US DOE Electrolyzer Installation Workshop

Electric Utility Perspective

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Decarbonization Pathways Enabled by Innovation

~10-15 years

~15-30 years

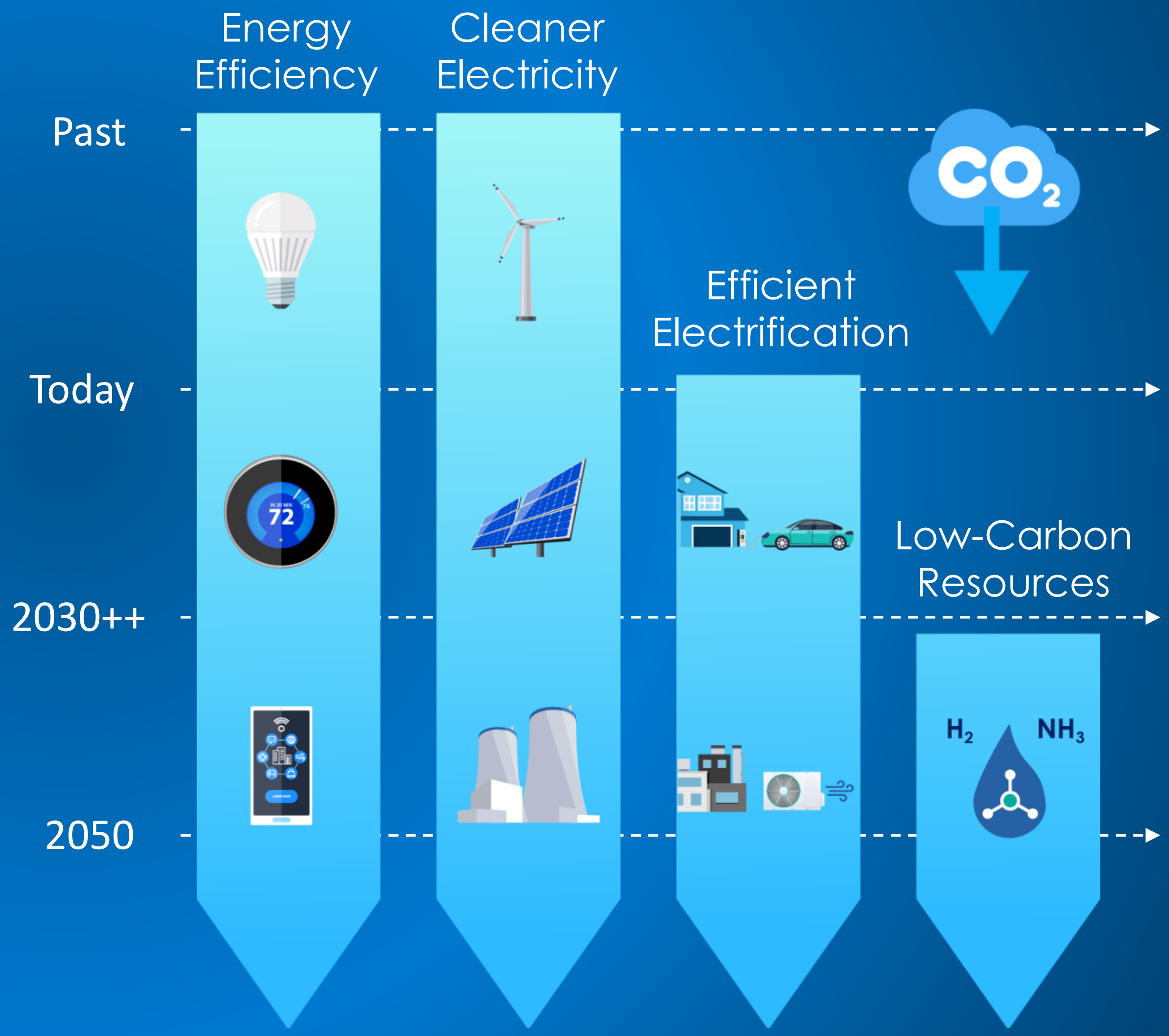
Decarbonization

Accelerate economy-wide, low-carbon solutions

- Electric sector decarbonization
- Transmission and grid flexibility: storage, demand, EVs
- Efficient electrification

Achieve a net-zero clean energy system

- Ubiquitous clean electricity: renewables, advanced nuclear, CCUS
- Negative-emission technologies
- Low-carbon resources: hydrogen and related, low-carbon fuels, biofuels, and biogas



LCRI MISSION

Achieving **net zero emissions across the economy** by 2050 will require accelerating a safe, affordable, and reliable energy transition through advancements in a **variety of clean energy technologies and options**.

EPRI and GTI Energy have created the LCRI to evaluate pathways for deployment of **low-carbon fuels and energy carriers** in support of decarbonization across the energy economy.

The LCRI is focused on a vision of the future global energy system that is **decarbonized, consumer-focused, sustainable, and resilient**.

LCRI Focus

Hydrogen | Ammonia | Synfuels | Biofuels | CCS

Utilities need to information on electrolyzers:

COST

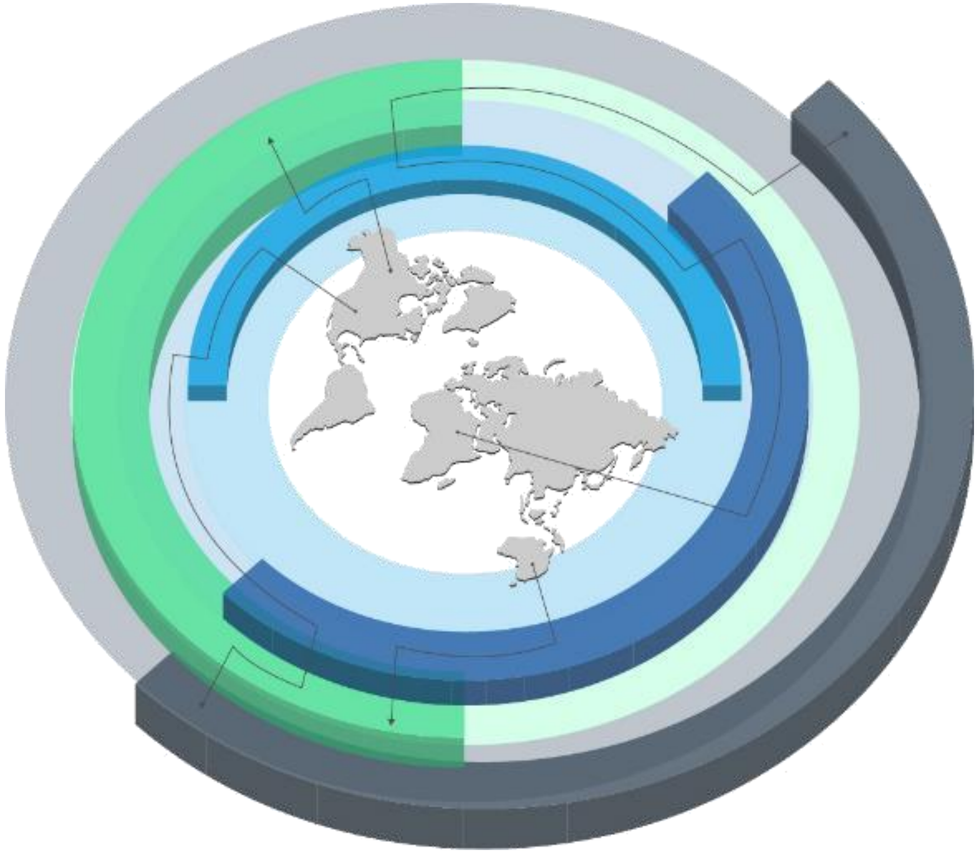
PERFORMANCE

LIFETIME

In the context of utility decision making.

Portfolio Planning → Project Design → Procurement → Operations → End-of-Life

Siting Considerations



Input: Electricity Source

- Depends on Operating Paradigm (Baseload versus Flexible)
- Grid Tie-in, Electrical Infrastructure

Input: Sustainable Water Source

- Water agreements or contracts and purification equipment

System Footprint

- Size of electrolyzer and balance of system
- Size of Renewables if coupled

Output: Offtake for Hydrogen

- Co-located use for Hydrogen or conversion to Alternative Energy Carrier (AEC)
- Infrastructure or Pipelines for Market Delivery

Operating Paradigms – Shifting to Flexible?

Baseload Operation

- Follows load interconnection path
- Use Data Center as a model

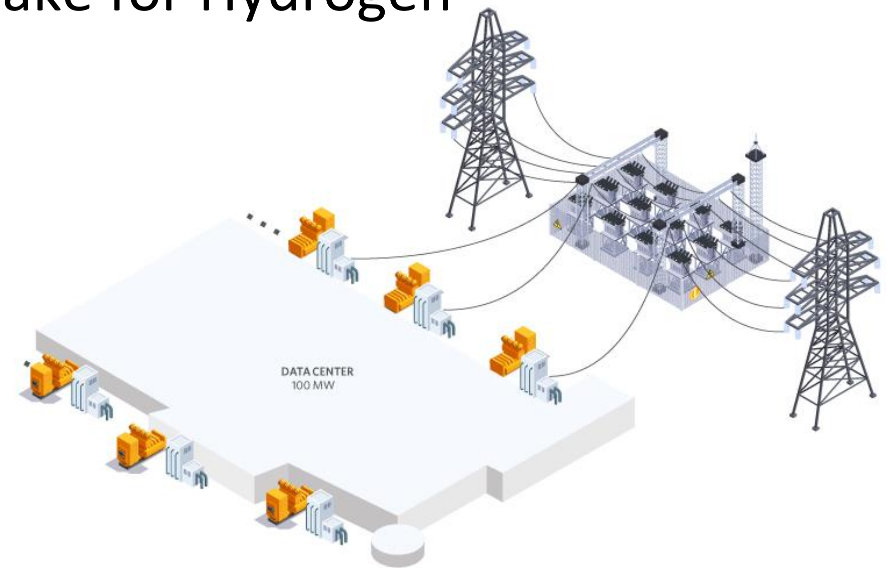
Flexible – Renewable coupled/connected/tied

- More complicated
- Would a Renewable + Electrolyzer connect through the Interconnection process like Solar + Storage?
- System Planning and Design Considerations

Baseload Operation - Data Center Load-like Comparison

Electrolyzer Owners and Developers Address

- System Sizing and Capital Cost
- Access to Low-Carbon Electricity
- Access to Sustainable Water Source
- Offtake for Hydrogen

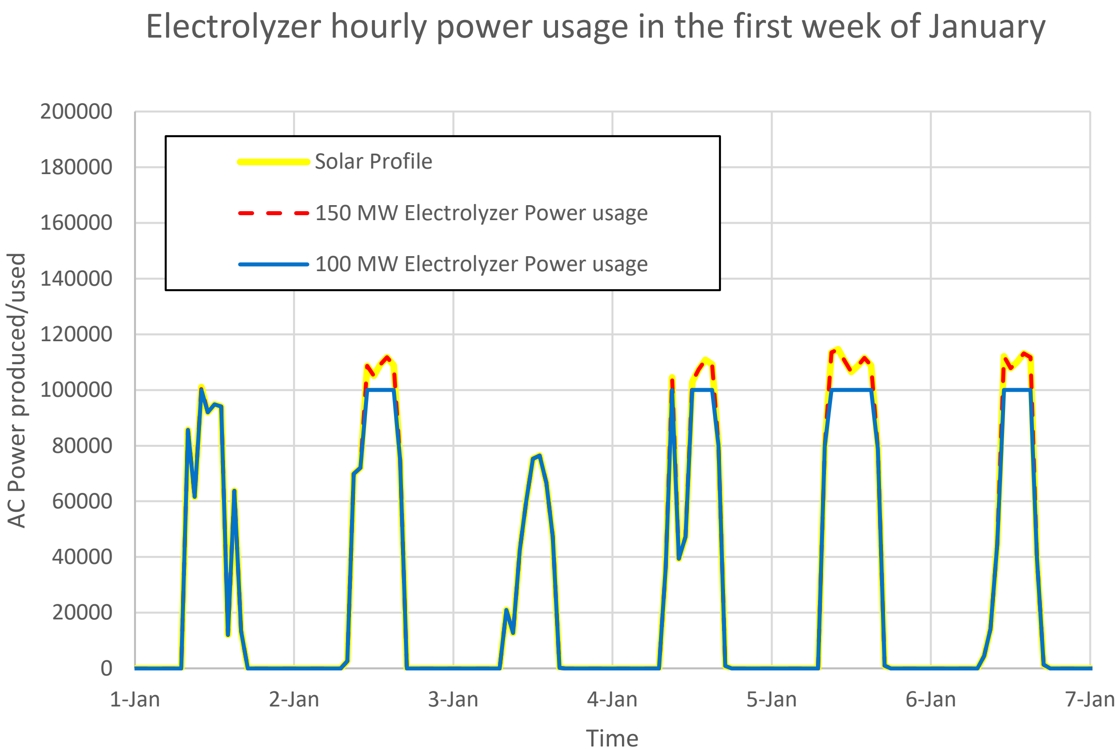


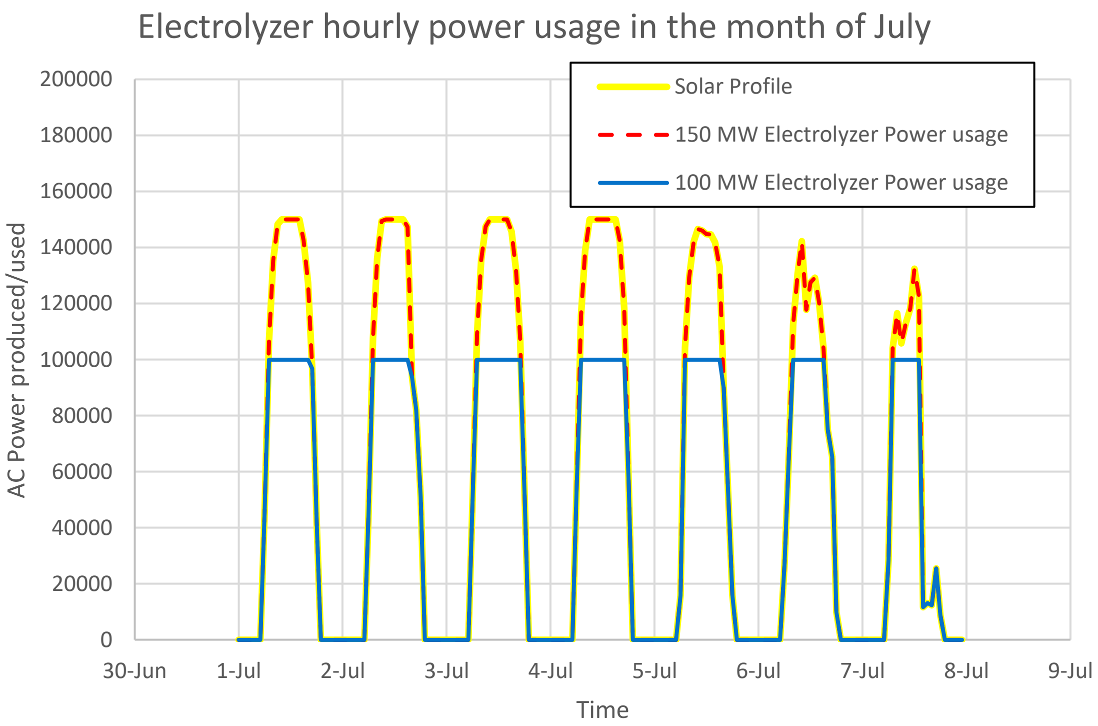
Utilities Must Consider

- Schedule to Build Infrastructure
  - Planning
  - Permitting
  - Constructing or upgrading power lines
  - Constructing or upgrading substations
- Costs – Rate payers of customer for interconnection costs
- System Impacts – Transmission Impacts and New Generation Impacts
- Grid Reliability and Power Quality of New Load

https://www.hdrinc.com/insights/rethinking-data-center-power

Flexible Operation – Solar Coupled Example





How to design electrolyzer and balance of system to manage ramping operation

Research Opportunities around Flexible Operation

- Translating renewable profiles into operational profiles.
- Design considerations for electrolyzer and balance of system.
- Impact on electrolyzer capacity factor (CF) (hours of system usage).
- Impact on system sizing and renewable utilization (RU).
  - Rule of thumb for sizing?
- Opportunity for batteries to increase CF and RU, reduce system ramping, or prevent clipping.
- If co-located, benefits and tradeoffs of DC coupled system operation.

Example Substation – Red Bluff Substation Project

- Riverside County
  - Connected renewable-project to the transmission grid
- Major Project Components
  - New 500/220 kV substation
  - Two new parallel transmission line segments
  - Rebuild of an existing distribution line
- Project Timeline
  - November 2010: Filed project application with CPUC for approval
  - September 2011: Construction scheduled to begin
  - June 2013: Substation in service
- Context from LBNL
  - Time to commercial operation for projects built 2000-2010 was 2.1 years.
  - For projects built 2011-2021 the time was 3.7 years.

SCE Project Site - https://www.sce.com/about-us/reliability/upgrading-transmission/red-bluff

Connection and Substation Equipment and Key Lead Times

- Line Upgrade: 12 months
- Circuit Breaker: 6 months
- Surge Arresters: 20 weeks
- Disconnect Switch: 22 weeks
- Transformers:

  24-38 months

  - Tap Changers: 6-15 weeks
  - Bushings: 8-31 weeks

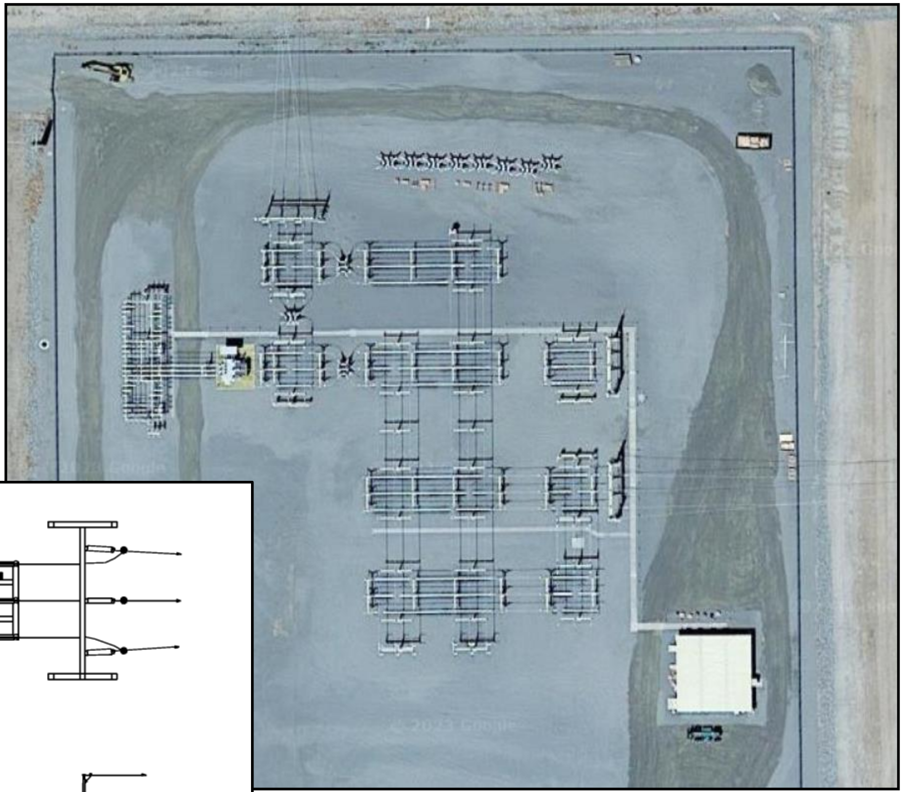


Photo Credit: Google Maps, Nevada Substation

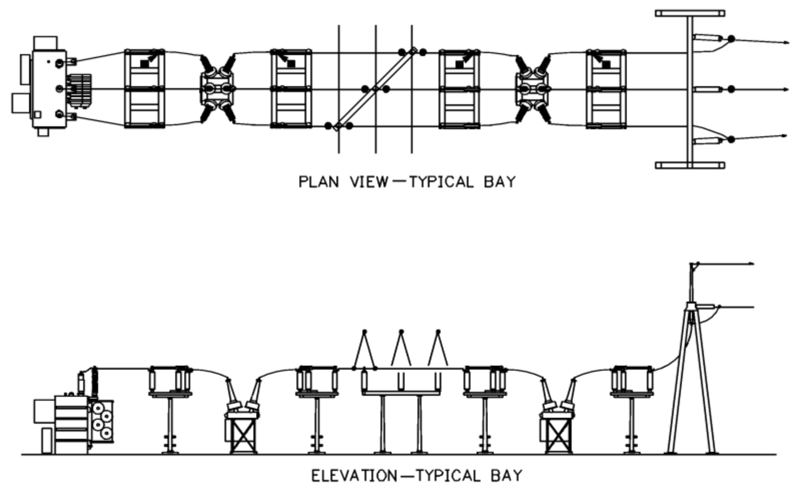


Figure 4-9: Single Bus—Low Profile

Design Guide for Rural Substations - https://www.rd.usda.gov/sites/default/files/UEP_Bulletin_1724E-300.pdf

Interconnection Process – Add to Site Selection List?

- **CalISO** - http://www.caiso.com/planning/Pages/GeneratorInterconnection/Default.aspx
- **MISO** - https://www.misoenergy.org/planning/generator-interconnection/
- **PJM** - https://www.pjm.com/-/media/committees-groups/task-forces/iprtf/postings/interconnection-process-overview.ashx
- **NYISO** - https://www.nyiso.com/interconnections
- **ISO New England** - https://www.iso-ne.com/participate/applications-status-changes/interconnection-process-guide
- **HydroOne** - https://www.oeb.ca/documents/cases/EB-2006-0189-0200/h1n_transmission-customerconnectionprocess-final_101106.pdf
- **…**

Lessons from Smaller System Deployments

Importance of simple, clear communication!

Community Stakeholders

Explain new technologies and highlight design safety. Important to be accessible to a wide ranging, non-technical audience.

Local Government and Approval Boards

Electrolysis technologies need to be understandable to local decision makers, so they can weigh the information in their planning and approval processes and address community concerns.

Regulators

Regulators need to be able to evaluate electrolysis technologies within the portfolio of energy options.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