U.S. DEPARTMENT OF ENERGY

Energy Storage Grand Challenge

Pacific/Northwest Regional Workshop

MAY 20, 2020

U.S. DEPARTMENT OF ENERGY

Energy Storage Grand Challenge Overview

Alejandro Moreno

Office of Energy Efficiency and Renewable Energy

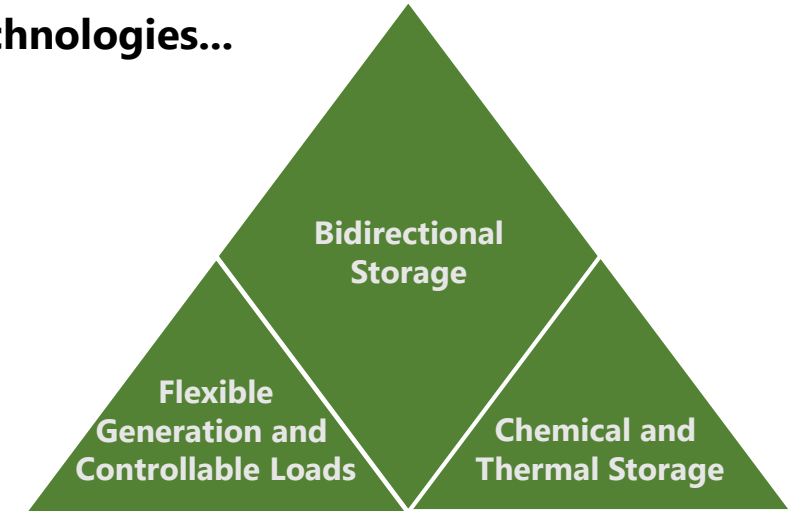
U.S. Department of Energy

ESGC Vision, Mission, and Scope

DOE-wide strategy to accelerate US leadership in energy storage technologies

- Coordinated across DOE:

technologies…



…offices…

- Office of Electricity
- Energy Efficiency and Renewable Energy
- Office of Science
- Office of Technology Transitions
- Nuclear Energy
- Fossil Energy
- ARPA-E
- Loan Programs Office

…and functions.

U.S. DEPARTMENT OF ENERGY

ESGC Focus Areas

Five tracks to achieve US leadership in energy storage

Technology Development	Domestic Manufacturing and Supply Chain	Technology Transition	Policy and Valuation	Workforce Development
• Establish ambitious, achievable performance goals, and a comprehensive R&D portfolio to achieve them.	• Design new technologies to strengthen U.S. manufacturing, recyclability, and reduce dependence on foreign sources of critical minerals.	• Accelerate the technology pipeline from research to system design to private sector adoption through rigorous system evaluation, performance validation, siting tools, and targeted collaborations.	• Develop best-in-class models, data, and analysis to inform the most effective value proposition and use cases for storage technologies.	• Train the next generation of American workers to meet the needs of the 21st century grid and energy storage value chain.

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Welcome and Opening Remarks

Jud Virden

Associate Laboratory Director
Energy and Environment Directorate
Pacific Northwest National Laboratory

Questions

Please submit your questions in the Chat box to the host. Reference the speaker or topic.

Keynote

Ann Rendahl

Commissioner

Washington Utilities and Transportation Commission

WA Clean Energy Transformation Act

Clean, Affordable, Reliable, Equitable

2025: Eliminate coal from retail portfolios

2030: Greenhouse gas neutral standard

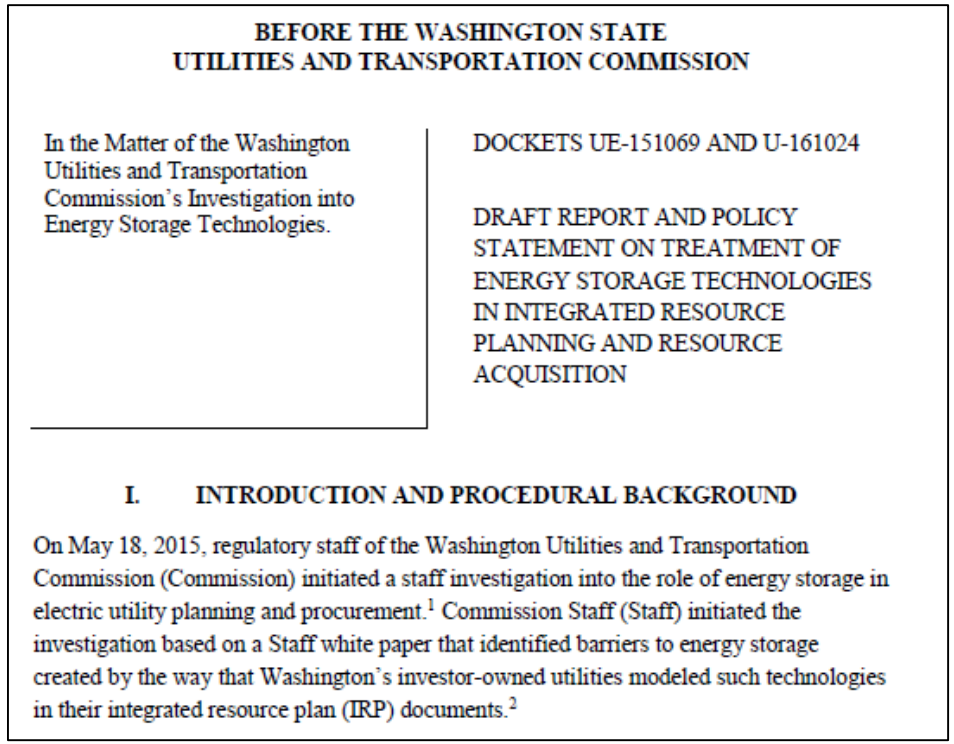
- At least 80 percent of electricity delivered to load must be renewable or non-emitting
- Alternative compliance options for up to 20 percent

2045: 100 percent renewable or non-emitting retail electricity supply

UTC Storage Policy Statement

Recommendations:

- Sub-hourly modelling of benefits over useful life of asset
- Publicly available, non-proprietary models
- Accurate and up-to date costs
- Evaluate a range of available technologies



BEFORE THE WASHINGTON STATE
UTILITIES AND TRANSPORTATION COMMISSION

In the Matter of the Washington Utilities and Transportation Commission's Investigation into Energy Storage Technologies.

DOCKETS UE-151069 AND U-161024

DRAFT REPORT AND POLICY STATEMENT ON TREATMENT OF ENERGY STORAGE TECHNOLOGIES IN INTEGRATED RESOURCE PLANNING AND RESOURCE ACQUISITION

I. INTRODUCTION AND PROCEDURAL BACKGROUND

On May 18, 2015, regulatory staff of the Washington Utilities and Transportation Commission (Commission) initiated a staff investigation into the role of energy storage in electric utility planning and procurement.[1] Commission Staff (Staff) initiated the investigation based on a Staff white paper that identified barriers to energy storage created by the way that Washington's investor-owned utilities modeled such technologies in their integrated resource plan (IRP) documents.[2]

Pacific Northwest NATIONAL LABORATORY

EPRI ELECTRIC POWER RESEARCH INSTITUTE

ESA Energy Storage Association

Questions

Please submit your questions in the Chat box to the host. Reference the speaker or topic.

Panel 1: 2030 Goals and Vision

Moderator

Clay Koplin, Cordova Electric

Panelists

- Larry Bekkedahl, Portland General Electric
- Kevin Woolfolk, Salt River Project
- Curt Kirkeby, AVISTA
- Chris Yunker, Hawaii State Energy Office
- Daniel Schwartz, University of Washington

ESGC Vision & Goals: Ground View

Utility Perspectives on 2030 Energy Storage (ES) Targets:

- How can ES support new suites of services for customers?
- How can ES facilitate intermittent renewables and dispatchable loads?
- What are some of the off-grid applications for ES?
- What technology advancements does industry need from ES?
- What are some of the novel and emerging application for ES?
- How can ES support beneficial electrification for heat/transportation?

PGE – Battery Programs

Resiliency Meets Flexibility

- Decarbonize
- Electrify - Improve integration of renewables
- Defer investment in generation, transmission, and distribution
- Improve grid reliability and flexibility

Category	Service
Bulk Energy	Generation Capacity / Resource Adequacy
Ancillary Services	Regulation Load Following Spinning / Non-Spinning Reserves Voltage Support Black Start
Transmission Services	Transmission Congestion Relief Transmission Upgrade Deferral
Distribution Services	Distribution Congestion Relief Distribution Upgrade Deferral Volt-VAR Control Outage Mitigation
Customer Energy Management Services	Power Reliability Time-of-Use Charge Reduction Demand Charge Reduction
Primary Control	Frequency Response UFLS

Storage Activities Underway

2030 GHG targets require storage across the Grid

- Generation
- Substation
- Mid-Feeder
- Micro-Grids
- Residential
- Fast Charging Stations

SRP's Storage Plan

Beyond the current 20MW/80MWh online.....

- Tesla standalone grid-charged BESS – 25MW/100MWh (May 2021)
- Sonoran Energy Center – 250MW solar + 250MW/1,000MWh BESS (June 2023)
- Storey Energy Center – 88MW solar + 88MW/264MWh BESS (June 2023)

SRP Storage Considerations

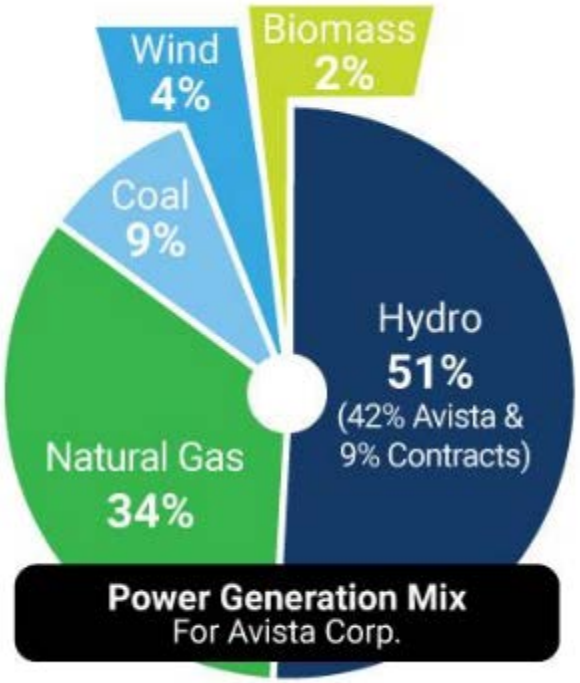
Benefits

- Allows increased renewable integration.
- Helps us meet sustainability/carbon goals.
- Can be cost effective against traditional generation options.

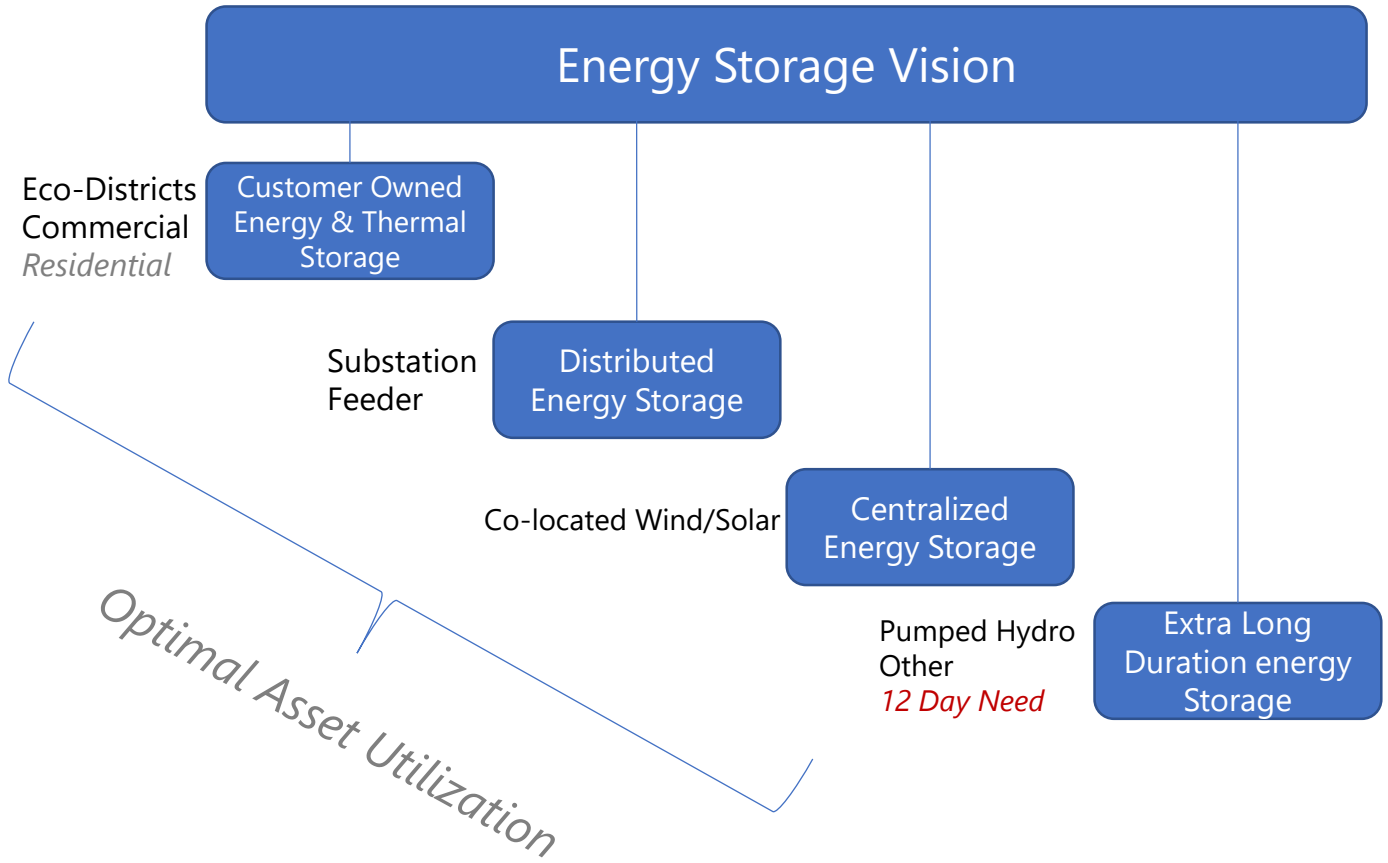
Challenges

- Diminishing capacity contribution with increasing installations.
- Longer duration seems inevitable, but at what cost?
- Reliability and useful life.

Avista Utilities Vision



Carbon Neutral by 2027
Carbon Free by 2045



Avista - Grand Challenge Needs

- Safety, reliability, and testing (best practices)
- Valid nameplate specifications for selecting systems
- Interoperability for utility and customer outcomes:
  - Reliability/backup
  - Grid edge optimization
  - Micro-grid optimization and formation
  - Load management
  - Power quality
- Accurate, inclusive valuations to incent investment

Demonstrate & Validate

Value Proposition for Storage Integrating Resiliency into Planning

HAWAII STATE Energy Office

- One of the main priorities after a storm will be to get the Critical Customers back on line.
- The CCC concept is a variant of a Micro Grid concept:
  - More cost effective than installing permanent generation.
  - Maintains greater flexibility.
- The CCC is a grouping of several neighboring critical customers.
- The key is to ensure CCCs get power as soon as possible.

Critical Community Cluster (CCC)

Valuing Storage Measuring Resiliency

HAWAII STATE Energy Office

- Utilities need metrics by which to compare alternative resource portfolios on resiliency
- This will require guidance on priority customers and performance expectations

Resilience Measures and Composite Index

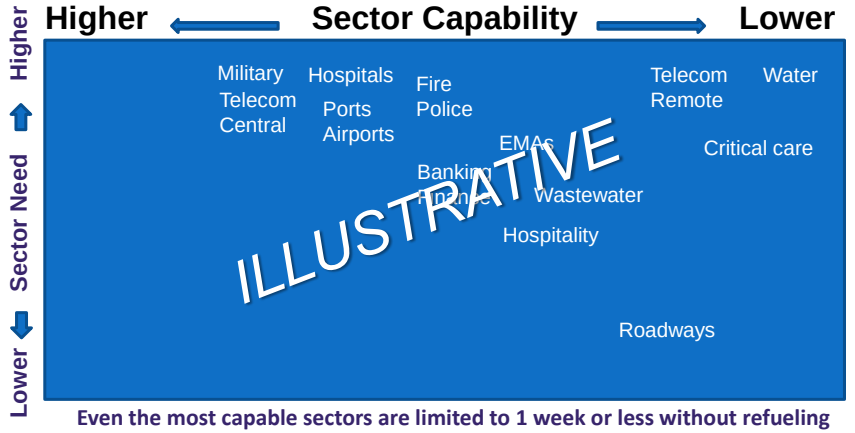
Resilience index measures how well a resilient grid performs under proposed severe threat scenarios. It is used to make comparisons among various strategies and options. The index is not a utility target or requirement – simply a measuring device to compare how well different solutions perform under severe circumstances.

▪Resilience Index (Sample Index Weighting Shown)

- Percent of Tier 1 customer sites that lose offsite power day or less (25%)
- Percent of Tier 2 customer sites that lose offsite power 3 days or less (15%)
- Percent of Tier 3 customers that lose offsite power 14 days or less (10%)
- Percent of Tier 1 customer sites restored within 3 days days (25%)
- Percent of Tier 2 customer sites restored within 7 days days (15%)
- Percent of tier 3 customers restored within 28 days (10%)

▪Cost

Customer Sector Need vs Capability



Even the most capable sectors are limited to 1 week or less without refueling

Sample Score Card Summary of Portfolio Options

Criteria		Affordability			Resilience	Sustainability	
Portfolio		2020-2030 Cost NPV ($Mil)	2020-2040 Levelized Cost (2019 $/MWh)	Cost Rating Score	Resilience Composite	CO_2 Changes from (%)	Renewable Generation As % of Load (%)
Status Quo							
Portfolio 1							
Portfolio 2							
Portfolio 3							
Portfolio 4							
Portfolio 5							
Portfolio 6							
Portfolio 7							
Portfolio 8							
Portfolio 9							

ILLUSTRATIVE

Electric Aviation – Observations

Daniel T. Schwartz, UW

Search ▾ The Guardian US edition ▾

World's first fully electric commercial aircraft takes flight in Canada

magniX

Both events happened on Dec. 10, 2019

5 distinct aviation energy storage segments

- Drone Cargo (eVTOL, cargo)
- Air Taxi (eVTOL, 4 – 6 PAX)
- Light Haul Commuter (eCTOL, ≤19 PAX)
- Regional (hybrid CTOL, ≤60 PAX)
- Airliner (hybrid CTOL, ≤200 PAX)

Electric Aviation – Observations

Daniel T. Schwartz, UW

Light duty EV vs. Light Haul Commuter

USABC Goals for Low-Cost / Fast-Charge Advanced Batteries for EVs - CY 2023

End of Life Characteristics at 30°C	Units	Cell Level
Peak Discharge Power Density, 30 s Pulse	W/L	1400
Peak Specific Discharge Power , 30 s Pulse	W/kg	700
Peak Specific Regen Power , 10 s Pulse	W/kg	300
Useable Energy Density @ C/3 Discharge Rate	Wh/L	550
Useable Specific Energy @ C/3 Discharge Rate	Wh/kg	275
Useable Energy @ C/3 Discharge Rate	kWh	50
Calendar Life	Years	10
DST Discharge Throughput, Discharge Energy	MWh	50
Cost	$/kWh	75
Operating Environment	°C	-30 to +52
Normal Recharge Time	Hours	< 7 Hours, J1772
Fast High Rate Charge	Minutes	80% ΔSOC in 15 min

Electric Aviation – Observations

Daniel T. Schwartz, UW

Light duty EV vs. Light Haul Commuter

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Useable Energy Density @ C/3 Discharge Rate	Wh/L	550
Useable Specific Energy @ C/3 Discharge Rate	Wh/kg	275
Useable Energy @ C/3 Discharge Rate	kWh	50
Calendar Life	Years	10
DST Discharge Throughput, Discharge Energy	MWh	50
Cost	$/kWh	75
Operating Environment	°C	-30 to +52
Normal Recharge Time	Hours	< 7 Hours, J1772
Fast High Rate Charge	Minutes	80% ΔSOC in 15 min

Aviation Energy Storage Metric (Pack)	Light Haul Commuter 5 year goals
Peak specific discharge power, **90 sec pulse**	3E discharge rate @ 20% SOC; Note [1]
Useable specific energy density **@ 1E discharge**	>300 Wh/kg
Useable energy @ 1E discharge	Aircraft and market specific
Discharge throughput (MWh)	(n years)*(annual MWh); Note [2]
Shelf life	1 calendar year
Operating Temp (˚C)	May be controlled.
Normal Charge Time	50% < ΔSOC < 70% in 30 minutes
Reserve Capacity	30% of energy; Note [3]
Cell-to-pack overhead on energy density	10%

Questions

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Panel 2: Enhancement to Regional Operations and Flexibility

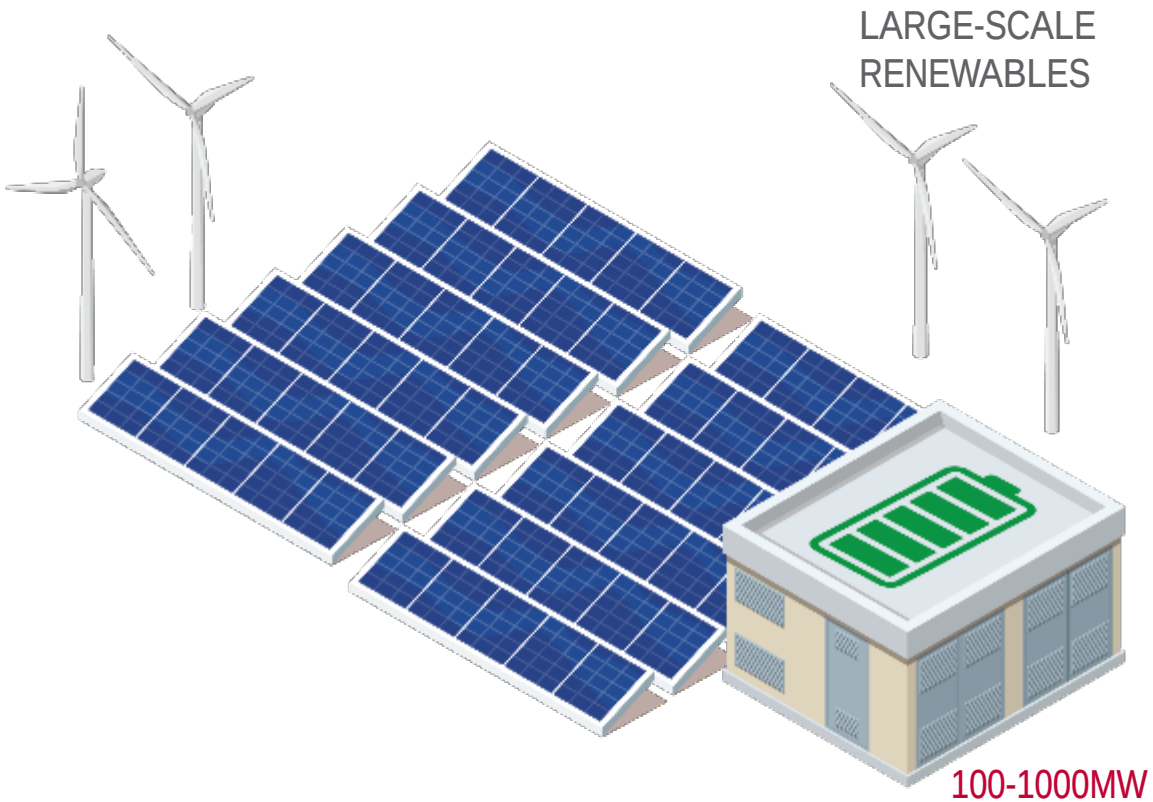
Moderator

Angela Becker-Dippmann, PNNL

Panelists

- Uzma Siddiqi, Seattle City Light
- Mark Monroe, Microsoft
- Russell Guerry, OPALCO
- Matt S. Von Ruden, Washington State Ferries
- Jennifer States, DNV GL Energy Insights USA

Energy Storage at the Convergence of Infrastructure



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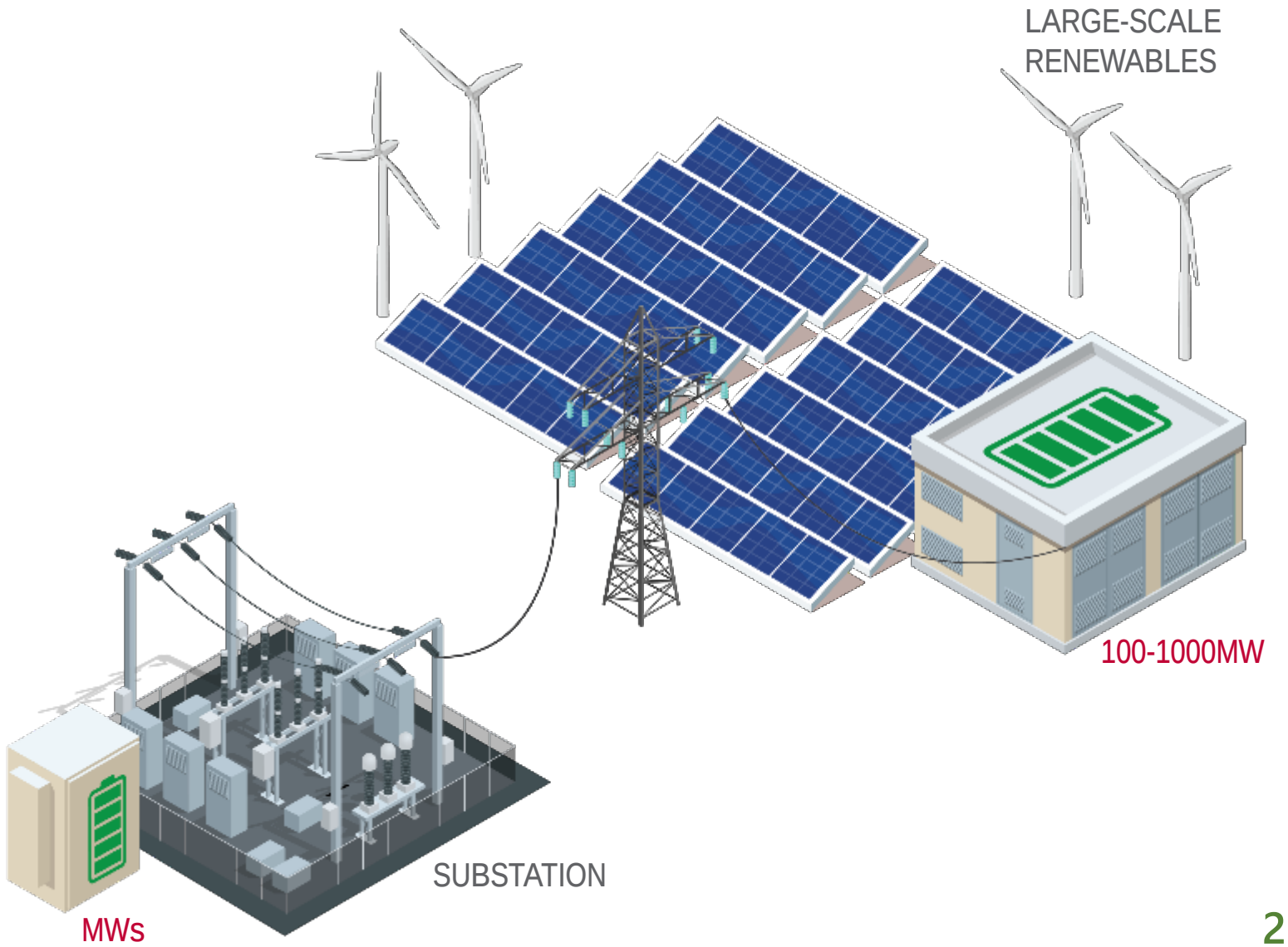

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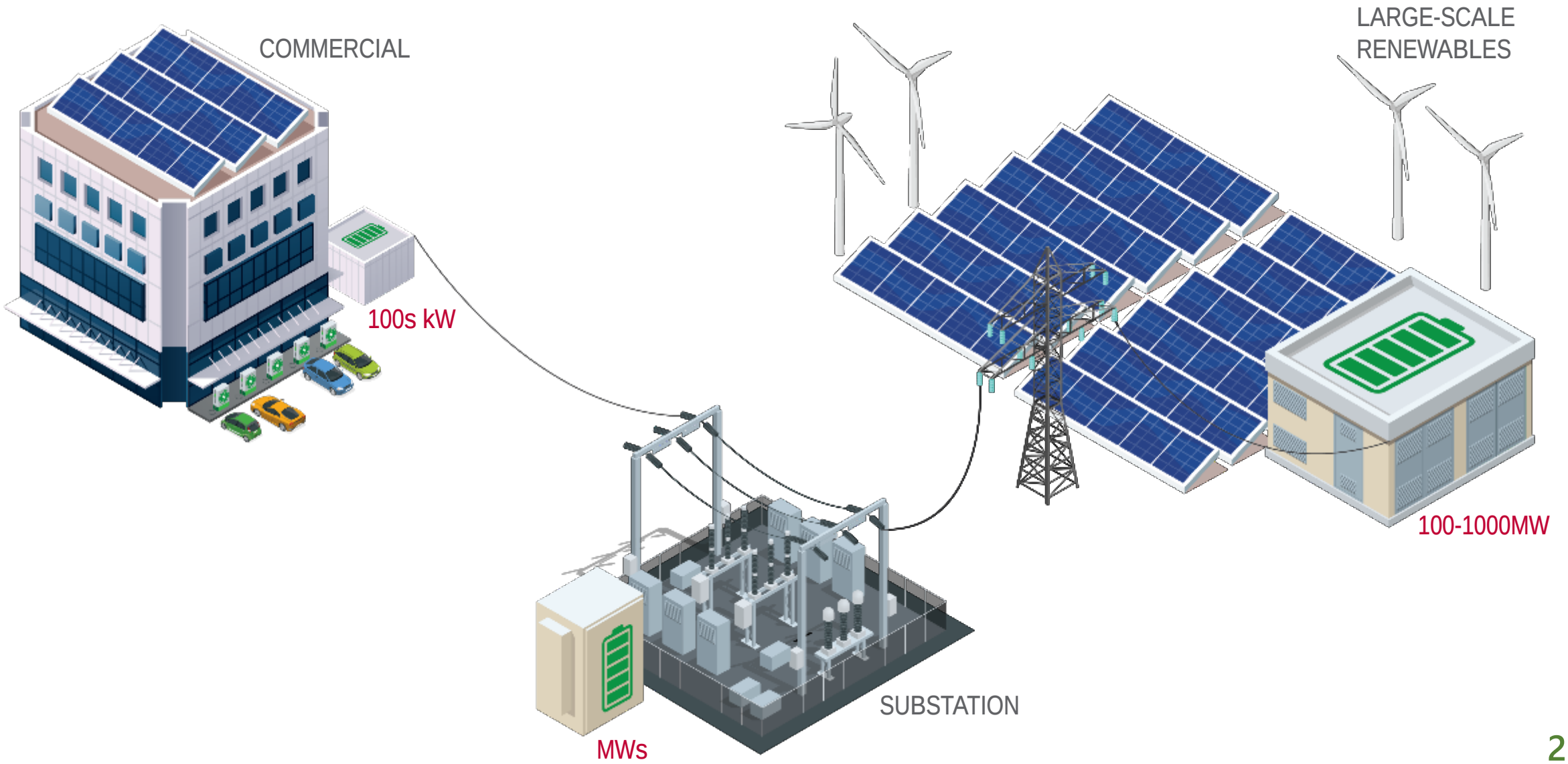

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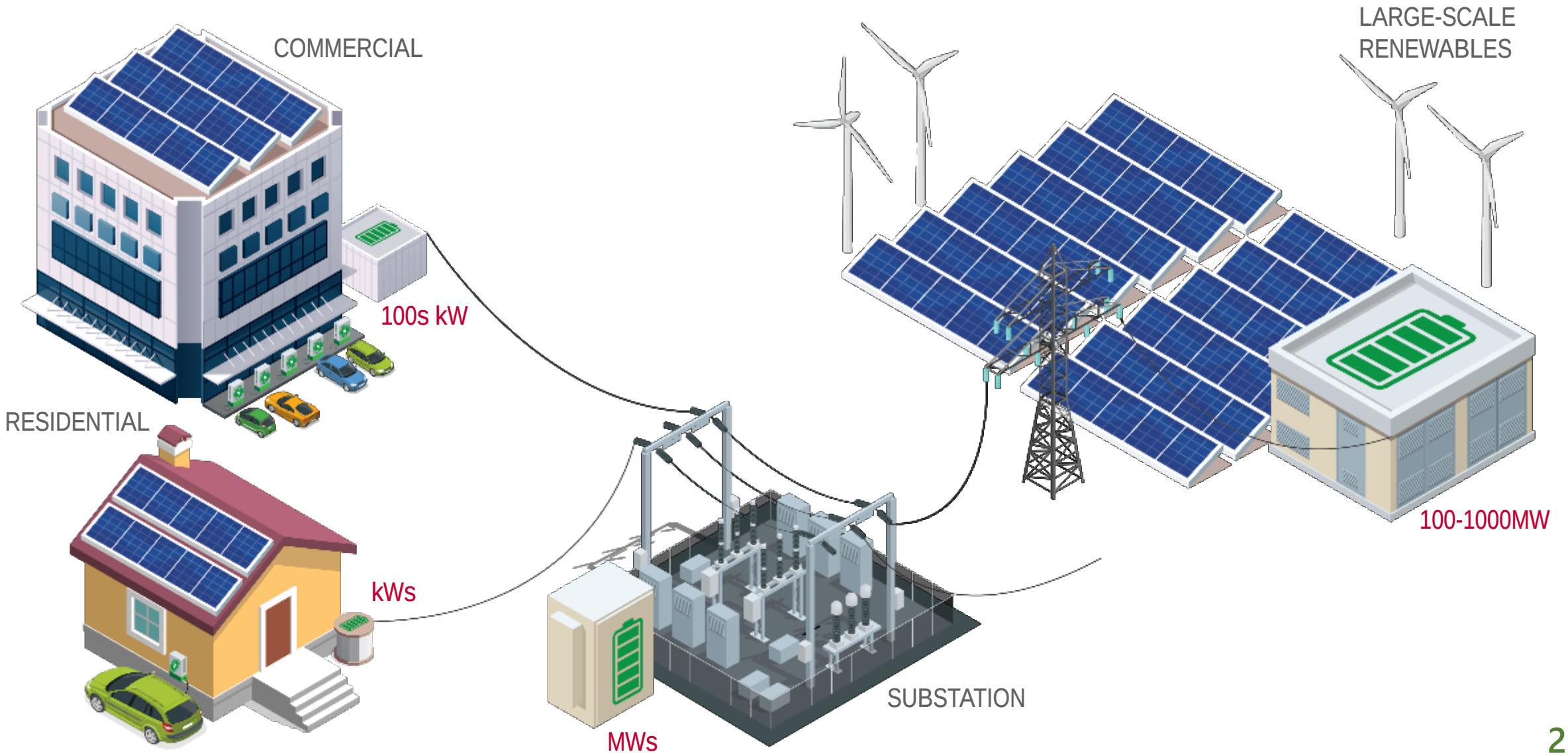

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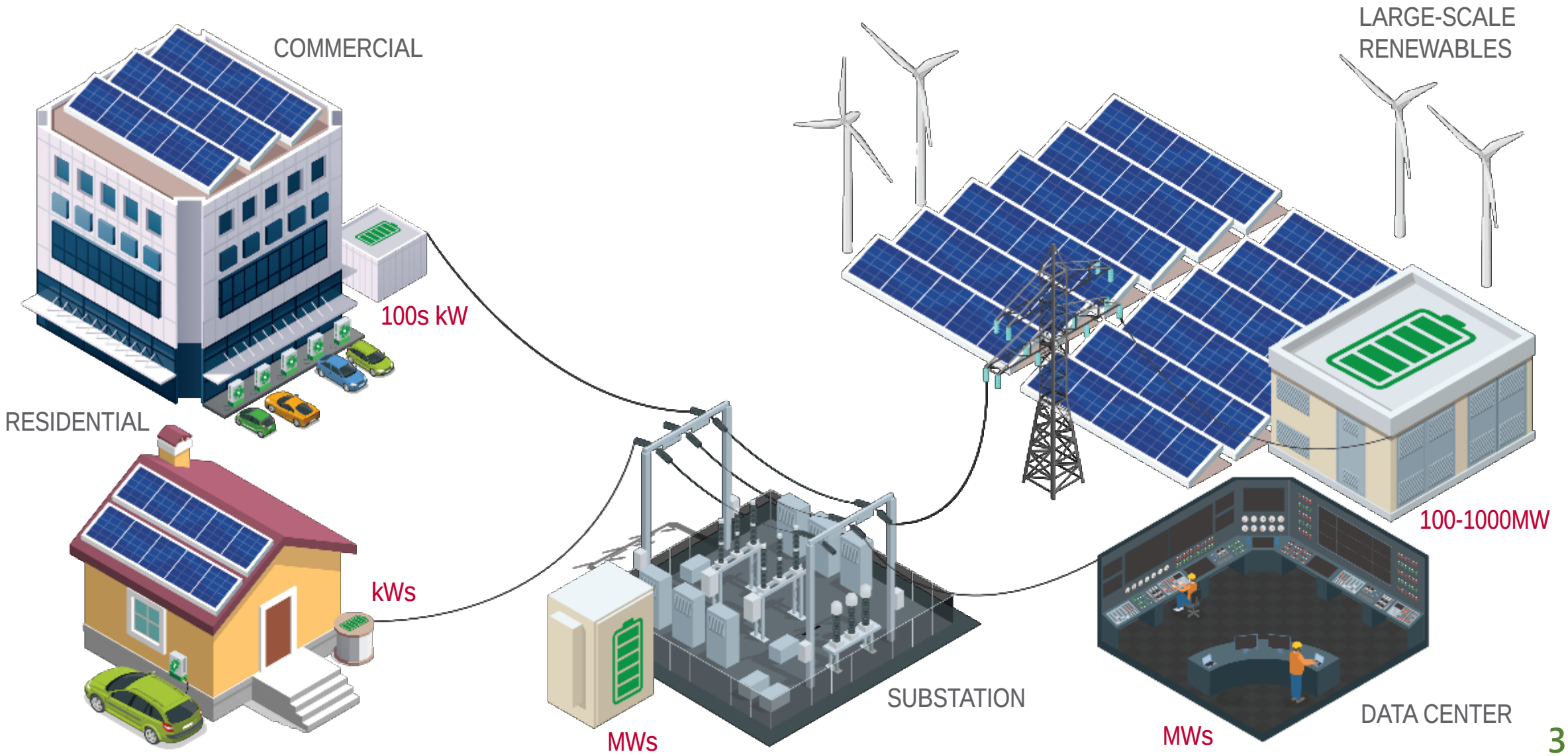

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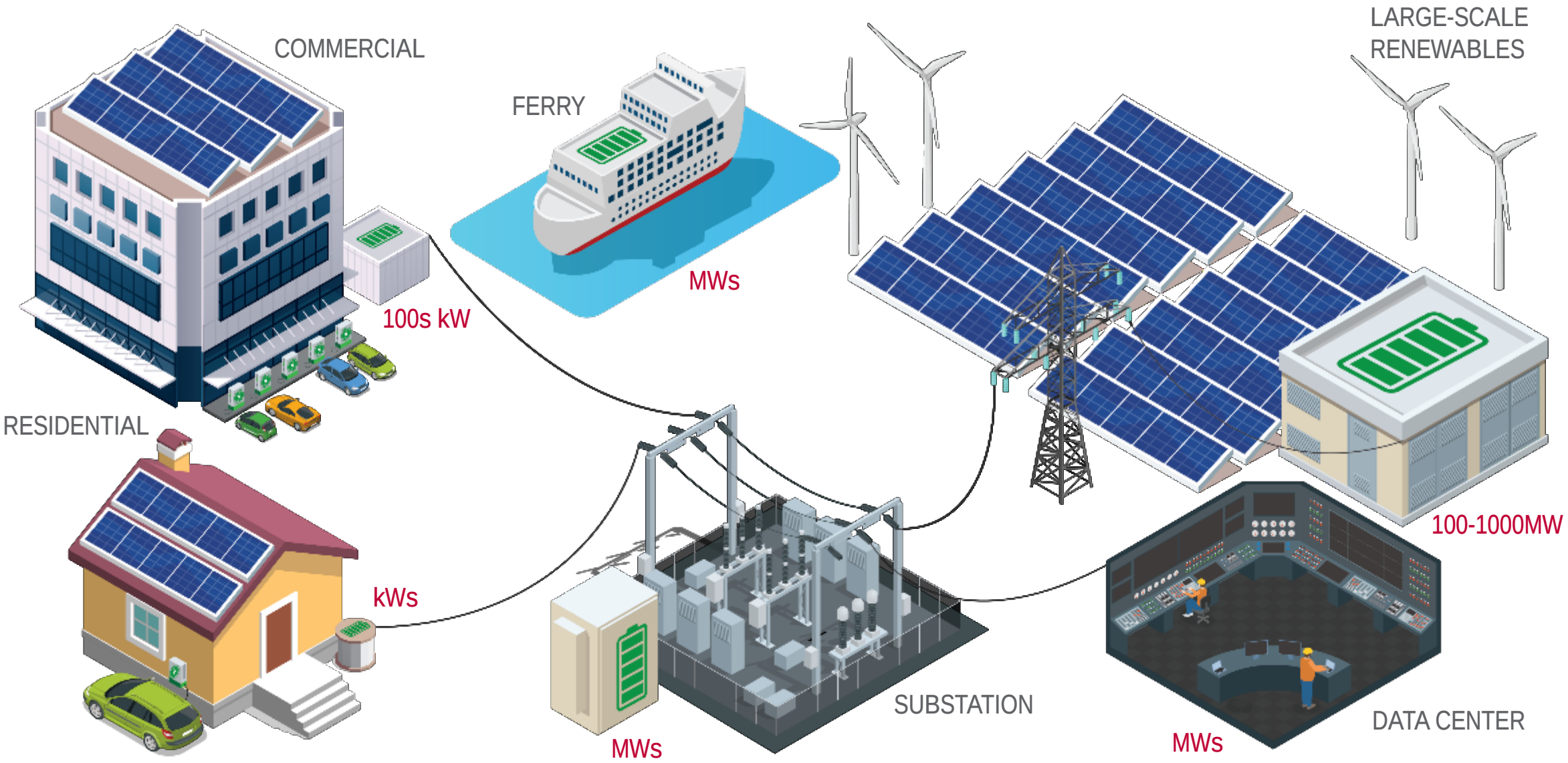
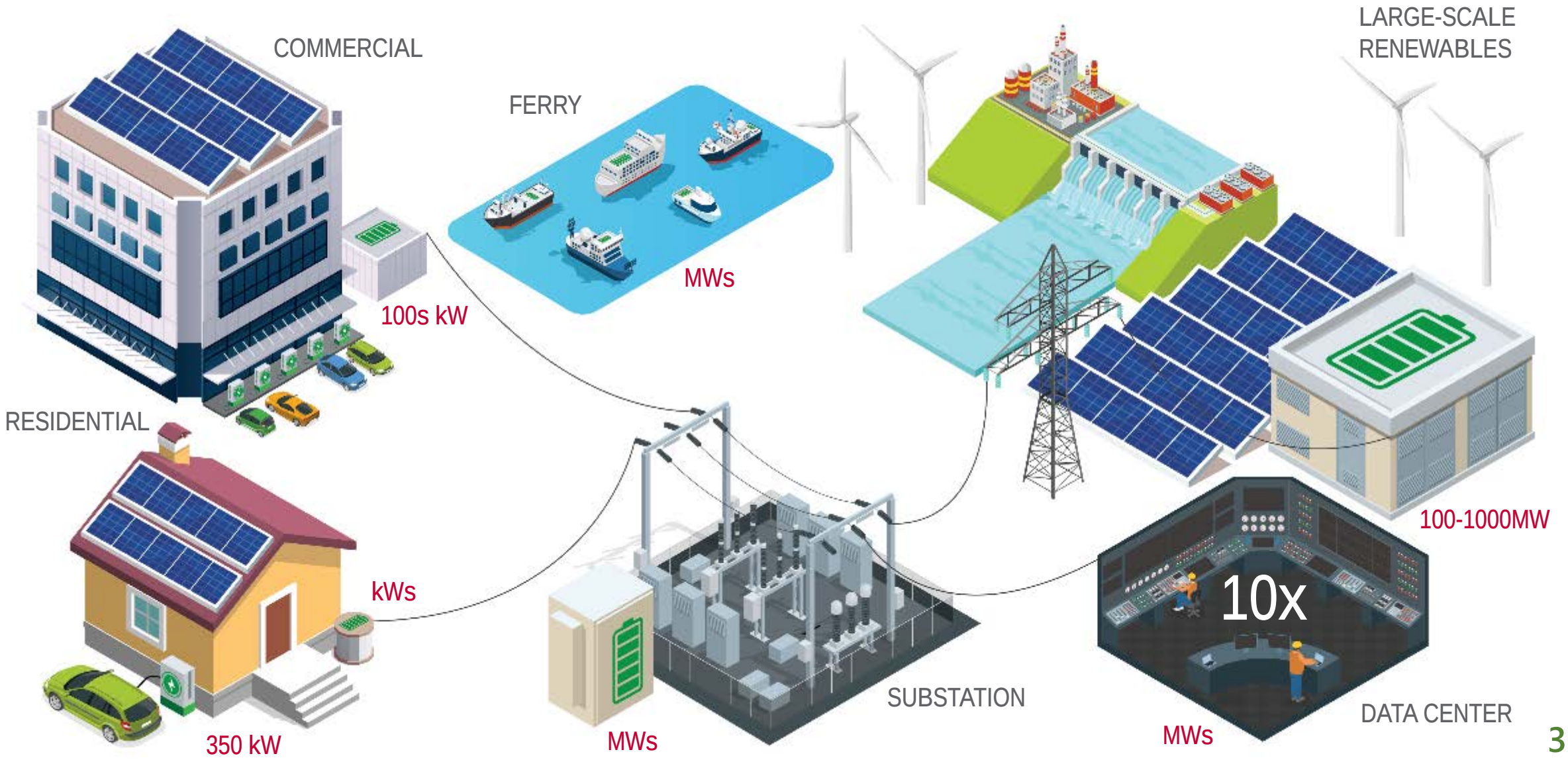
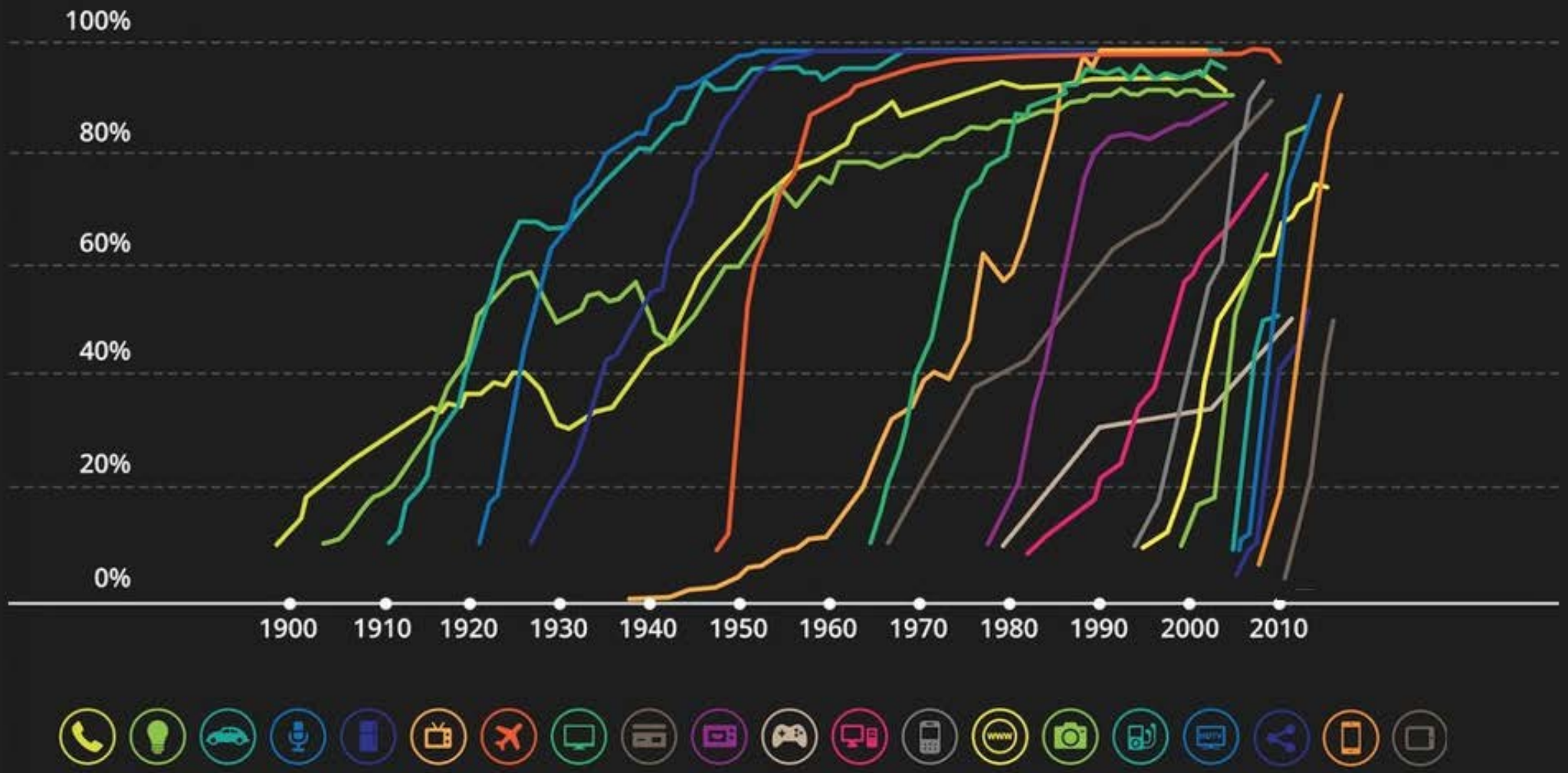


Energy Storage at the Convergence of Infrastructure

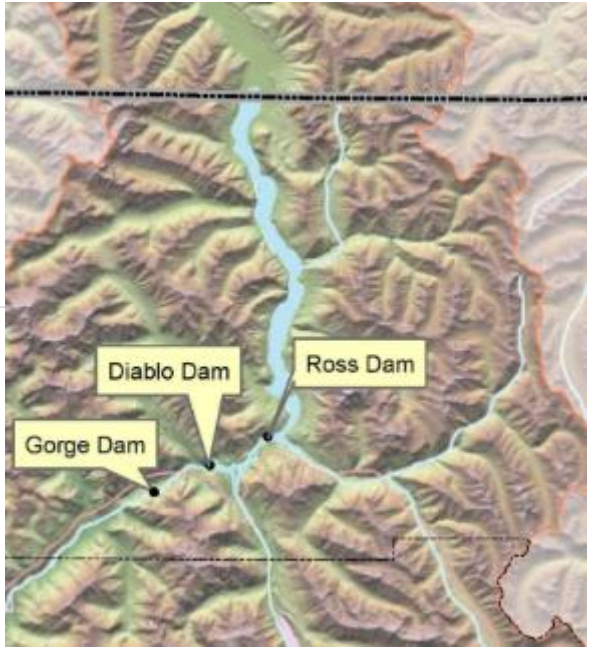


Adoption of **Technology** in the US



Source: Comin and Hobijn (2004) and others. OurWorldinData.org/technology-adoption/ • CC BY
Note: See the sources tab for definitions of household adoption, or adoption rates, by technology type.

Seattle City Light



Beyond Li-Ion and Diesel…

Existing

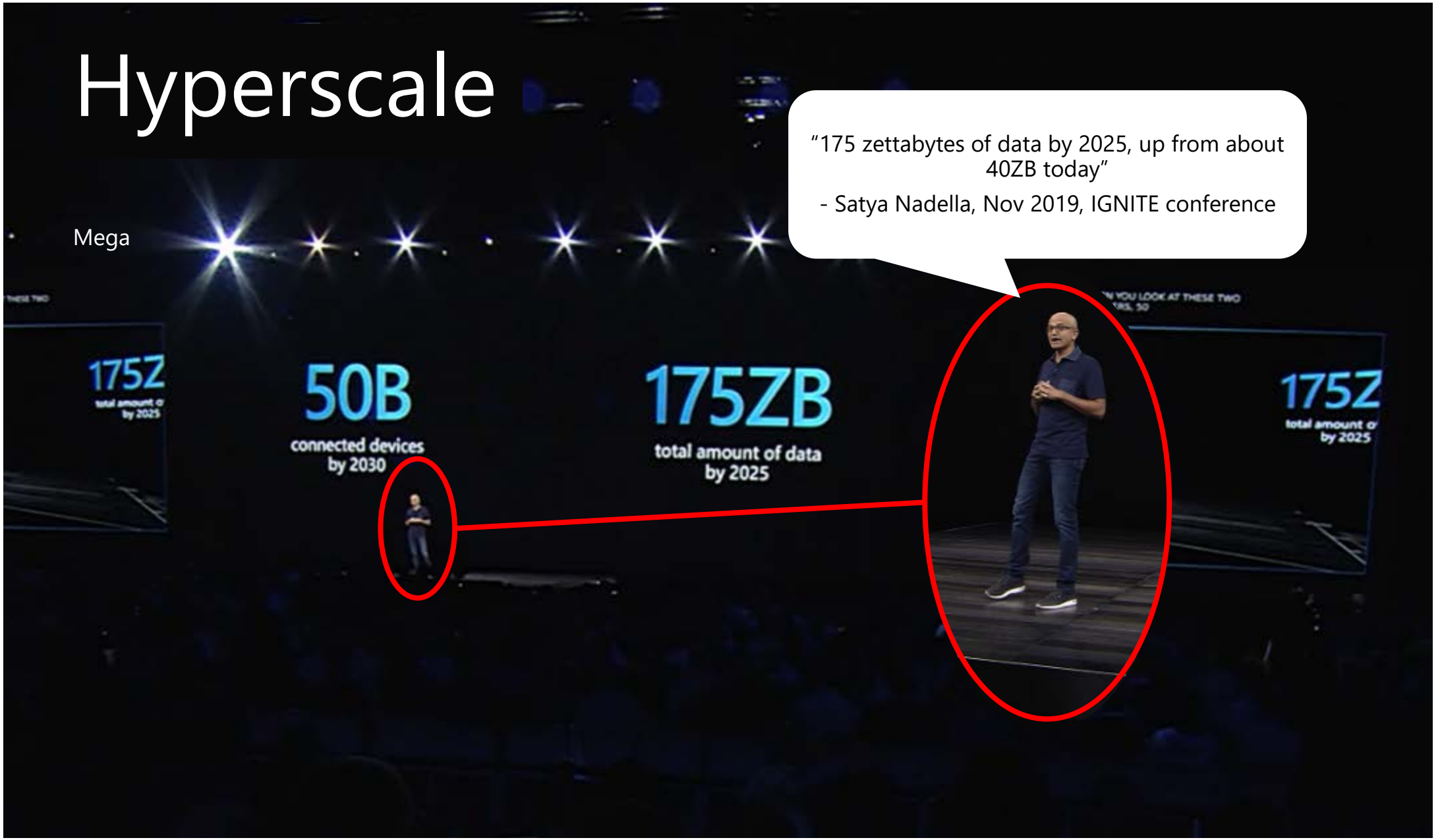
- Utility owned BESS – Li-Ion 200kW/800kWh at Microgrid
- Residential customer batteries (planning for IEEE 1547-2018)
- Diesel generator backup

Future Vision

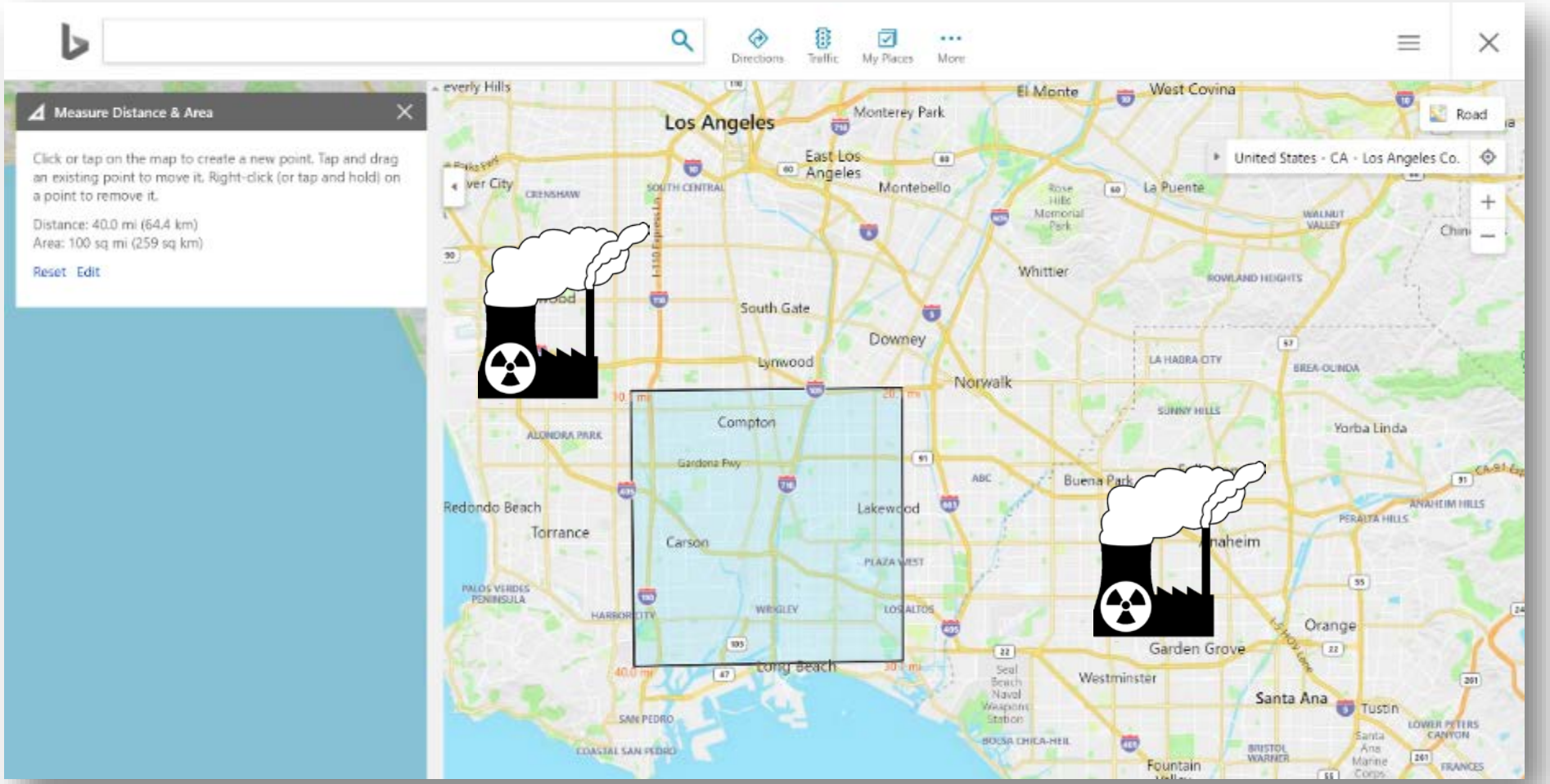
- BESS to delay Distribution system upgrades
- Energy Storage/Infrastructure
- Pumped Storage project at Skagit dams
- Advantageous Business Models (customers and grid)

Hyperscale

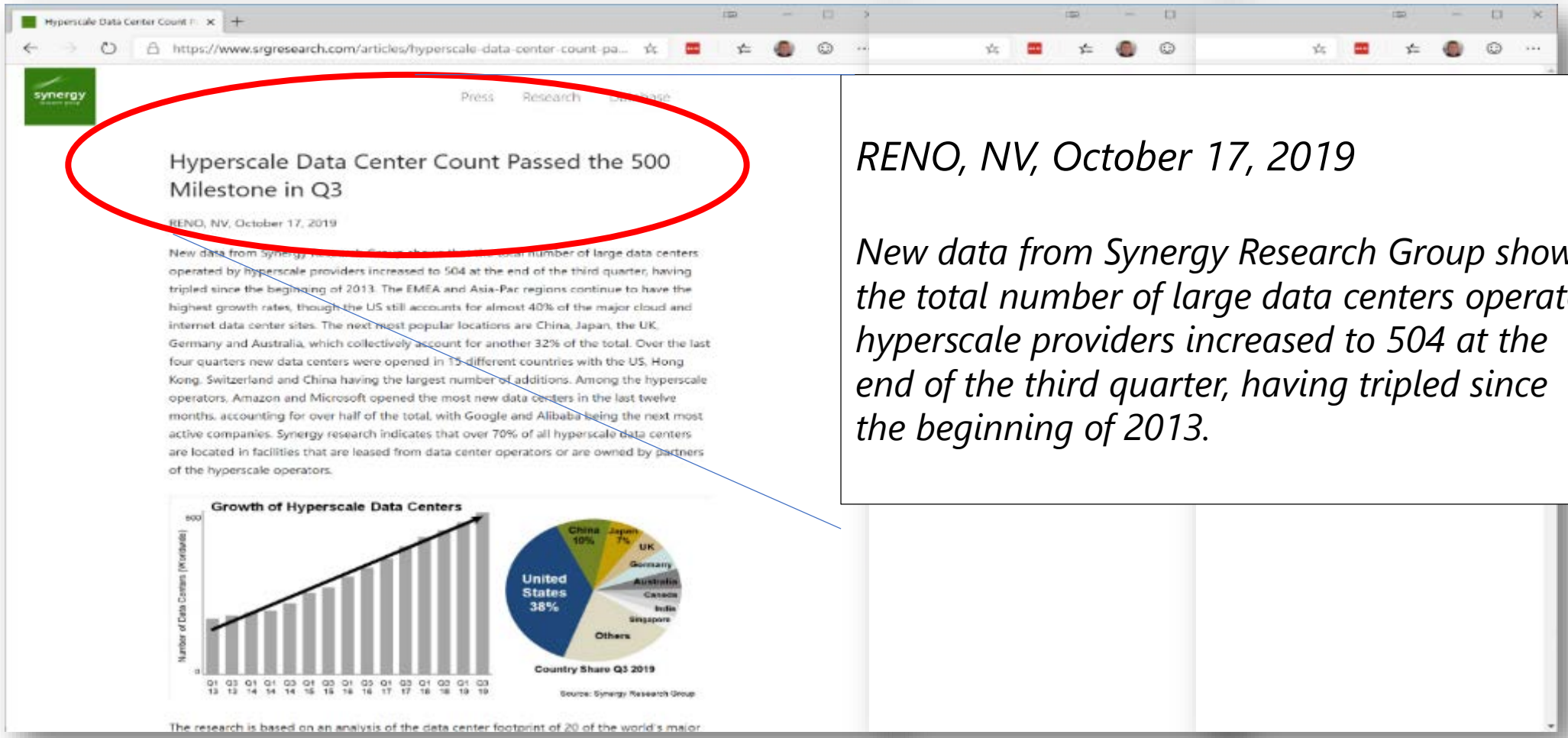
Mega



105 sq mi, 2,016 MW (…just storage)



~24 Hyperscale Companies, 500+ D.C.



Hyperscale Data Center Count Passed the 500 Milestone in Q3

RENO, NV, October 17, 2019

New data from Synergy Research Group shows that the total number of large data centers operated by hyperscale providers increased to 504 at the end of the third quarter, having tripled since the beginning of 2013. The EMEA and Asia-Pac regions continue to have the highest growth rates, though the US still accounts for almost 40% of the major cloud and internet data center sites. The next most popular locations are China, Japan, the UK, Germany and Australia, which collectively account for another 32% of the total. Over the last four quarters new data centers were opened in 15 different countries with the US, Hong Kong, Switzerland and China having the largest number of additions. Among the hyperscale operators, Amazon and Microsoft opened the most new data centers in the last twelve months, accounting for over half of the total, with Google and Alibaba being the next most active companies. Synergy research indicates that over 70% of all hyperscale data centers are located in facilities that are leased from data center operators or are owned by partners of the hyperscale operators.

The research is based on an analysis of the data center footprint of 20 of the world's major

RENO, NV, October 17, 2019

New data from Synergy Research Group shows that the total number of large data centers operated by hyperscale providers increased to 504 at the end of the third quarter, having tripled since the beginning of 2013.

1 MW x 24 hours = 2,000 kg H2
30 MW x 48 hours = 100,000 kg H2

Microsoft

Orcas Power & Light Cooperative

Serving the San Juan Islands since 1937

San Juan Islands is a unique rural territory serving over 20 islands (14,700 services) in Washington.

Energy Storage benefits:

- Outage Mitigation for Critical Infrastructure/Remote Island
- Submarine Cable Replacement Deferral
- Further allowance of intermittent renewables

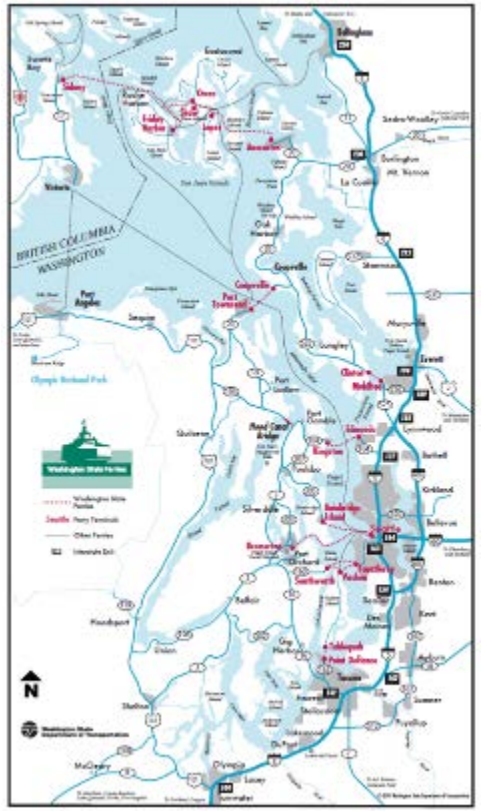
Future Vision:

- Tidal Generation
- Vehicle-to-Grid Integration
- Distributed Storage and other resources

WSF System-Wide Electrification Plan

Addition to 2040 Long Range Plan

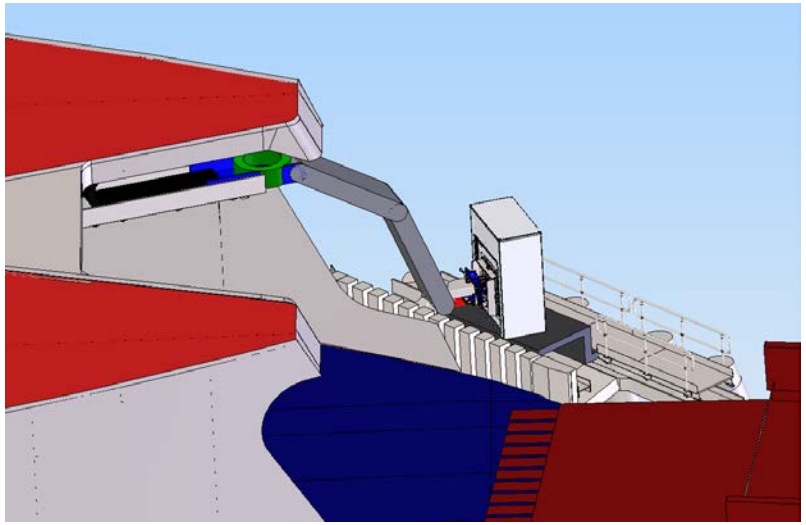
- Technology Assessment
- Vessel Requirements & Feasibility Analysis
- Terminal Requirements & Feasibility Analysis
- Construction Project Schedule
- Workforce Assessment
- Financial Model
- Emissions Impact Estimate



Designs in Progress

Jumbo MKII Conversion

- 1st Vessel Commissioned in 1997
- 460 ft long, 202 Vehicle capacity
- 3 vessels, 2 routes
- 2 of 4 Diesel Generators Removed
- 6.3 MW-Hr of Energy Storage Installed
- 5 Million Gallons/yr Fuel Savings

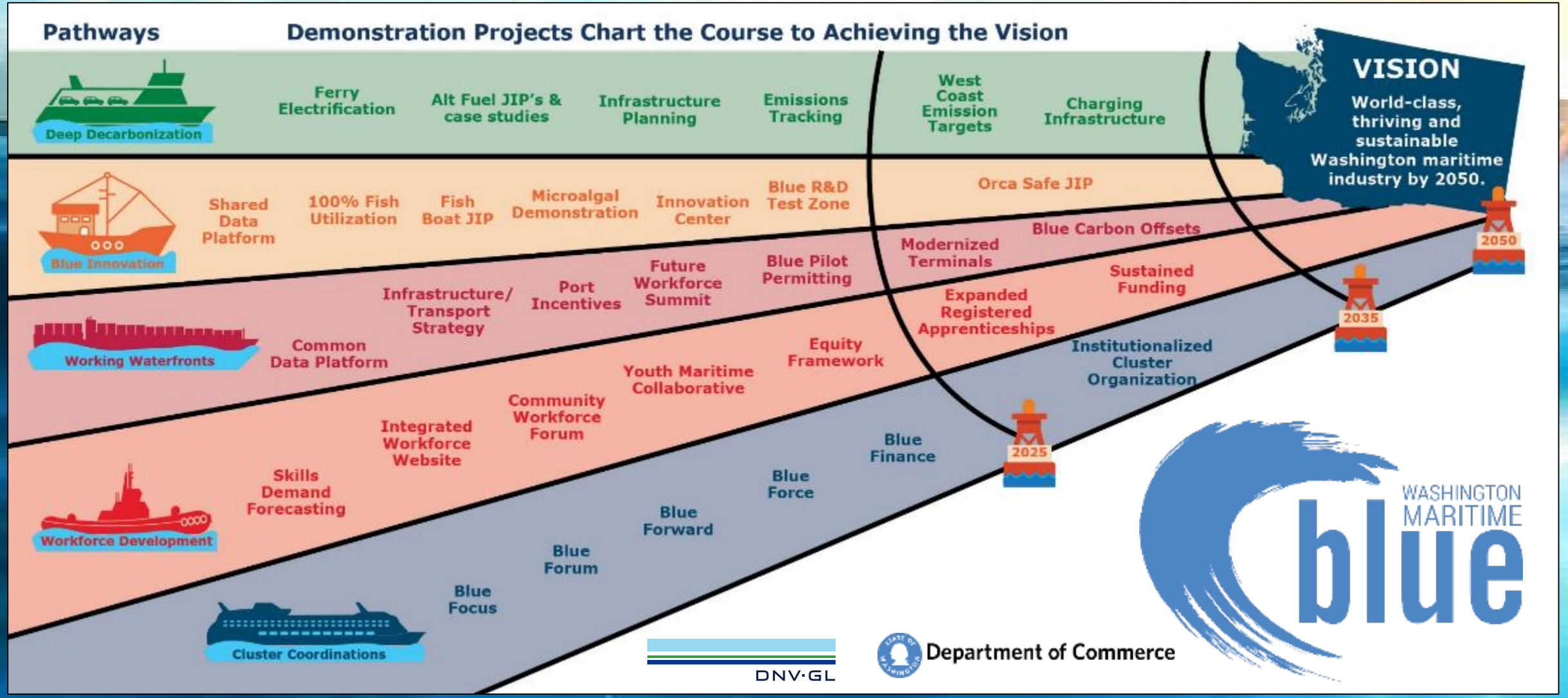


Rapid Charging System

- 12.4 KV
- 15 MW Maximum Charging Power
- 20 Minutes Charging Time
- 20 ft Tidal Range
- Minimal Over-Water Construction

Olympic Class New Build

- Original 4 Vessels Diesel-Mechanical
- 5 vessels, 2 routes
- New Propulsion Design - DC Grid
- 12 MW-Hr of Energy Storage Installed
- 5 Million Gallons/yr Fuel Savings



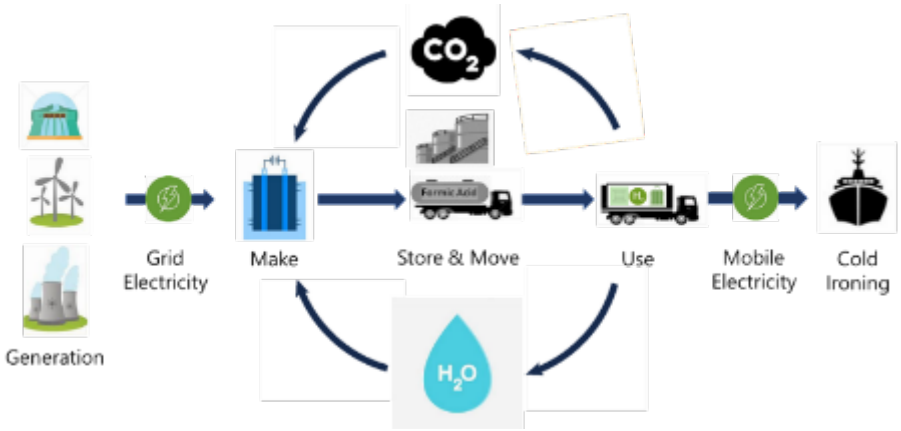
Washington Maritime Blue - from Strategy to Implementation

Example Joint Innovation Project (JIP)

Scaling a Zero-carbon Green Hydrogen Maritime Ecosystem: Mobile Cold Ironing through Formic Acid Storage Pathways

CHALLENGE

Alternative fuels and energy are needed to reduce emissions from transportation and port operations. Hydrogen shows great promise, if it can be generated at scale in our region from renewable energy, as well as stored and transported in a safe manner. Tacoma Power has excess clean hydropower generation that can be utilized to make Green Hydrogen. They also need to provide energy for cold ironing services to berthed vessels, which have large variances in power demand and timing.



SOLUTION

- Build and scale a Maritime hydrogen ecosystem through a project at the Port of Tacoma that demonstrates a port-based hydrogen (H_2) solution utilizing Formic Acid for lower cost and safer storage and movement.
- Tacoma Power will provide the green electricity, primarily from hydropower, and is 97% carbon free. They will also be the end user of the H_2, to generate energy on demand for mobile cold ironing (shore power) to berthed vessels.
- The demo features a system that creates a liquid H_2 carrier, Formic Acid, directly from renewable electricity, water and recycled CO_2. This unique technology is provided by OCO Inc., whose electrolyzer technology creates the Formic Acid and PNNL, who provides the reformer technology to decompose and release H_2 from formic acid as needed.
- DNV GL will provide techno-economic modeling so this demo can be used as the anchor for scaling-out hydrogen use in other maritime applications like H_2 fueling for trucks, trains, vessels and a wide variety of cargo handling applications.

VISION

Regional collaboration to make Tacoma, WA the production and distribution nerve center for scaling up the use of clean hydrogen for port and maritime applications.

BENEFITS

This approach provides a large-scale local production and use for Hydrogen in maritime ports that can be stored as a liquid carrier in the form of Formic Acid, overcoming some of the key storage and movement challenges. This demonstration has the potential to show ports, utilities, and numerous maritime end-users what can be achieved when H_2 is used at scale.

Questions

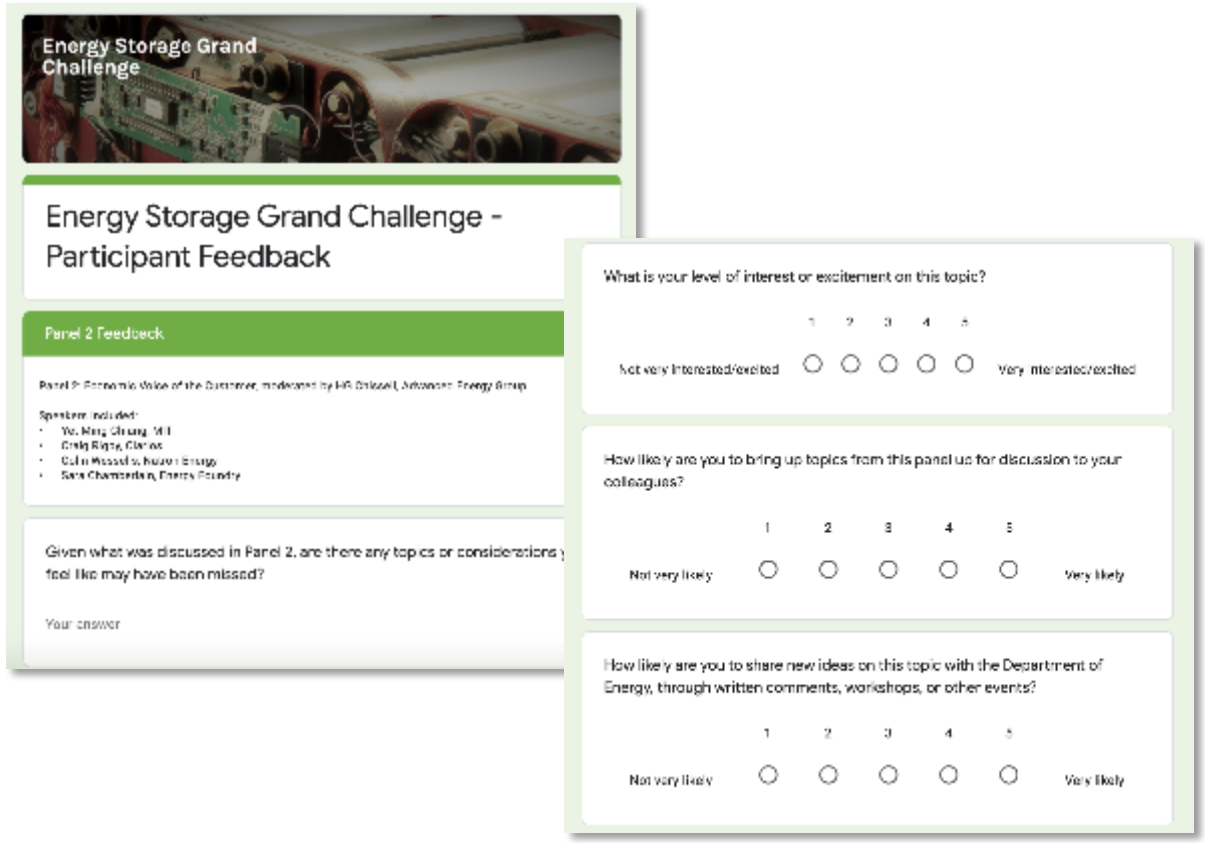
Please submit your questions in the Chat box to the host. Reference the speaker or topic.

Workshop Feedback Form

After this workshop, we invite you to share your additional thoughts and comments about the presentations you heard today. This may include additional questions, concerns, considerations, or suggestions for the Department of Energy.

This is an opportunity to provide us with feedback on how interesting and relevant the material from the panels were. You are also able to opt-in to be involved in future Department of Energy events.

The link is available through the chat function in WebEx.



Wrap Up

Michael Furze

Assistant Director, Energy Division
Washington State Department of Commerce

Thank you.

Our next workshop:

- Midwest/Northeast Regional Workshop, May 27

For more information, visit:

https://www.energy.gov/energy-storage-grand-challenge

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