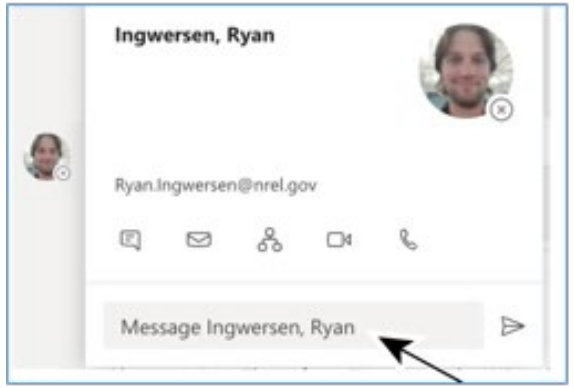
Breakout II

Multi-Timescale Storage for Utility-Scale Renewable Power Generation

Rob Hovsapian, Senior Research Advisor, NREL

Meeting Logistics



- **Please mute** yourself when not speaking.
- You are welcome to have your camera on for today's conversation.
- **Use the chat box** and raise hand features to ask questions or provide comments.
- The first part of the workshop will be recorded, but the breakout sessions will not to promote candid discussion (Chatham House rules)
- Use chat or direct message our Teams workshop coordinator Ryan if you have questions or concerns throughout the workshop
- **Teams does not support call-in users in breakout sessions.**
  - If you joined the meeting using your phone for audio, you will need to hang up when we start the breakout sessions, then rejoin phone audio once the breakout has started. You will need to do this again when the breakout sessions close and you rejoin the main session.
- There will be a slight delay when we start and end the breakout sessions. You will be automatically transferred to your chosen breakout session and back to the main session.
- If you **have a question** anytime during today's workshop and would prefer not to use the chat, send an email to aries@nrel.gov.

Objectives for This Breakout Session

1. Get your perspective on research needs for energy storage, areas of interest for energy storage advancement, and potential opportunities for collaboration.

2. Any additional feedback you would like to share on how we can make ARIES a more valuable research platform to help you achieve your goals.

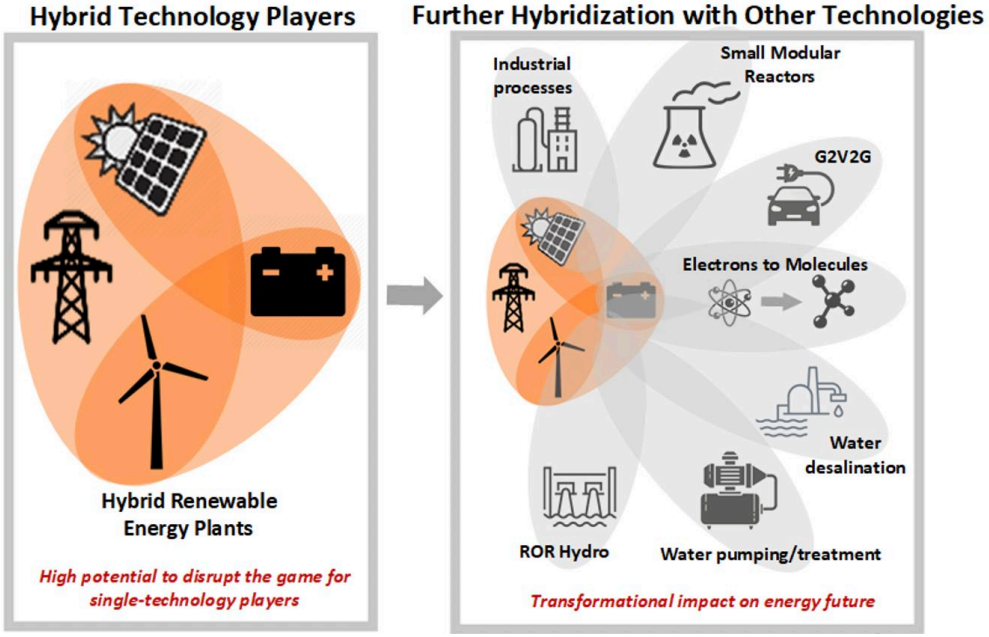
ARIES can evaluate widescale and multi-technology solutions for hybrid renewable energy systems

Challenges

- Growth in renewables, dynamic loads, and behind-the-meter assets is resulting in a **complex interaction of synchronously interfaced and inverter-interfaced** devices across the transmission and distribution grid at **multiple timescales**.
- Adoption of energy storage is increasing for both **grid-scale** (multi-MW) and **end-user** (few kW to MW) applications, which is shifting the electric grid into a new paradigm where **large capacity** and **large numbers of devices** can offer flexibility but require coordinated operation at different timescales.
- **Hybridization** of some of these new technologies is **unproven**, posing **interoperability** and **stability challenges** that are compounded by physical (man-made and nature) and cyber threats, thereby affecting resilience.

ARIES Value Proposition

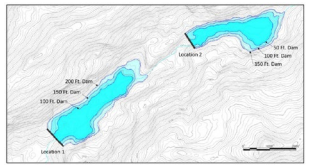
At-scale evaluation for multi-technology hybridization strategies and electrical-thermal energy storage considering various criterion such as cost, provision of grid services at **multiple timescales**, asset management, coordination of controllable loads, **electrons-to-molecules**, and utility scale assets.



GMLC RADIANCE Project

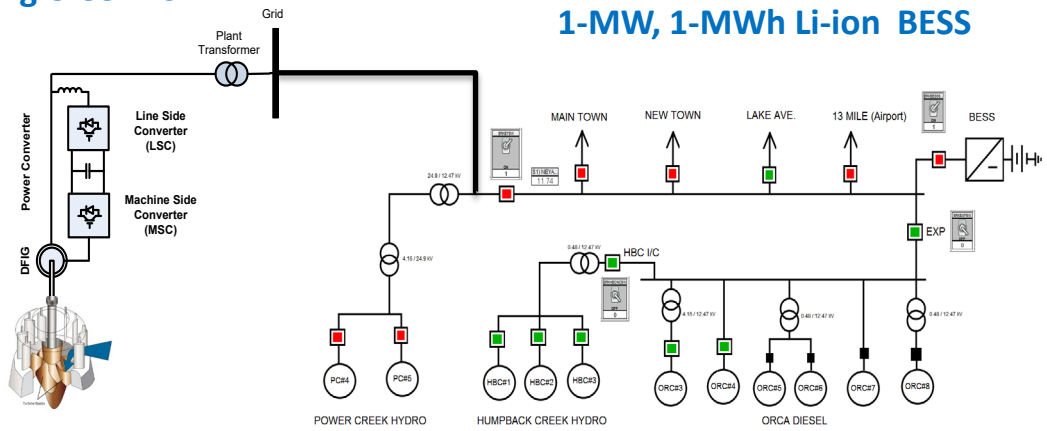
- Hydro-diesel-battery distribution system in Cordova, AK with seasonal dynamic industrial and commercial loads.
- Siemens Energy Storage Optimization Toolbox (ESOT) for multi-timescale hybrid energy storage control and inertial response.
- Pumped Storage Hydro (PSH) and Battery Energy Storage System (BESS) evaluation.

Raging Creek PSH

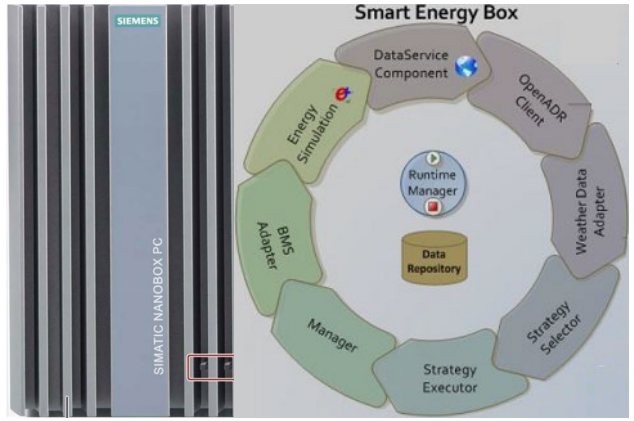


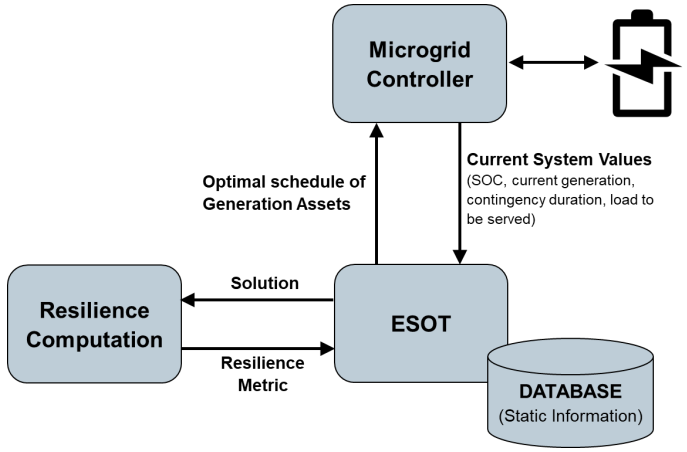
Evaluate Raging Creek PSH at two potential locations

1-MW, 1-MWh Li-ion BESS



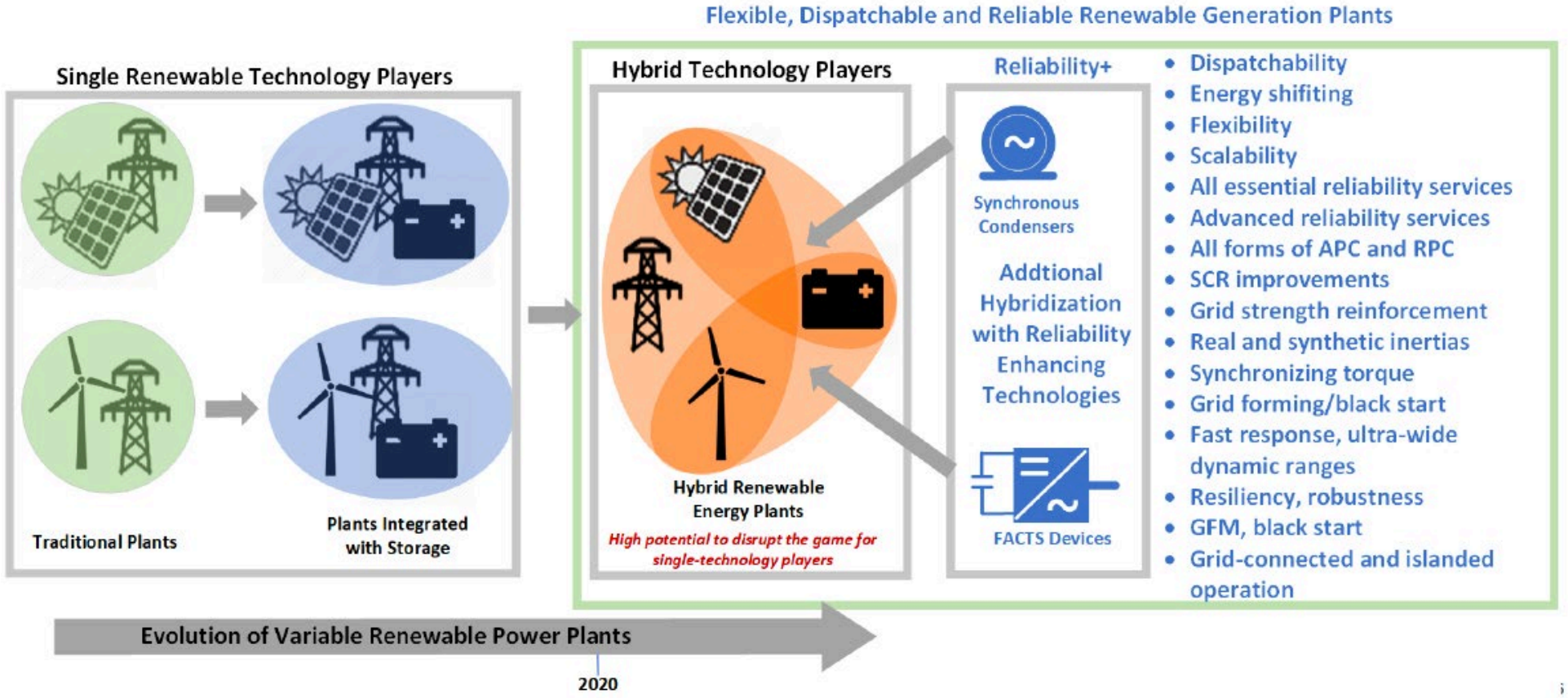
Energy Storage Optimization Toolbox (ESOT)





GMLC FlexPower Project

A pioneering demonstration of how technology hybridization can leverage utility-scale wind and PV generation combined with **batteries** and **hydrogen storage** to provide dispatchability and a full range of reliability services to the bulk power system, similar to or better than conventional plants

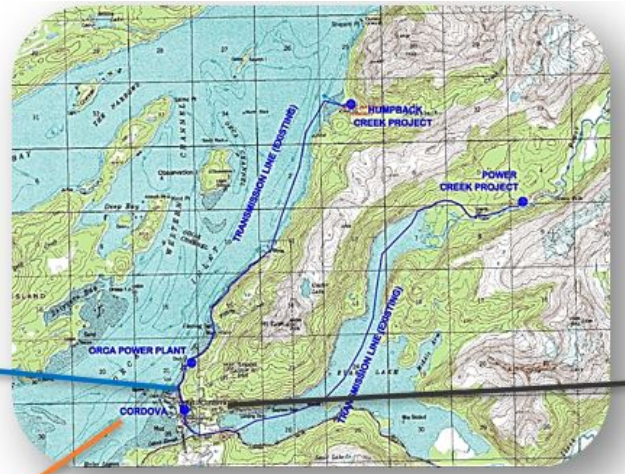


Marine hydrokinetic And Energy Storage for Resilient blue ecOnomy (MAEStRO)

Integration of MHK and energy storage for:

- 100% renewable energy integration in near-shore power grids;
- Complementary benefits of predictable MHK with dispatchable energy storage
- Energy affordability, energy sovereignty, and community resilience to support fisheries and the blue economy
- Energy technology de-risking using ARIES assets.

City of Cordova – future home of ***OpenHydro U.S.*** manufacturing facility

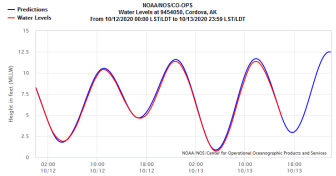


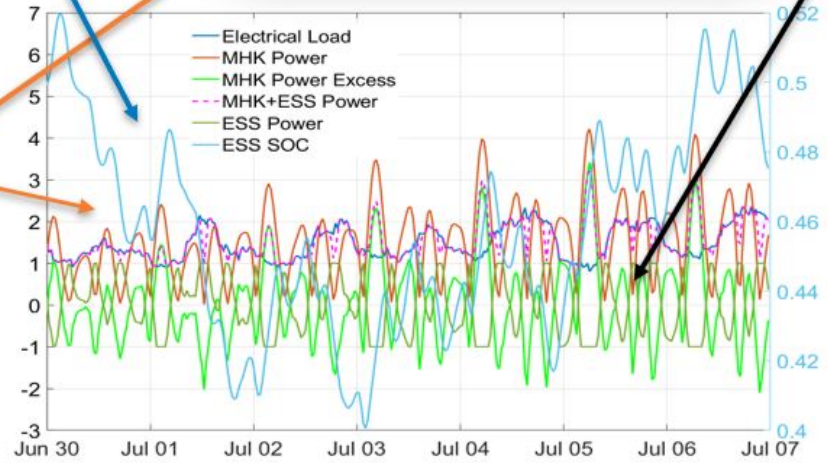
1MW-1MWh ESS

ESS SOC

Commercial Feeder Load

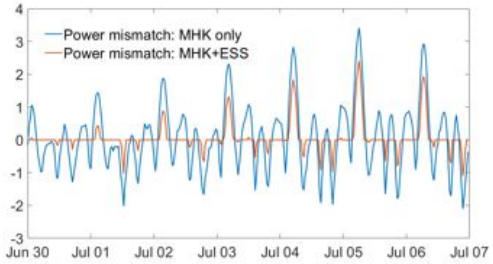
MHK





Hybrid MHK & ESS

- Can be optimized to achieve ***100% renewable energy*** for coastal AK communities
- Enabler for ***Blue Economy*** and provide energy resilience through local near-shore renewables

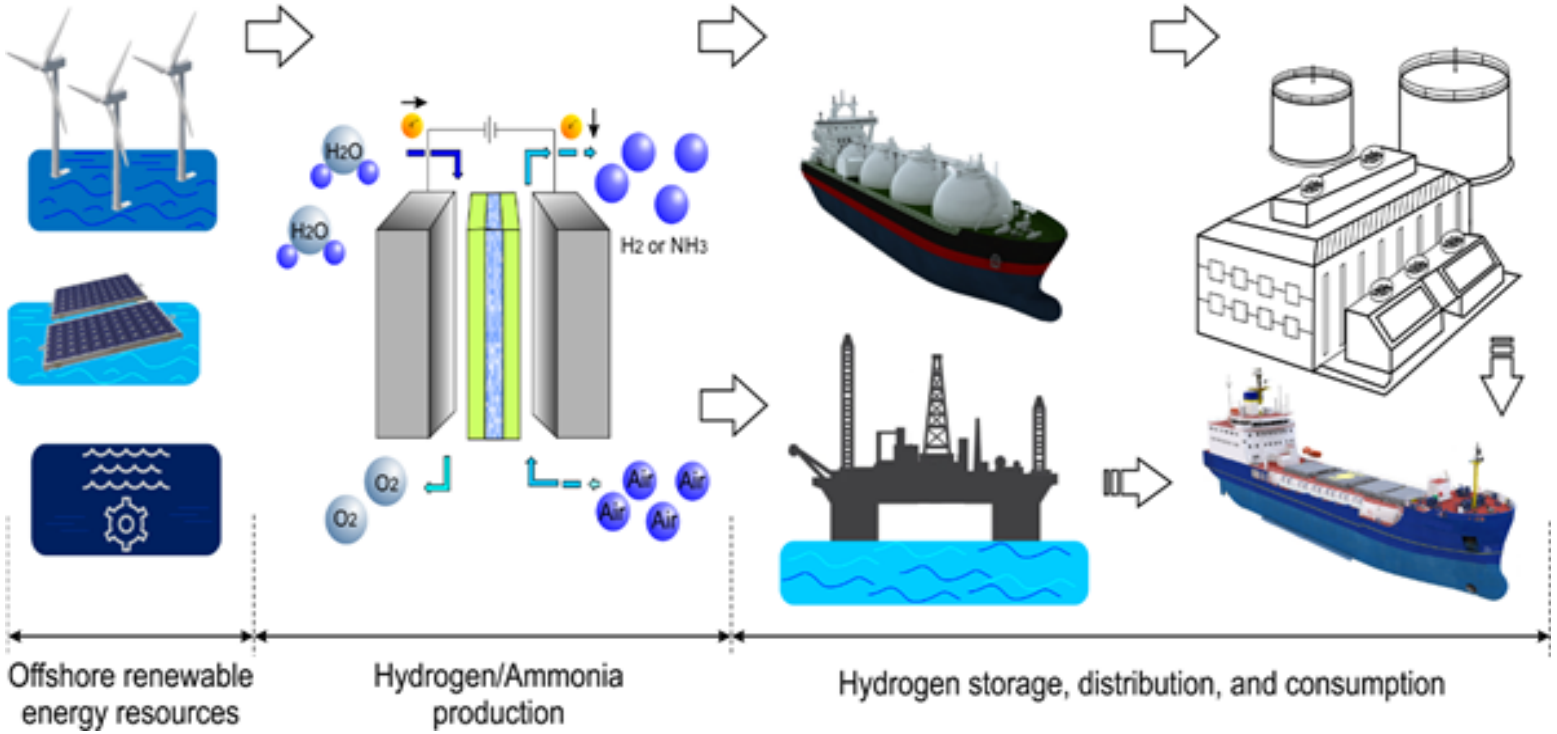


Examples of Future Opportunities: Controls for Hybrid Energy Storage

- Utility scale storage to support increases in renewable energy penetration.
- Advanced energy storage optimization toolbox using machine learning.
- Multi-timescale controls for hybrid energy storage application

Examples of Future Opportunities: Offshore Hydrogen From Renewables

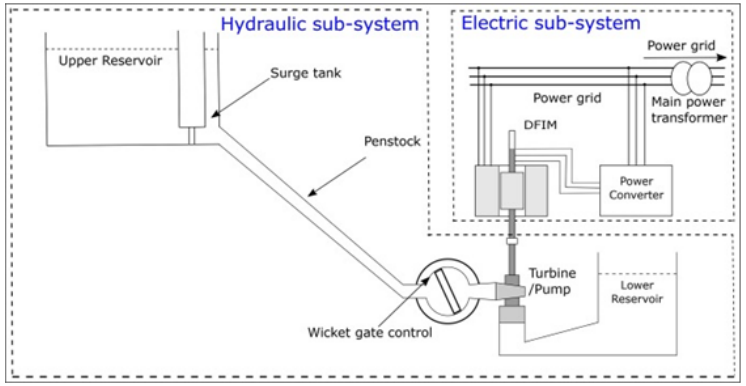
- Offshore hydrogen generation from renewables for mariner applications, flexible SOFC operation, and water desalination.
- Blending hydrogen into the existing natural gas pipeline.

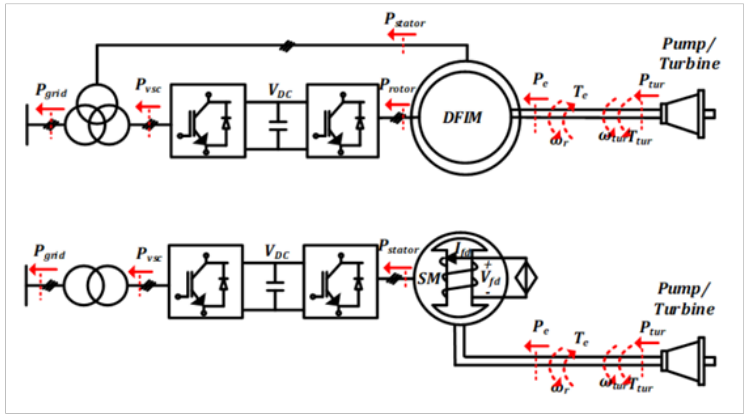


Examples of Future Opportunities Integrating Long- and Short-term Storage

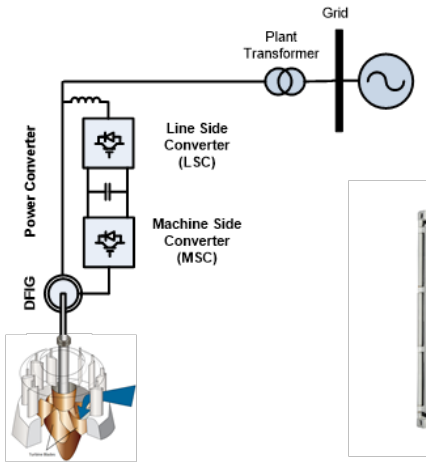
- Conventional PSH integration with other energy storage technologies to operate flexibly for grid services, using **short term storage (BES) or long term (H_2)**.

Variable speed PSH



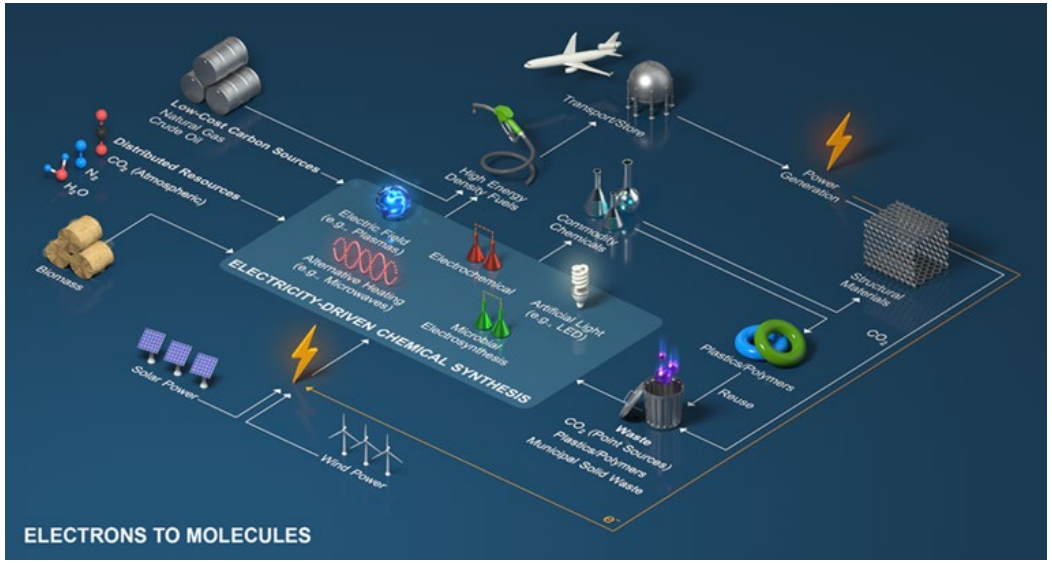


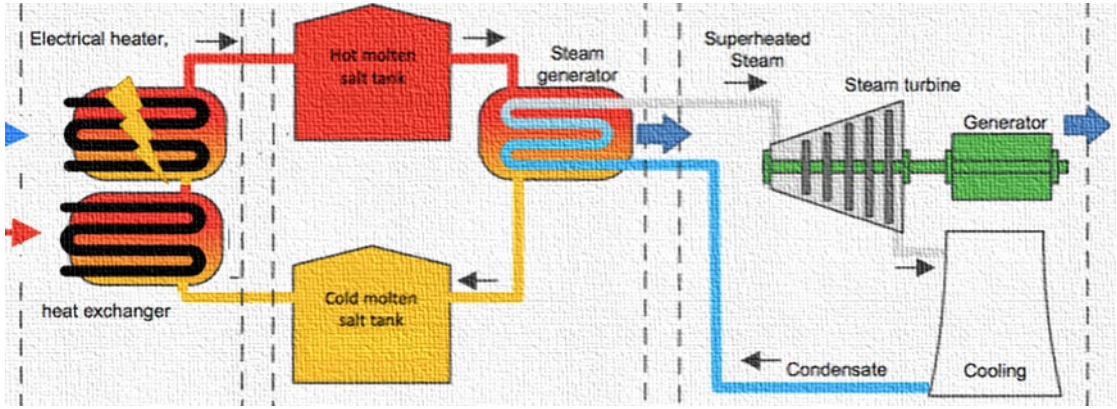
Hybrid PSH-Battery Energy Storage



Future Opportunities

- Electricity driven methods for processing and/or co-processing biomass, waste, hydrocarbons, and CO_2 to chemicals and materials.
- Thermal energy storage for co-optimized geothermal and electricity for localized industry needs.



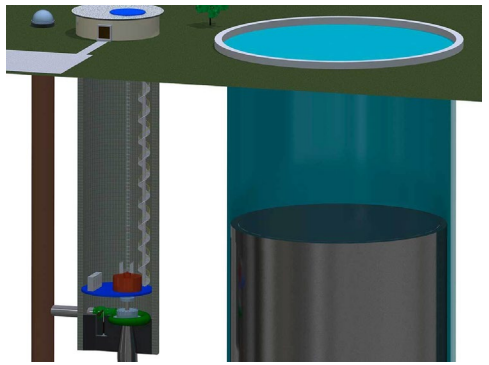


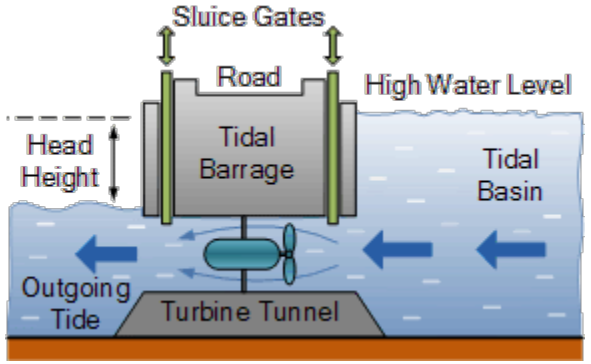
Long-term thermal energy storage and power generation

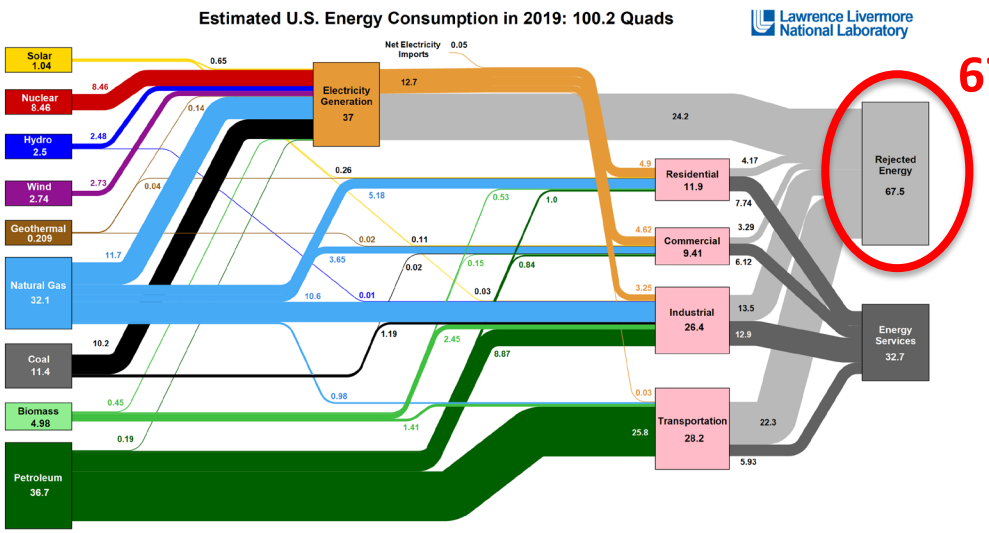
Examples of Future Opportunities

Other non-conventional energy storage options

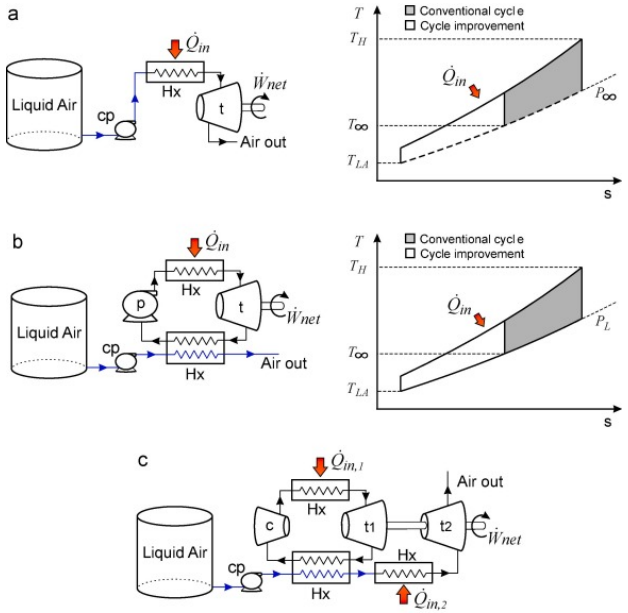
- Liquid air
- Gravity
- Salt water PSH
- Tidal barrages







67.5%



Discussion

Contact

Email: aries@nrel.gov
Web: nrel.gov/aries