	$0 (already completed)
Misc Site Improvements	Rainier View	$100,000	$0
Alley	Heritage	$1,673,412	$1,673,412
Park & Playground	Heritage	$1,253,458	$1,253,458
Building	Heritage	$11,700,000	$0
Master Plan	Lucy V. Ryan	$75,000	$0
Demo	Lucy V. Ryan	$185,000	$0
Development	Lucy V. Ryan	$100,000	$100,000
Drainage & Site Improvements	Loyalty	$109,000	$0
Picnic/Shade Shelter	Loyalty	$25,000	$25,000
Expansion & Parking	Loyalty	$700,000	$700,000
Field	Heath Sports	$3,000,000	$1,000,000
Lighting	Heath Sports	$600,000	$0
Fencing	Heath Sports	$375,000	$0
Pump & Sk8	Heath Sports	$1,200,000	$1,200,000
Picnic & Pathways	Heath Sports	$365,000	$91,250
Site Improvements (phases)	Seibenthaler	$9,756,000	$3,219,480
ROW Improvements	Seibenthaler	$352,700	$0
Site Improvements (phases)	Bennett	$10,157,000	$10,157,000
Master Plan	Qunell	$35,000	$0
Site Improvements	Qunell	$1,090,000	$1,090,000
Master Site Plan	New & Expanding Parks	$200,000	$0

Project	Park	Updated Estimate (2024$)	Amount Potentially Eligible for Impact Fees
Acquisition	New & Expanding Parks	$1,000,000	$1,000,000
Minimum Park Standard Investment	New & Expanding Parks	$1,000,000	$1,000,000
Total		**$45,988,570**	**$22,509,600**

ORDINANCE NO. 2916

CITY OF SUMNER, WASHINGTON

AN ORDINANCE UPDATING THE CITY OF SUMNER PARKS IMPACT FEE; SPECIFIC DEFINITIONS; FEE CALCULATIONS AND AMENDING SUMNER MUNICIPAL CODE CHAPTER 12.38 INCLUDING SECTIONS 12.38.010; 12.38.020(I) AND (J); 12.38.040; AND 12.38.100.

WHEREAS Sumner's *2018 Parks & Trail Plan* assisted the City in planning for parks and trails and is due for an update; and

WHEREAS the *2024-2030 Parks & Trails Plan* will maintain consistency, as required by RCW 36.70A.130 (2)(a) (iv), with the Sumner Comprehensive Plan and associated Capital Facility Plan, and is compatible with the City's budget, and would enhance the City's eligibility for grants such as with the Washington State Recreation and Conservation Office; and

WHEREAS the Growth Management Act as codified in Chapter 36.70A RCW requires a Capital Facility Plan including parks that supports planned growth at City-defined levels of service, and within considered funding capabilities; and

WHEREAS, on May 20, 2024 the Sumner City Council approved Resolution No. 1686 adopting the *2024-2030 Parks & Trails Plan*; and

WHEREAS the City completed a *Parks Impact Fee Rate Study*, dated December 31, 2024 evaluating, and documenting the methodology and updated Park Impact Fee calculations and fee schedule consistent with state law; and

WHEREAS the City Council was presented the *Parks Impact Fee Rate Study* and Ordinance at a Study Session on January 13, 2025; and

WHEREAS the City Council finds that adopting this Ordinance to update the City's park impact fees consistent with the updated rate study is in the public interest and will advance public health, safety, and welfare.

NOW, THEREFORE, THE CITY COUNCIL OF THE CITY OF SUMNER, WASHINGTON DOES HEREBY ORDAIN AS FOLLOWS:

<u>Section 1.</u> **Findings.** The recitals of this Ordinance are hereby adopted as findings of fact in support of this Ordinance.

<u>Section 2.</u> **Amended Section.** That Sumner Municipal Code section 12.38.010 "Findings, purpose and authority," subsection (A) is hereby amended to read as follows:

12.38.010 Findings, purpose and authority.
A. The city council finds and determines that new residential growth and development in the city will create additional demand and need for ~~public facilities (~~parks~~)~~ in the city and finds that new residential growth and development should pay a proportionate share of the cost of new ~~public facilitie~~<u>parks, recreational facilities and open space</u>s needed to serve the new growth and development. The city has conducted an extensive study documenting the procedures for measuring the impact of new residential <u>and non-residential</u> developments on public facilities<u> like parks</u> and has prepared a rate study as identified below. The city council accepts the methodology and data contained in the rate study. Therefore, pursuant to the city's police powers, the Growth Management Act as codified in Chapter 36.70A RCW ("the Act") and the impact fee statutes as codified in RCW 82.02.050 through 82.02.100, the city council adopts this chapter to assess impact fees for public facilities.

<u>Section 3.</u> **Amended Section.** That Sumner Municipal Code section SMC 12.38.020 (I) definition for "Impact Fee Schedule" is hereby amended to read as follows:

I. "Impact fee schedule" means the table of impact fees to be charged per unit of development, computed by the formula contained in the Parks and Trails Impact Fee Rate Study completed by Berk Consulting Inc. dated ~~January 5, 2018~~<u>December 31, 2024</u> (the rate study), indicating the standard fee amount per unit of development that shall be paid as a condition of such development within the city.

<u>Section 4.</u> **Amended Section.** That Sumner Municipal Code section SMC 12.38.020 (J) definition for "Park Facilities" is hereby amended to read as follows:

J. "Parks facilities" mean publicly owned parks, open space, ~~trails,~~ and recreational facilities.

<u>Section 5.</u> **Amended Section.** That Sumner Municipal Code section SMC 12.38.040 "Fee Calculations" is hereby amended to read as follows:

12.38.040 Fee calculations.
A. The fee shall be calculated based on the methodology set forth in the parks impact fee rate study.

B. Any impact fee imposed shall be reasonably related to the impact caused by the development and shall not exceed a proportionate share of the costs of system improvements that are reasonably related to the new development. The impact fee formula shall take into account the future revenues the city will receive from the development, along with system costs related to serving the new development.

C. The fee schedule shall reflect the proportionate impact of new housing units, including multifamily and condominium units, based on the square footage, number of bedrooms, or trips generated, in the housing unit in order to produce a proportionally lower impact fee for smaller housing units.

~~C~~D. For the purpose of this chapter, single-family dwellings, multifamily dwellings and mobile homes shall ~~be treated as single-family dwellings and duplexes shall be treated as multifamily dwellings~~ have fees calculated based on the number of bedrooms per SMC 12.38.100(A).

~~D~~E. For the purposes of this chapter, an accessory dwelling unit (ADU) defined in SMC 18.04.0035 and as regulated in SMC Title 18 ~~is considered a multifamily unit and~~ shall be charged in accordance with the number of bedrooms, provided that an ADU with no bedrooms shall be charged a no bedroom fee and an ADU with two or three bedrooms shall be charged 50 percent of the 2 or 3 bedroom fee listed in SMC 12.38.100(A)~~rate~~.

~~E~~F. The methodology shall provide for an in-kind credit for acceptable park facilities or open space sites actually ~~provided~~constructed or dedicated to the City by a developer ~~which the~~, in the sole discretion ~~city finds acceptable~~ of the City.

Section 6. Amended Section. That Sumner Municipal Code section SMC 12.38.100 "Fee schedule and updates," is hereby amended to read as follows:

12.38.100 Fee schedule and updates.
A. The following impact fees are based on the city's ~~2018~~ 2024 rate study:

~~1. Single-family dwelling unit: $2,580.23 per dwelling unit.~~

~~2. Multifamily: $2,214.08 per dwelling unit.~~

~~3. Commercial: $1,294.76 per 1,000 square feet.~~

~~4. Industrial: $606.92 per 1,000 square feet.~~1. Residential – No Bedroom (Studio): $2,021.54.

2. Residential – 1 Bedroom: $3,369.24.

3. Residential – 2 or 3 Bedroom: $4,211.55.

4. Residential – 4 plus Bedrooms: $6,738.48.

5. Commercial: $210.07 per 1,000 square feet.

6.Industrial: $116.70 per 1,000 square feet.

B. Park impact fee rates shall be updated annually using the following procedures:

1. The director shall use the ~~Construction Cost~~Consumer Price Index – Urban Consumers for the Seattle-Tacoma-Bellevue Metropolitan Area (CPI-U) ~~(June-June) published by the~~

~~Engineering News-Record~~ to calculate annual inflation adjustments in the impact fee rates. The park impact fees shall not be adjusted for inflation should the index remain unchanged.

2. The indexed impact fee rates shall be effective January 1st. A copy of the indexed impact fee rates shall be provided to the city council but the indexed rates shall become effective without further council review.

C. The director shall review the park impact fee rates biennially to determine when a new park impact fee rate study should be prepared and recommend to the city council when a new study should be prepared.

Section 7. Severability. Should any section, paragraph, sentence, clause or phrase of this Ordinance, or its application to any person or circumstance, be declared unconstitutional or invalid for any reason, or should any portion of this Ordinance be preempted by state or federal law or regulation, such decision or preemption shall not affect the validity of the remaining portions of this Ordinance or its application to other persons or circumstances.

Section 8. Corrections by City Clerk or Code Reviser. Upon approval of the city attorney, the city clerk and the code reviser are authorized to make necessary corrections to this ordinance, including the correction of clerical errors; ordinance, section, or subsection numbering; or references to other local, state, or federal laws, codes, rules, or regulations.

Section 9. Effective Date. This ordinance shall take effect five (5) days from the date of publication in the City's official newspaper.

Passed by the City Council and approved by the Mayor of the City of Sumner, Washington, at a regular meeting thereof this _____day of ____________ 2025

____

Mayor Kathy Hayden

ATTEST: | **APPROVED AS TO FORM:**

____________________________________ | ____________________________________

City Clerk Michelle Converse, CMC | Andrea Marquez, City Attorney

First Reading:

Date Adopted:
Date of Publication:
Effective Date:

STUDY SESSION
DATE: January 13, 2025
AGENDA BILL: 25-5

SUBJECT: 2025 Comprehensive Plan Annual Amendments **CATEGORY:** Information Only

BUDGET IMPACT:
Expenditure Required: None Within Budget Allocation: N/A

ATTACHMENTS:
1. Amend Cycle Opening- Staff Memo
2. 2025 Comprehensive Plan Annual Amendments

STAFF CONTACT: Chrissanda Walker, Associate Planner

SUMMARY BACKGROUND:
Per the Sumner Zoning Code, the City Council is required to determine by April 1st whether it will consider "annual amendments" to the Comprehensive Plan for that year. This amendment cycle must occur annually or at least every other year. The last amendment cycle was opened in January 2023; therefore, code requires that the Council now open the amendment cycle for 2025.

In the previous Comprehensive Plan process in 2024, the Growth Management Act mandated that the city complete the required "10-year periodic amendment" of the Comprehensive Plan and it did not include any zoning map changes. There were no Map Amendment applications received during the 2023/2024 plan cycle. However, over the last year, there has been interest from private property owners to make Zoning Map changes. Therefore, staff is recommending that the City Council allow for Comprehensive Plan Annual amendment applications in 2025.

Anticipated Timeline:

City Council opens annual amendment cycle:	January 2025
Public notices (call for applications) published:	end of January 2025
Applications for amendments due:	Mid-February 2025
Planning Commission decides on applications to consider:	March 2025
Public hearings and Council adoption:	By end of 2025

COUNCIL COMMITTEE/STUDY SESSION:
MEETING/STUDY SESSION DATE:
COMMITTEE RECOMMENDATION:

STAFF RECOMMENDATIONS/MOTION:
Confirm that staff may begin the public notice process to accept applications for annual amendments.

1104 MAPLE STREET, SUMNER WA 98390

CITY OF SUMNER WASHINGTON

Memorandum

DATE: January 13, 2025
TO: Mayor Hayden and City Council
FROM: Chrissanda Walker, Associate Planner
CC: Jason Wilson, City Administrator
RE: 2025 Annual Amendments

Prior to April 1st of each year, per City code, the City Council determines whether or not Comprehensive Plan amendment applications will be accepted for that year. Per state law the Comprehensive Plan can only be amended once per year and City code requires that applications for amendments be accepted at least every two years.

The 2023 annual amendment cycle was opened for applications and there were no City sponsored proposals at that time, and the city did not receive any private applications.

City staff has had interest over the last year from private property owners who would like to apply for a Comprehensive Plan map amendments to change the zoning of their property.

City staff would also like to sponsor a zoning code text amendment to the 2018 Town Center Plan and Form Based Code, to be consistent with the latest adopted 2024 Comprehensive Plan. Staff proposes minor map amendments to the Town Center plan and zoning map.

Proposed Map Amendments	Location	Summary Description of Proposal
TCP-01: Rezone a portion of West Sumner District	Zehnder Street	• Reduce minimum height from 3 stories to 2 stories. • Change the zoning to TC-3 or TC-4
TCP-02: Reduce height in a portion of the Historic District	Cherry Ave/Main Street	• Reduce height in the Historic District from 5 stories to no more than 4 stories, change to TC-4
MA-01: Rezone Heavy Industrial (M-2)-Center of Town	North of Zehnder, approximately 16 parcels located between Fryar and Steele Ave;	• Rezone from M-2 into M-1, light industrial uses.
Private Interest:	• 14 parcels south of 410-Orton area/Sumner's UGA • Parcels 0420124027 & 0420124035 on 30th St Ct E	• Comprehensive Plan map designation amendment to the area known as Orton UGA, current designation is LDR-2 • Zoning map amendment rezone from LDR-85 to M-1, potential access off 32nd Street

Since the public was not given an opportunity to apply for amendments in 2024 during the periodic update, and there is private interest, staff is recommending that the City Council allow for Comprehensive Plan amendment applications in 2025.

If there is no objection from the Council, staff will begin the public notice process and advertise that applications can be submitted.

2025 Annual Comprehensive Plan Amendments

City Council Meeting

Study Session meeting

January 13, 2024

Comprehensive Plan - Annual Amendments

- Prior to April 1st of each year, per City code, the City Council determines whether or not Comprehensive Plan amendment applications will be accepted for that year. Amendment cycles are not less frequent than every other year.

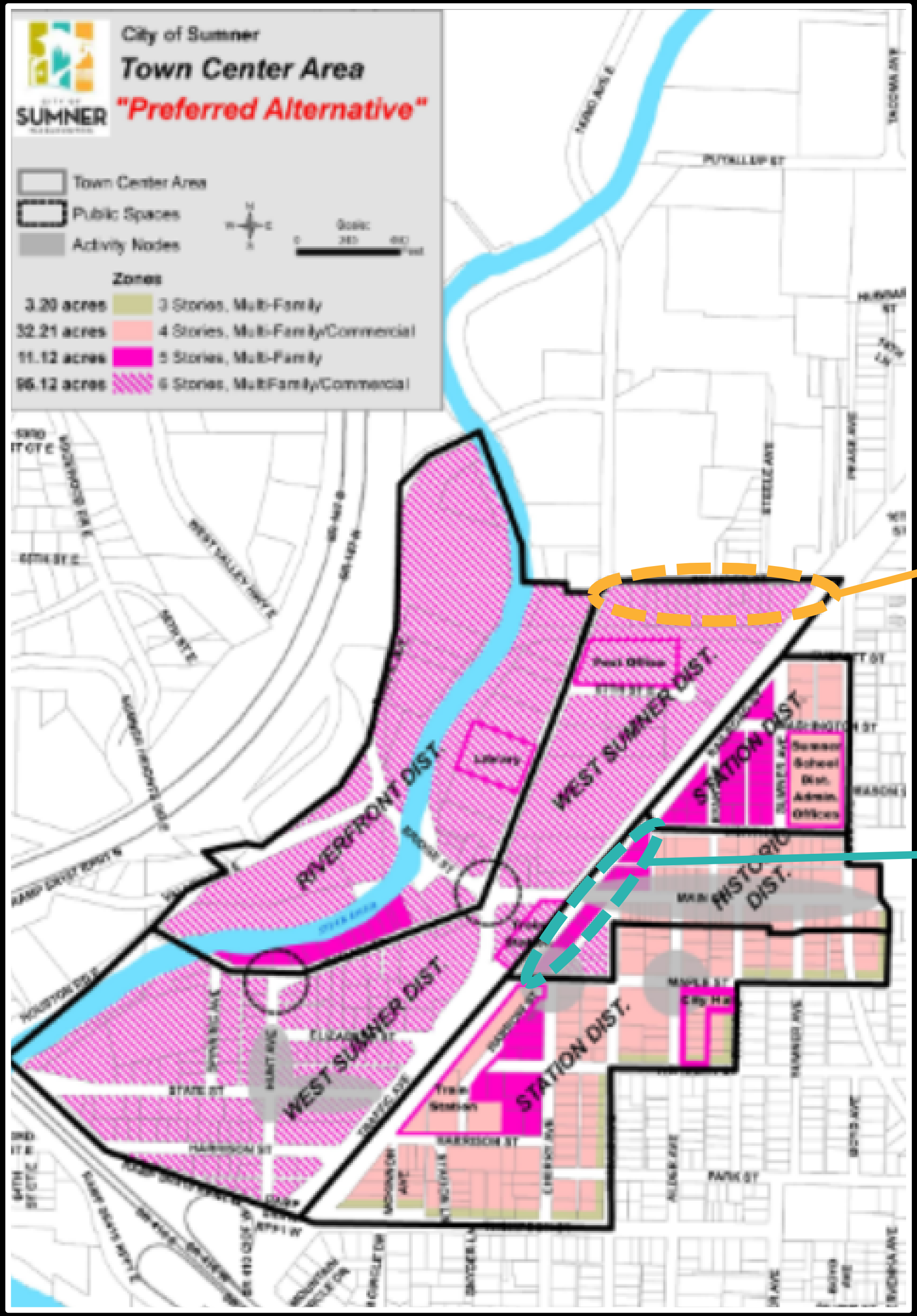
- **The City of Sumner is considering map amendments to the Comprehensive Plan and subsequent changes to the city Zoning Map to reflect the Comprehensive Plan Map changes.**

- Amendments to the Comprehensive Plan may be proposed to any element of the adopted Sumner Comprehensive Plan, including amendments to goals, policies, objectives, or comprehensive plan maps. Amendment applications must be complete and contain the information required in SMC 18.56.147

Applications for amendments due: **Mid-February 2025**

Fees: Comprehensive Plan Amendment--$2,600; Change in Zoning Map--$3,000.

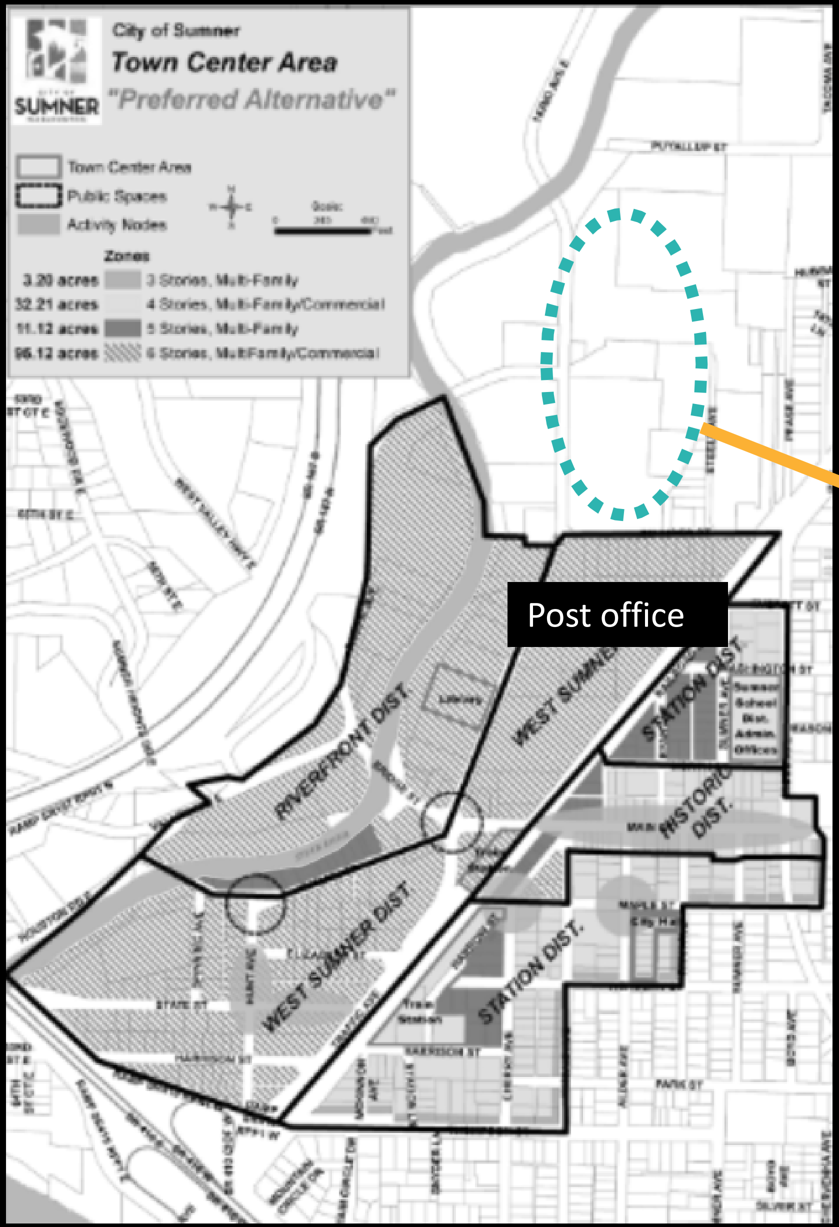
Proposed Map Amendments	Location	Summary Description of Proposal
Town Center (TC) map amendments:	• Zehnder (TC-6) in the West Sumner District • Cherry Ave/Main Street (TC-5) in the Historic District	1. Reduce the minimum height requirements in certain areas of the TCP 2. Rezone TC-5 by reducing story height to TC-4
City Map Amendments:	• Between Fryar Ave & Steele Ave with existing zoning of M-2 -heavy industrial	1. North of TCP, evaluate approximately 16 parcels located between Fryar and Steele Ave. 2. Propose rezone from M-2 into M-1 -light industrial uses
Private Interest:	• 14 parcels located in Sumner's UGA (south of 410) • 2 parcels located at the end of 30^{th} St Ct E	1. Comprehensive Plan map amendment to the area known as Orton UGA, current zone is LDR-2 2. Potential zoning map amendment rezone from LDR-85 to M-1, potential access form 32^{nd} Street

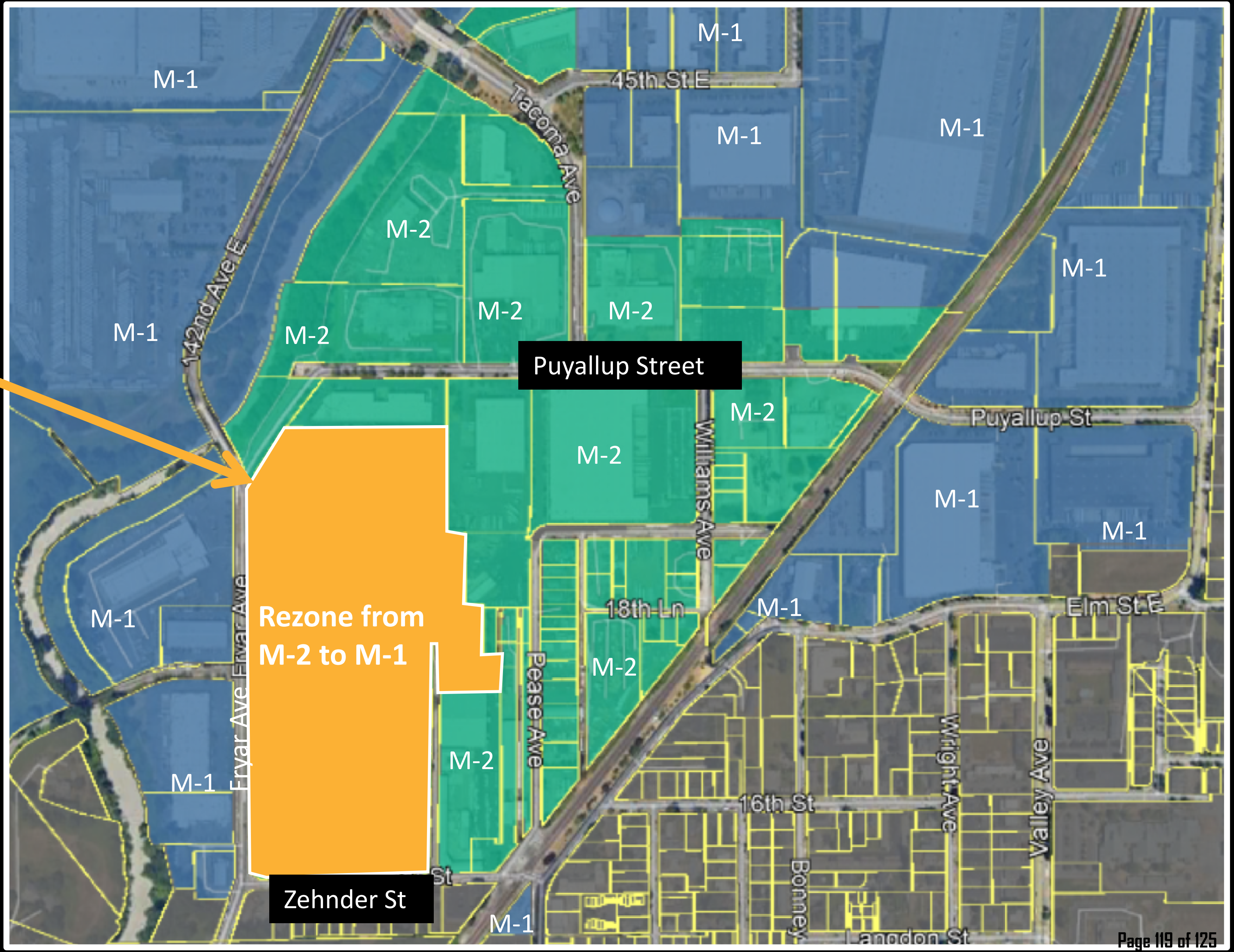


Town Center Map Amendments

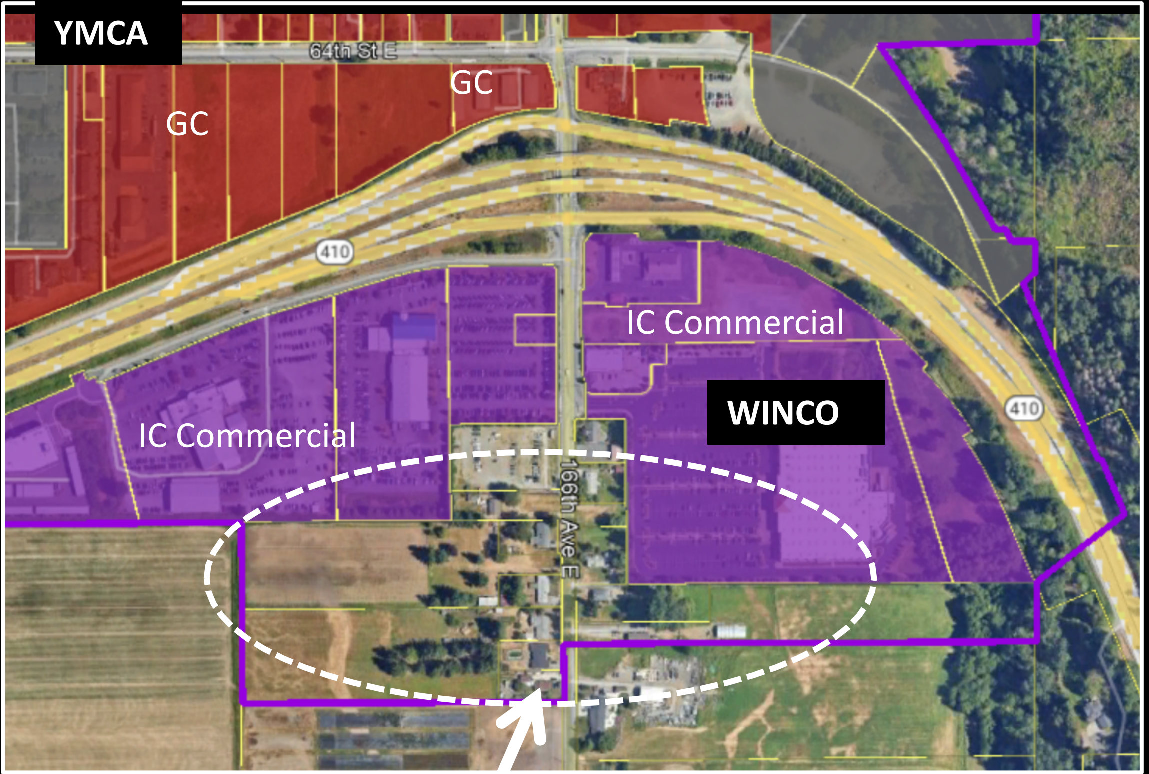
- **TCP-01: WSD-Zehnder Street**
  - Existing zoning= TC-6
  - Proposal: Reduce minimum heights from 3 stories to 2 stories. Rezone from TC-6 to TC-3
- **TCP-02: HCBD- Cherry Ave & Main Street**
  - Existing zoning = TC-5
  - Proposal: Reduce height and rezone from TC-5 to TC-4

City Map Amendments



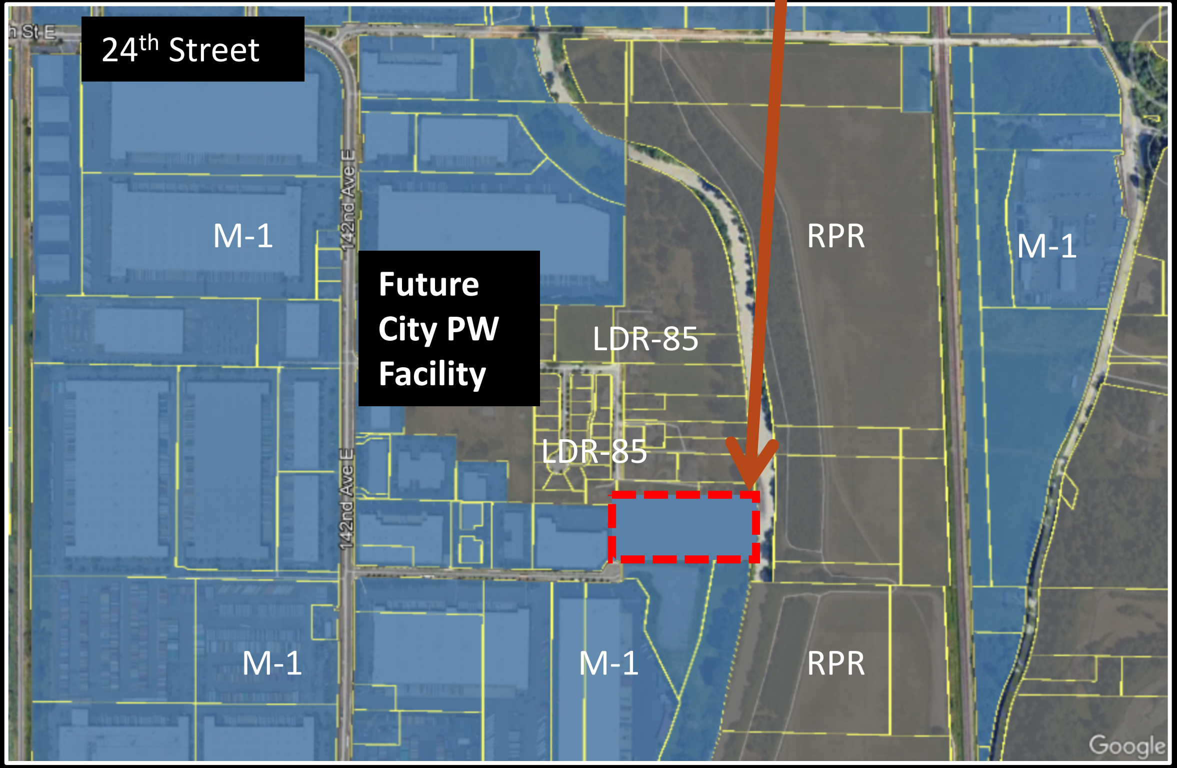


Private interest



Proposed Comp plan map designation amendment

Proposed zoning map amendment



Timeline and Proposed Schedule

January 2025
seek approval
to open cycle

The Planning Commission acts as the "gatekeeper" for new Comprehensive Plan amendments and must approve the docket of amendments prior to moving forward.

February 2025
Applications due and staff time to review

Provide public opportunities for public comment

March 2025
PC Meeting present docket and outreach plan

August 2025
Hold Public Hearing with PC to seek recommendatio

Present draft Ordinances for each amendment and/or zoning code text amendment

October 2025
Hold Public Hearing with Council

Adopt amendments by December 2025

Thank you

Any questions?

Email Staff: Chrissanda Walker, Associate Planner

chrissandaw@sumnerwa.gov

CITY COUNCIL AGENDA CALENDAR Updated January 6, 2025

CA – CONSENT AGENDA **ES** – EXECUTIVE SESSION **NB** – NEW BUSINESS	
UB – UNFINISHED BUSINESS **P** – PRESENTATION **PH** – PUBLIC HEARING **PR** - PROCLAMATION	

2025 All Staff Meetings / Events
- February 11th
- May 20th
- August 5th (BBQ)
- September 23rd
- December 10th (Breakfast)

<u>JANUARY 21, 2025 (Tuesday) (RCM)</u>

CA Resolution No. XXXX – Setting Hearing Date for MFTE Area *(RW)*
CA Resolution No. XXXX – LTAC Grant Acceptance (Heritage Park)
CA Resolution No. XXXX – S PAR Grant Acceptance (Public Defense) *(JS)*
CA Resolution No. XXXX - City Hall Energy Audit Certificate of Assurance *(PW)*
NB Ordinance No. XXXX - Park Impact Fees *(RW)*

<u>JANUARY 27, 2025 SS</u>

- Transportation Improvement Plan *(AOH)*
- Pierce Transit Long Range Plan Presentation
- Murrey's Rate Increase Discussion *(JS)*

<u>FEBRUARY 3 (RCM)</u>

PH Transportation Improvement Plan (*AOH)*
CA Resolution No. XXXX – WW Pretreatment Program
CA Resolution No. XXXX – Murrey's Rate Increase *(JS)*

<u>FEBRUARY 10 (SS)</u>

- Discussion: Funding Package for Public Works Operations Facility
- Ordinance No. XXXX Delegation Authority for Debt Issuance (Public Works Operations Facility)

<u>FEBRUARY 18 (RCM) (Tuesday)</u>

UB Transportation Improvement Plan
NB Ordinance No. XXXX Delegation Authority for Debt Issuance
NB Ordinance No. XXXX – Budget Amendment for PW Operations Facility

<u>FEBRUARY 24 (SS)</u>

- Transportation Benefit District

<u>MARCH 3 (RCM)</u>

PH Ordinance No. XXXX - Adopting New Residential Target Area for MFTE in East Sumner (Windish)

<u>MARCH 10 (SS)</u>

<u>MARCH 17 (RCM)</u>

UB Ordinance No. XXXX - Adopting New Residential Target Area for MFTE in East Sumner (Windish)

<u>MARCH 24 (SS)</u>

CA – CONSENT AGENDA	**ES** – EXECUTIVE SESSION	**NB** – NEW BUSINESS
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Pending

MISC.	MISC.	MISC.
Ordinance – Updating Short Plat Amendment Process (Legal)	Ordinance – Refuse Collection (Code Enforcement) (Doug)	Ordinance XXXX - Endangerment with a Controlled Substance Crime Adoption
CA State Homeland Security Program Grant Acceptance for Small Unmanned Aerial System (PD)	Public Memorial Policy (Ryan W.)	Water Cross Connection Control Code Update (Doug)
Ordinance Insurance Requirements (MC)	Heritage Park Right of Way Vacation	MFG Home Park Overlay Zone (Ryan W.)
Sign Code Update (off premise) (Ryan W.)	School Impact Fee Update (Doug)	CTR Adoption (June 16) (Ryan W.)
Sk8 Park (CD and Jeff S.)		

JANUARY 2025

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
		1	5	6	7
		Holiday – City Hall Closed	6:00PM – **Planning Commission** (Hybrid)		
6	7	8	9	10	11
6:00PM **Regular Council Meeting** (Hybrid)	4:00PM **Public Works Committee** (Hybrid)	~~6:00PM~~ (CANCELLED) ~~**Design Commission**~~	4:00PM **Finance Committee** (Hybrid) 4:30PM **Forestry/Parks Commission** (Hybrid)		
13	14	15	16	17	18
6:00PM **Study Session** (Hybrid)		4:00PM **Public Safety** (Hybrid)			
20	21	22	23	24	25
Holiday – City Hall Closed	6:00PM **Regular Council Meeting** (Hybrid)	4:00PM **CD Committee** (Hybrid)	6:00PM **Cultural Arts Commission** (Hybrid)		
27	28	29	30	31	
6:00PM **Study Session** (Hybrid)					

Meeting dates and times may change. Please contact City Hall to confirm this information prior to any meeting you plan to attend. ***These meetings are accessible to persons with disabilities.*** *For individuals who require special accommodations, please contact City Hall at (253) 299-5500, 24 hours in advance.*

Name: Michelle Converse, CMC

Title: City Clerk

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