

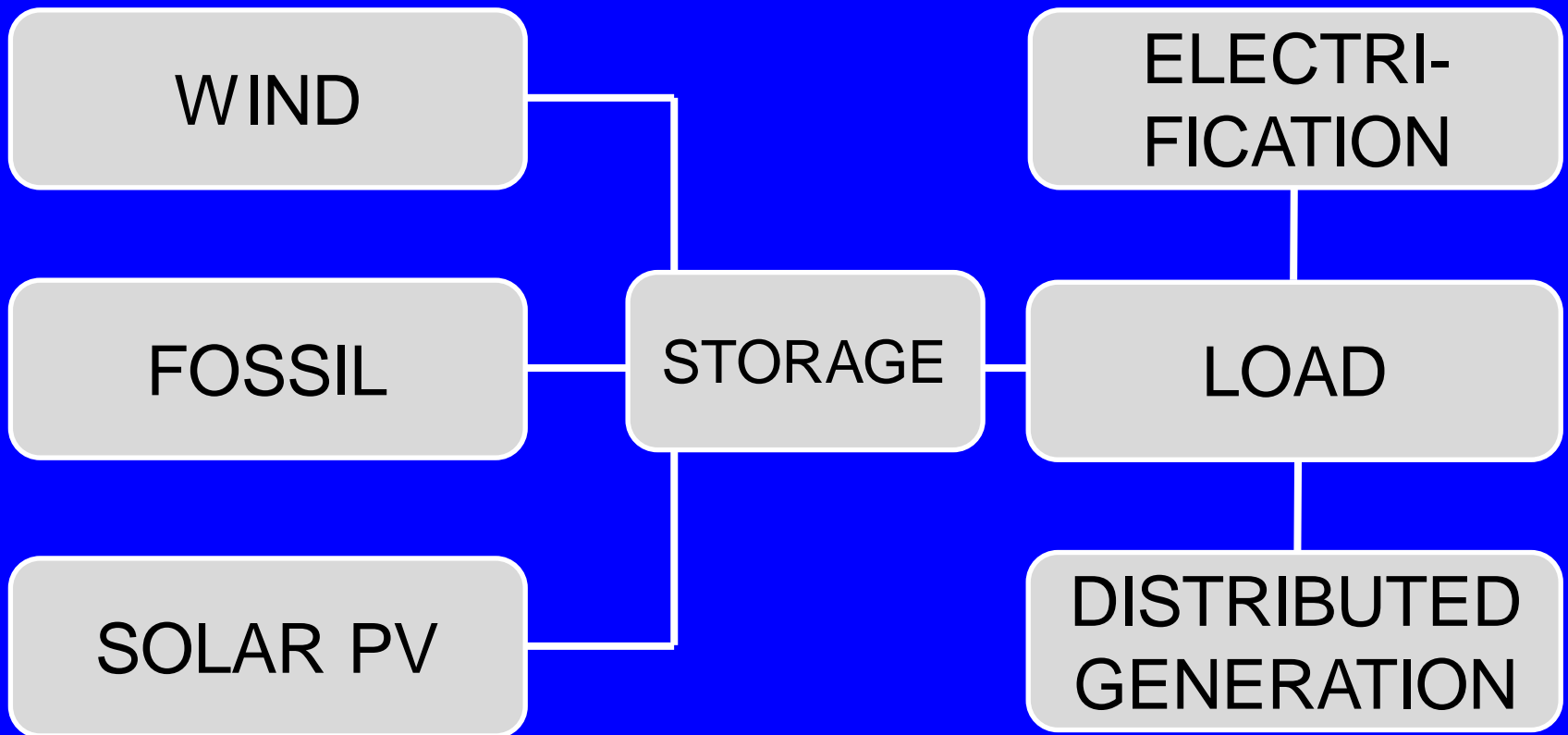
Energy Storage for Generation, Transmission and Distribution: Case Studies

IMRE GYUK, DIRECTOR,
ENERGY STORAGE RESEARCH, DOE-OE

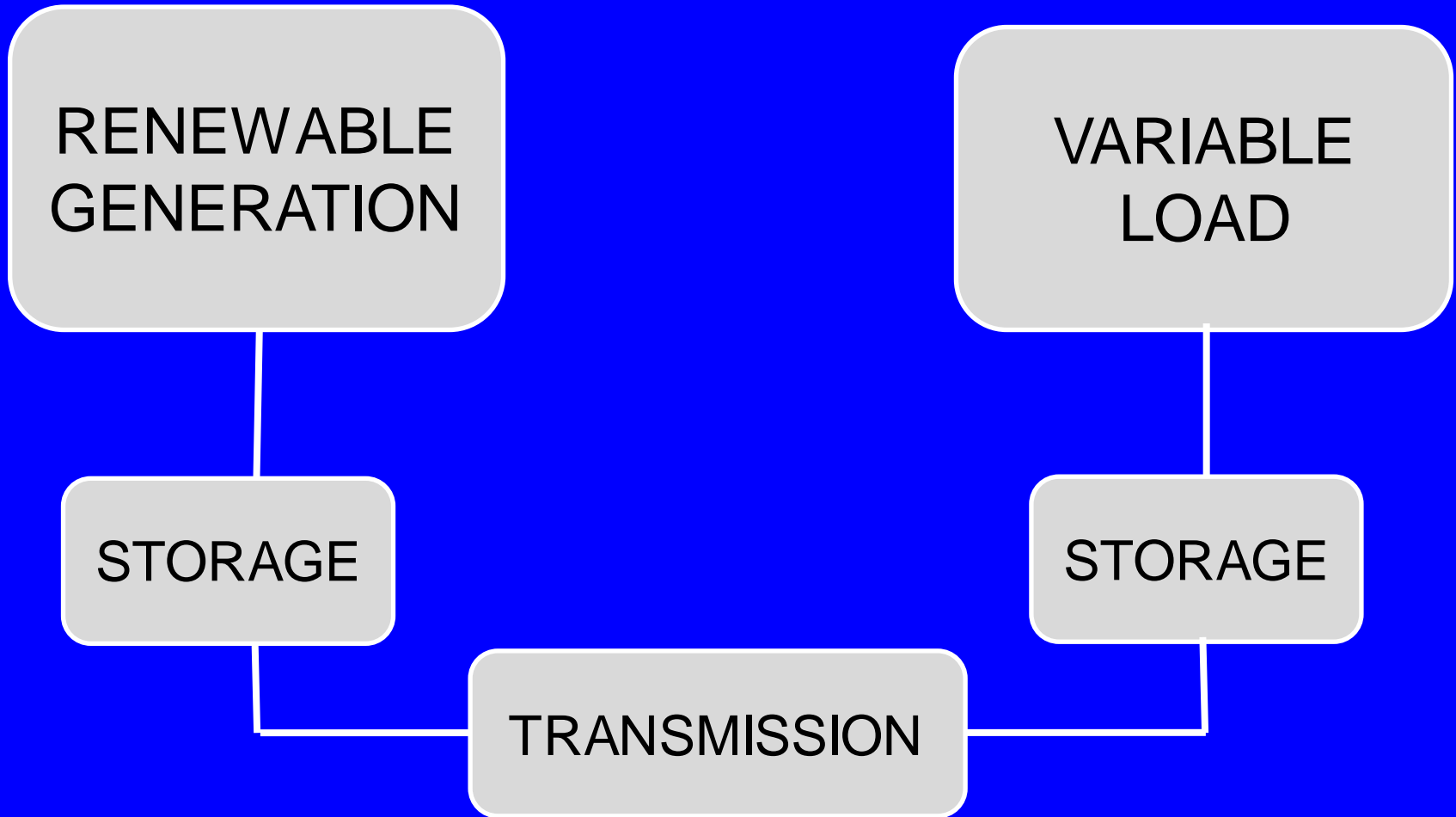
The Grid used to be quite simple



Variable Generation - Variable Load



Transmission and Storage



Generation:

- Smoothing Load to reduce Wear and Tear
- Augmenting Generation with +/- Stored Energy

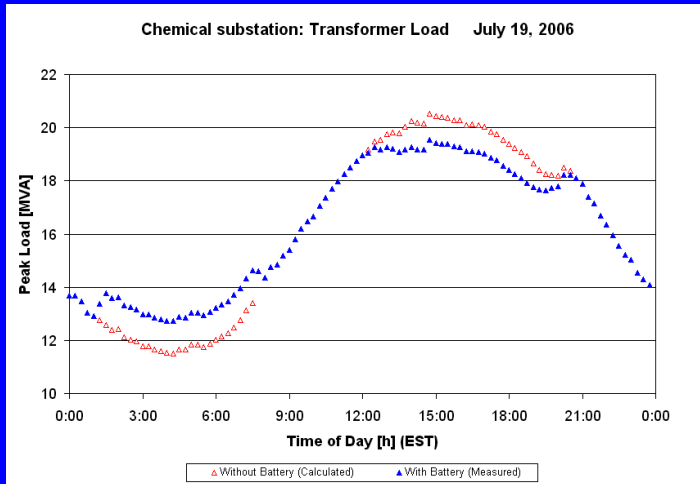
Transmission:

- Alleviating Congestion

Distribution:

- Substation Upgrade Deferral
- Enabling more Renewables

Storage for Substation Upgrade Deferral



AEP / DOE Project, Indiana
2MW, 14.4 MWh NaS

- Demand Charge Reduction
- Renewable Energy Management
- Aggregated Community Storage

Decorah, IA: Peak Shifting, Distribution Upgrade Deferral

Alliant Energy / DOE-OE, Sandia.

\$200K Grant from Iowa Economic Dev. Authority (IEDA),
and \$250K from DOE-OE, for a Total Cost of \$2,500k

3.3MW installed Renewables already on Circuit
2.5MW/2.9MWh storage will allow installation of 900kW new PV.



Li-ion batteries by ENEL-X

Cordova, Alaska, Municipal System



Cordova, Grid Isolated



6MW Run of River Hydro Power

Total Capacity: 7.25MW Hydro; 2x 1MW Diesel

0.5MW Deflected as Spinning Reserve

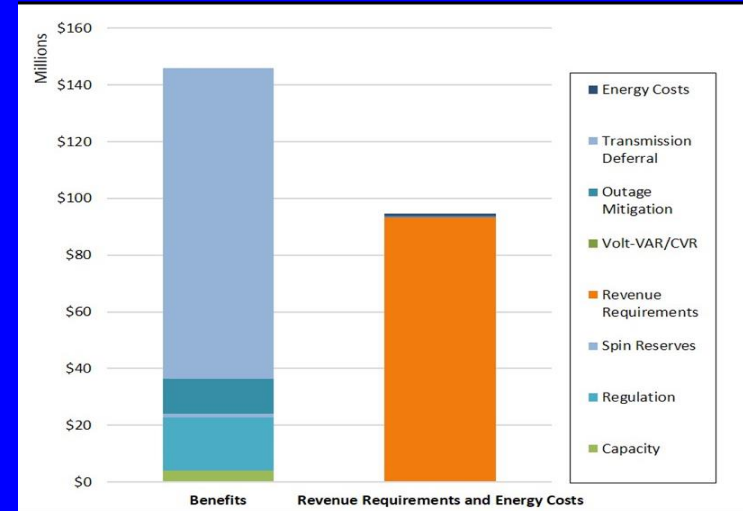
Hydro: \$0.06/kW; Diesel: \$0.60/kW

1MW/1hour Battery, Commissioned June 7, 2019

Nantucket Island, MA, National Grid Tesla, PNNL/DOE



71 MW Submarine Cables



Analytics: Balducci et al. PNNL

6MW/8hr Storage + 6-10 MW Generator
to yield required 91MW Peaking Capacity

*Ribbon Cutting: Oct. 8, 2019. Return on Investment: 1.55
\$110 million Deferral Value + \$36 million Operational Benefits*



PNNL evaluated technical and financial benefits of energy storage:

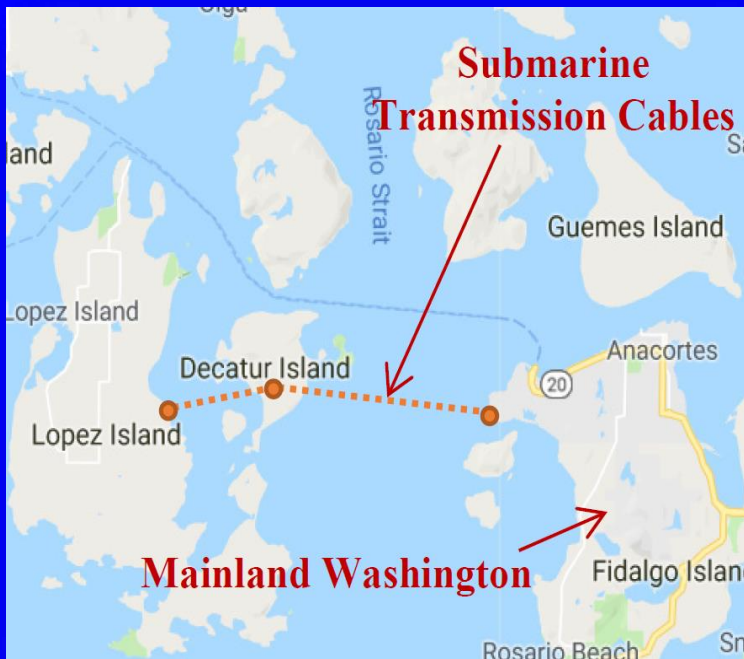
- Financial benefits of ES
- Technical impact on distribution system
- Control strategies to maximize financial benefits while achieving resiliency goals.

In addition to transmission deferral, other potential economic benefits could include:

- ISO-NE demand response program participation
- ISO-NE ancillary service markets
- ISO-NE forward capacity and reserve markets
- Energy arbitrage, Outage mitigation



Decatur Island, WA, OPALCO WA CEF, DOE/PNNL Analytics



San Juan Islands

San Juan Archipelago:
Peak Load exceeded
Transmission Capacity

Solution:

- Demand Shaping with 1 MW, 2.6 MWh
- Storage, Li-ion
- 504 kW DC Solar Array

Commissioned February 2021



Demand charge reduction
Cable replacement deferral
Transmission charge reduction
Energy cost reduction
Voltage regulation
Outage reduction
PNNL Report-27696

- Benefits – \$3.3M, higher than costs – \$2.9M
- Benefit cost ratio 1.13
- Submarine transmission cable deferral ~\$2M
- Demand charge reduction \$0.7M

North Troy, VT, Wind Curtailment GMP, VEC, Sandia/DOE

N-S Transmission forms bottleneck
for wind from the North to population in the South.
3MW / 12 MWh, Expected Completion: Sept. 2022
\$5,500,000 Storage to be installed at SHEI Interchange:

100% of all benefits accrue to VT retail customers.



Now and in Future,
Energy Storage
should be in
the Toolbox of every Utility!