Driving Transformational Change

Doug Arent

2018 Annual Meeting

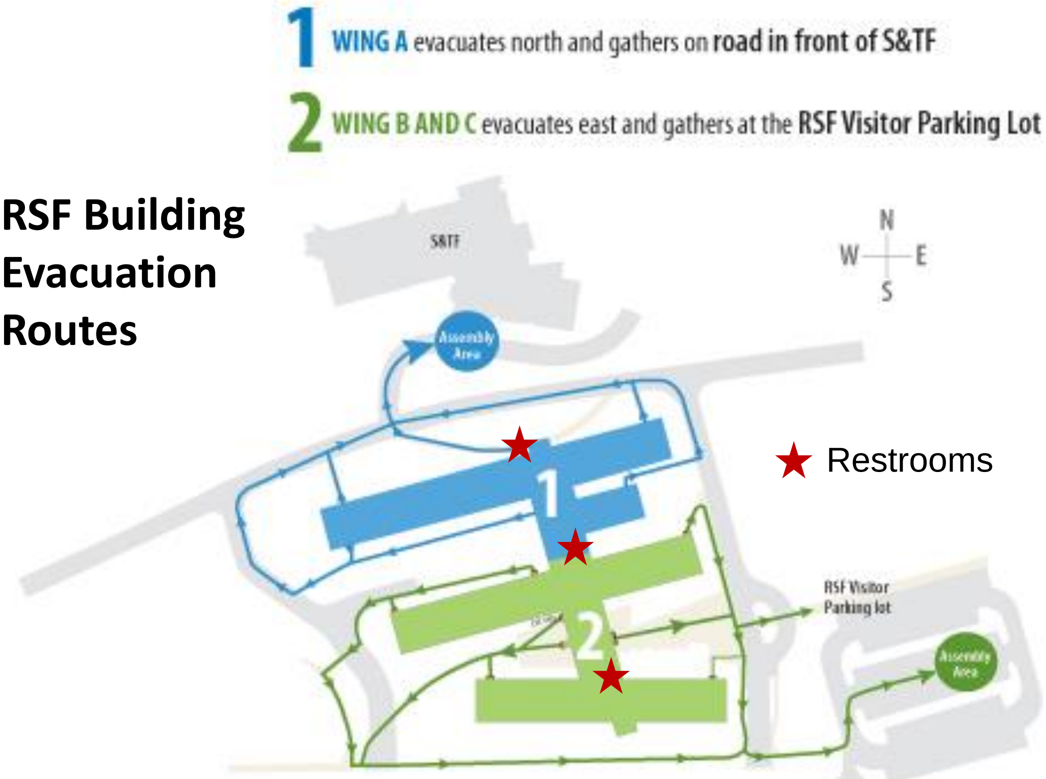
April 3, 2018

JISEA
Joint Institute for Strategic Energy Analysis

NREL National Renewable Energy Laboratory
Colorado School of Mines
Colorado State University
MIT Massachusetts Institute of Technology
Stanford University
University of Colorado Boulder

Logistics and Safety

RSF Building Evacuation Routes

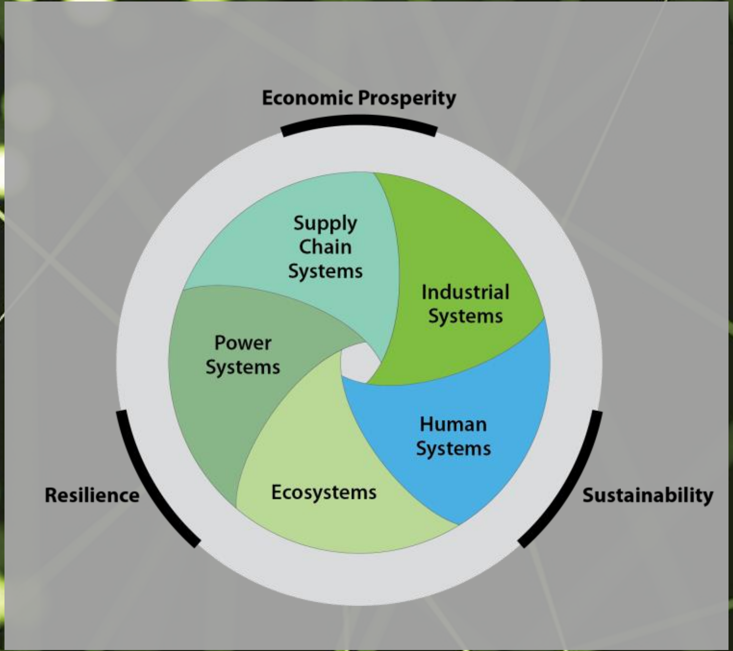


Recycling/Compost/Trash

Blue Bin – Recycling	Green Bin – Compost	Gray/Tan Bin – Trash
• Plastics 1-7 • Glass • Cans • Paper	• Any food product • Paper Plates • Napkins, Paper towels, Kleenex • Compostable cups, plates, utensils • Tea bags	• Foil and cellophane wrappers • Plastic bags • Styrofoam

JISEA's MISSION

Connecting technologies, economic sectors, and continents to catalyze the transition to the 21st century energy economy.



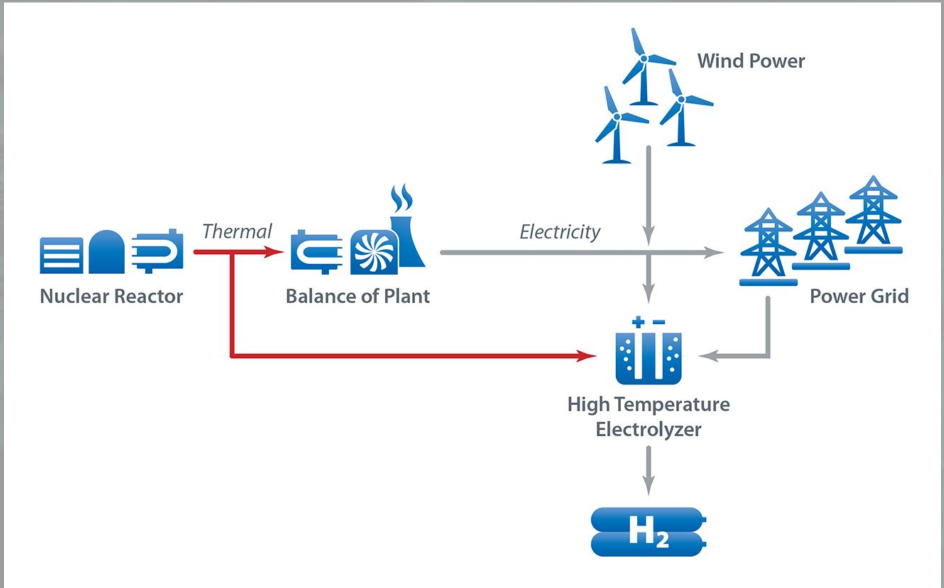
SYSTEMS SOLUTIONS

Integrated and coordinated energy solutions across power, thermal, buildings, industrial, and transportation sectors…in context of institutions, resources, earth and human systems..

SYSTEMS SOLUTIONS

Exploring nuclear-renewable hybrid energy systems:

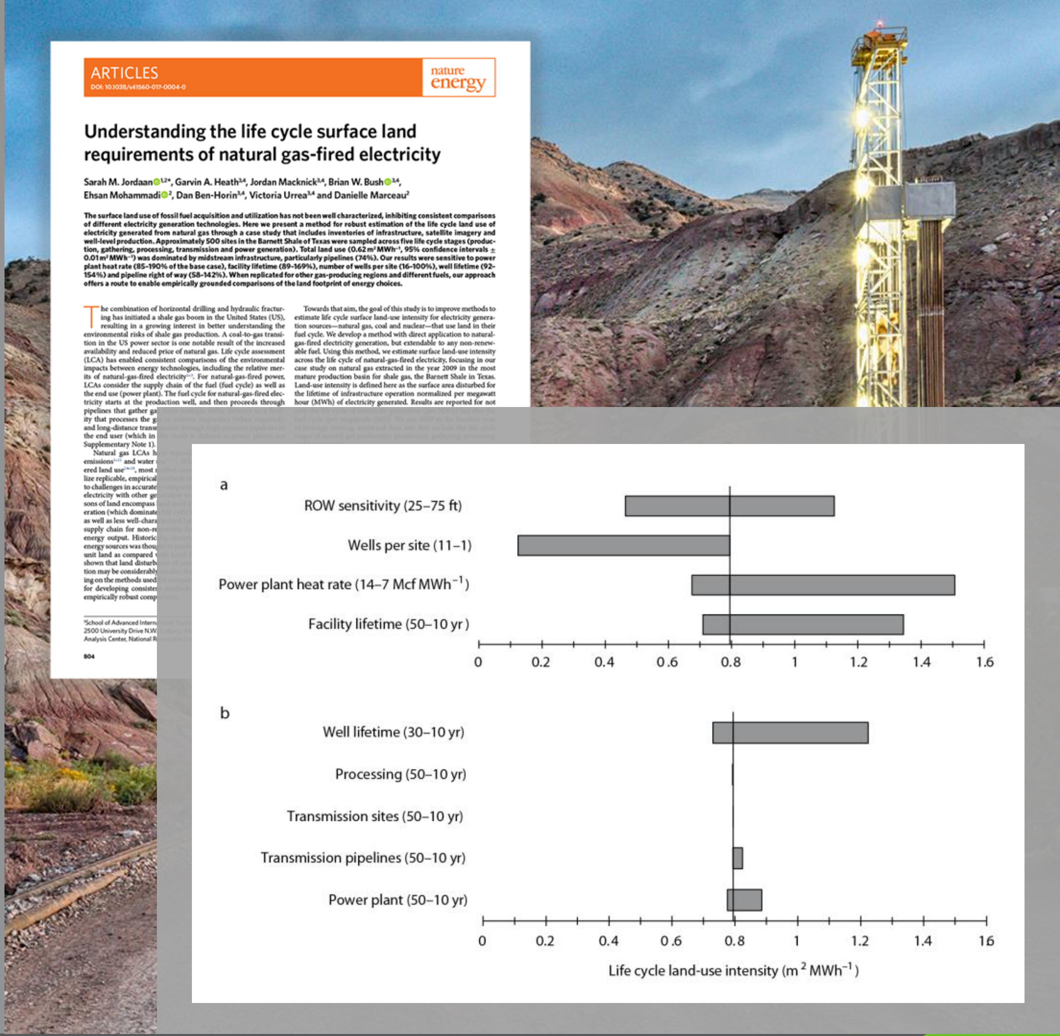
- System configurations
- Operations, Product options
- Value Stream
- Economics & Investment Insights



NATURAL GAS

Improving life cycle surface land-use intensity for power generation;

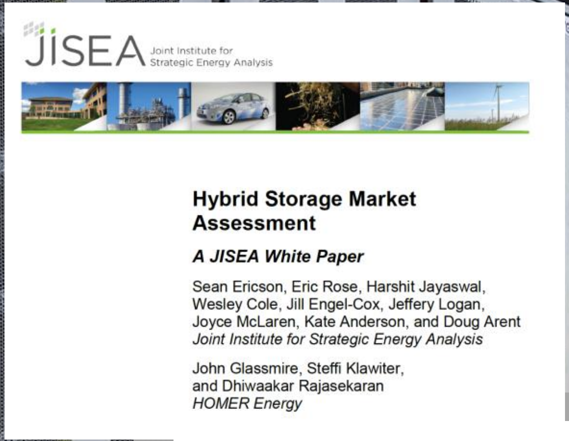
Prior work on Water and GHGs



BATTERY STORAGE HYBRIDS

Value Streams of Hybridization:

- Energy arbitrage
- Frequency regulation
- Spinning reserves
- Generation capacity
- Transmission deferral
- Demand charge reductions
- Resilience and reliability
- Decreased diesel generation

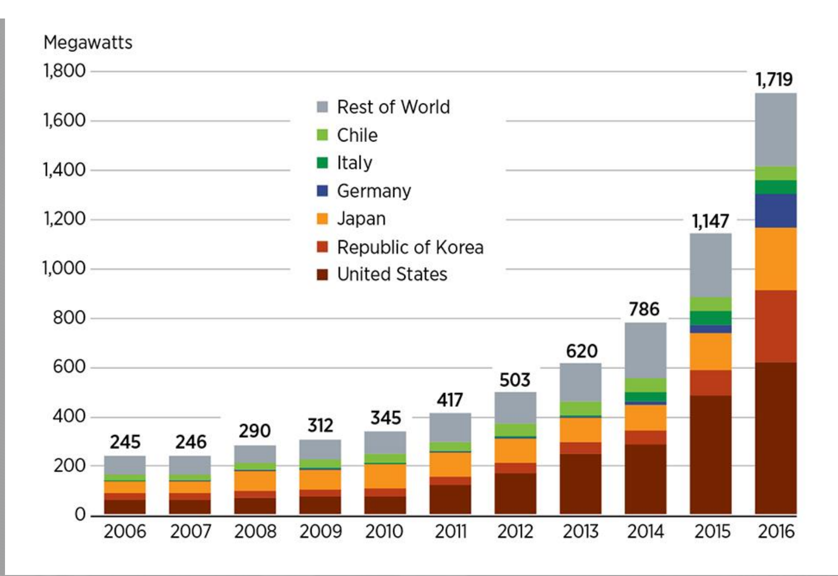

JISEA Joint Institute for Strategic Energy Analysis

Hybrid Storage Market Assessment

A JISEA White Paper

Sean Ericson, Eric Rose, Harshit Jayaswal, Wesley Cole, Jill Engel-Cox, Jeffery Logan, Joyce McLaren, Kate Anderson, and Doug Arent
Joint Institute for Strategic Energy Analysis

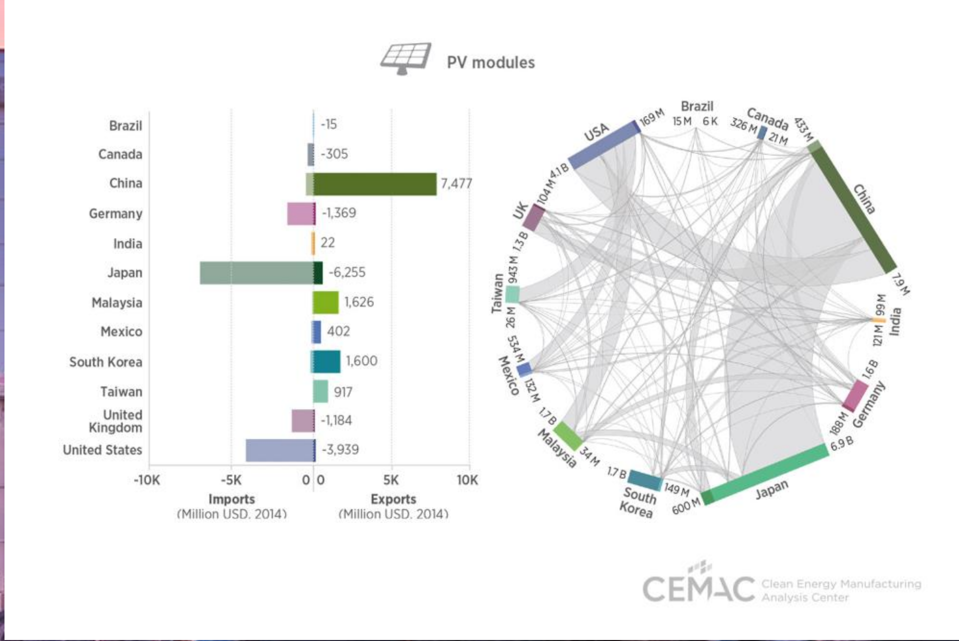
John Glassmire, Steffi Klawiter, and Dhiwaakar Rajasekaran
HOMER Energy



SUPPLY CHAINS

Analysis and Insights of the supply chains from critical materials to final products

Bottom-up cost analyses of emerging global supply chains

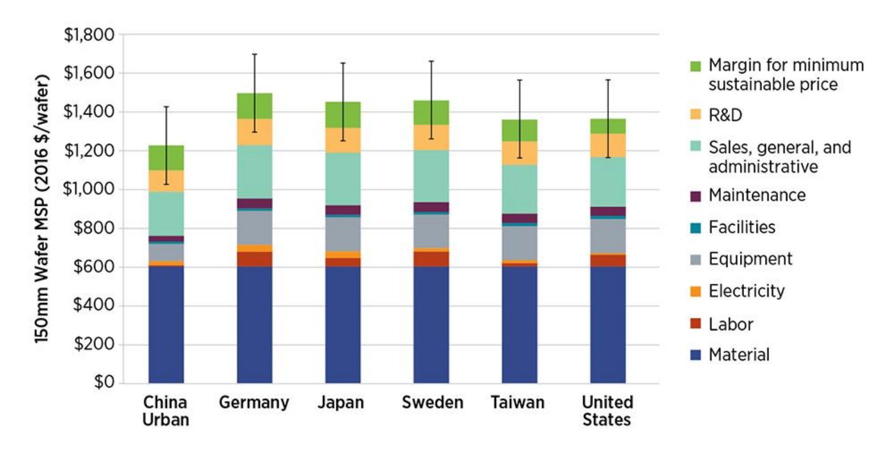


CEMAC Clean Energy Manufacturing Analysis Center

WIDE BANDCAP SEMICONDUCTORS

Wide bandgap semiconductor devices, notably silicon carbide (SiC) devices, show potential to:

- **Reduce energy lost** during power conversion
- Have a **smaller footprint, lighter weight**
- **Lower system cost** compared to traditional silicon devices
- Have the **largest energy impact**, followed by data centers, renewable generation, and EVs.

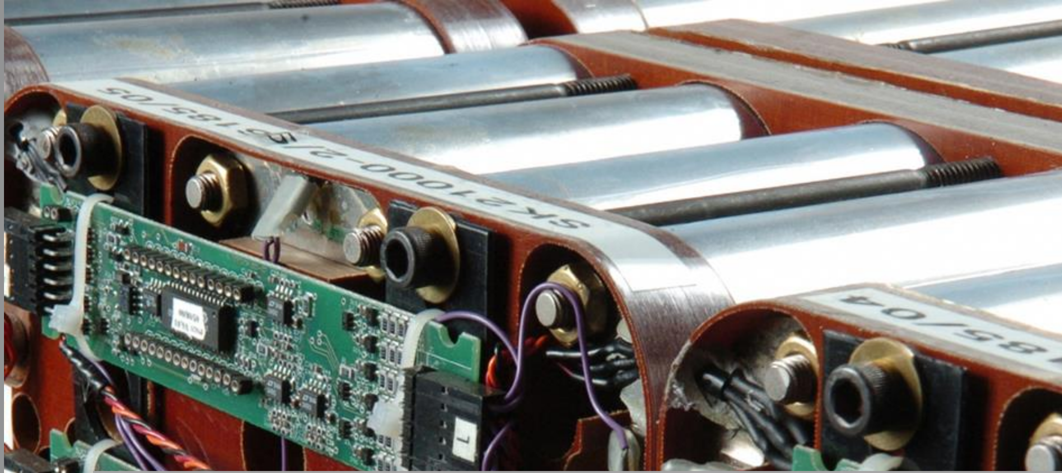


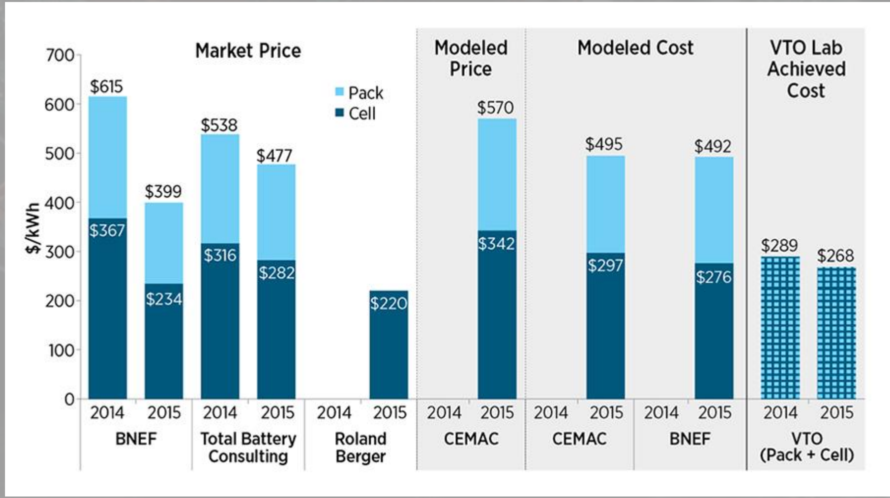
LITHIUM-ION BATTERIES

Cost Analysis

&

Market Dynamics





GLOBAL TRANSFORMATION

Serves as a platform to advance integrated policy, regulatory, financial, and technical solutions in power markets around the globe.

21st Century POWER PARTNERSHIP
Accelerating the transformation of power systems

GLOBAL THOUGHT LEADERSHIP

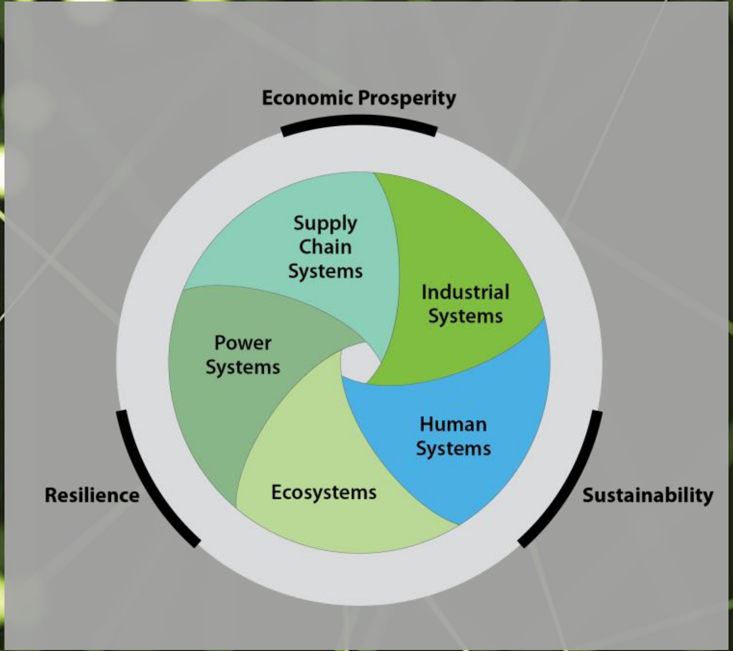
Helping Inform Energy Planning, Operations & Regulatory Considerations…

ACCELERATING TOWARD WHAT'S NEXT

- Co-simulate **power** and **natural gas network operations**.
- Define an "IEEE Standard" interconnected **power and natural gas test system**.
- Explore the potential **coordination of day-ahead power and natural gas network operations**.

Looking Forward

Connecting technologies, economic sectors, and continents to catalyze the transition to the 21st century energy economy.

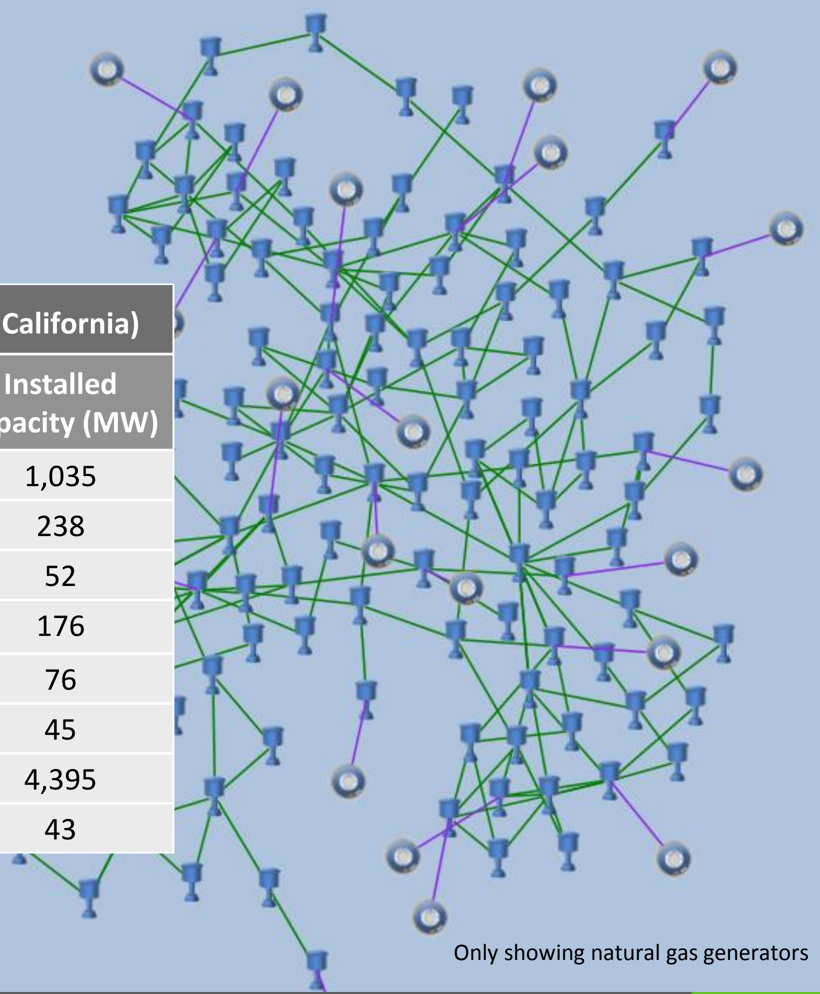


Backup slides

TEST SYSTEM
(Power – IEEE 118)

- Day-Ahead (DA) & Real-Time (RT) Unit Commitment & Economic Dispatch
- Peak Load: 4,620 MW
- Regulation & Contingency Reserves
- Wind & Solar Penetration Scenarios: 20% - 30% - 40%

Generation Mix (similar to California)		
Type	# Generators	Installed Capacity (MW)
Hydro	4	1,035
Nuclear	1	238
Coal	2	52
Geothermal	3	176
Biomass	5	76
Biogas	2	45
Natural Gas	25	4,395
Oil	2	43



Only showing natural gas generators

TEST SYSTEM
(Natural Gas – GNET90)

90 Nodes

46 Demand Nodes

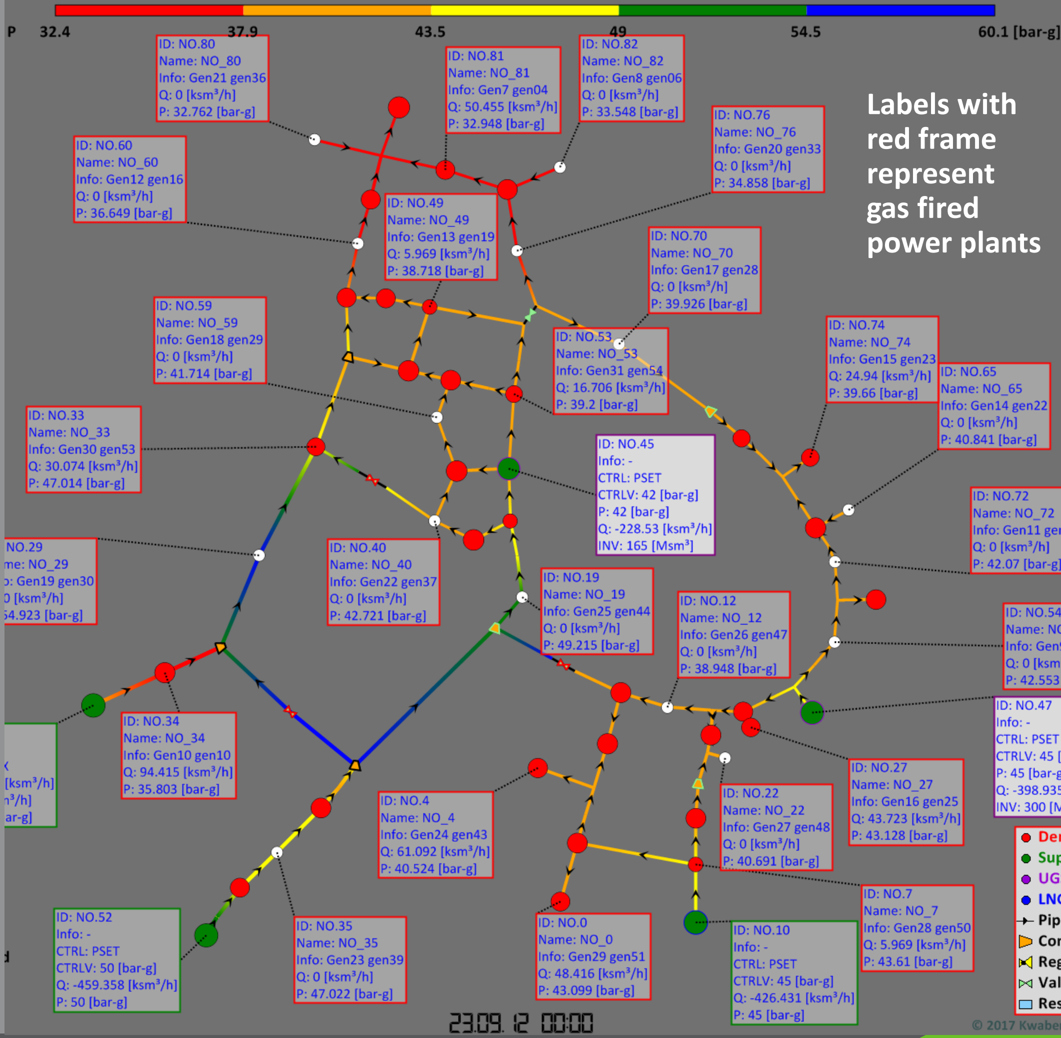
- **25 Gas Fired Power Plants** (GPP)
  - Min Delivery Pressure 30 [bar-g]
- **17 City Gate Stations** (CGS)
  - Min Delivery Pressure 16 [bar-g]

3 Supply Nodes

- **2 Cross Border Entry Stations**
- **1 LNG Terminal**
  - Max Inventory 80 [Msm^3]

2 Underground Gas Storage Facilities

- Max Total Inventory 1000 [Msm^3]



FUTURE WORK

- RT Coordination