Energy Storage

for Increased Resiliency and Grid Decarbonization

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ENERGY STORAGE RESEARCH, DOE-OE

DOE - Office of Electricity Energy Storage Program:

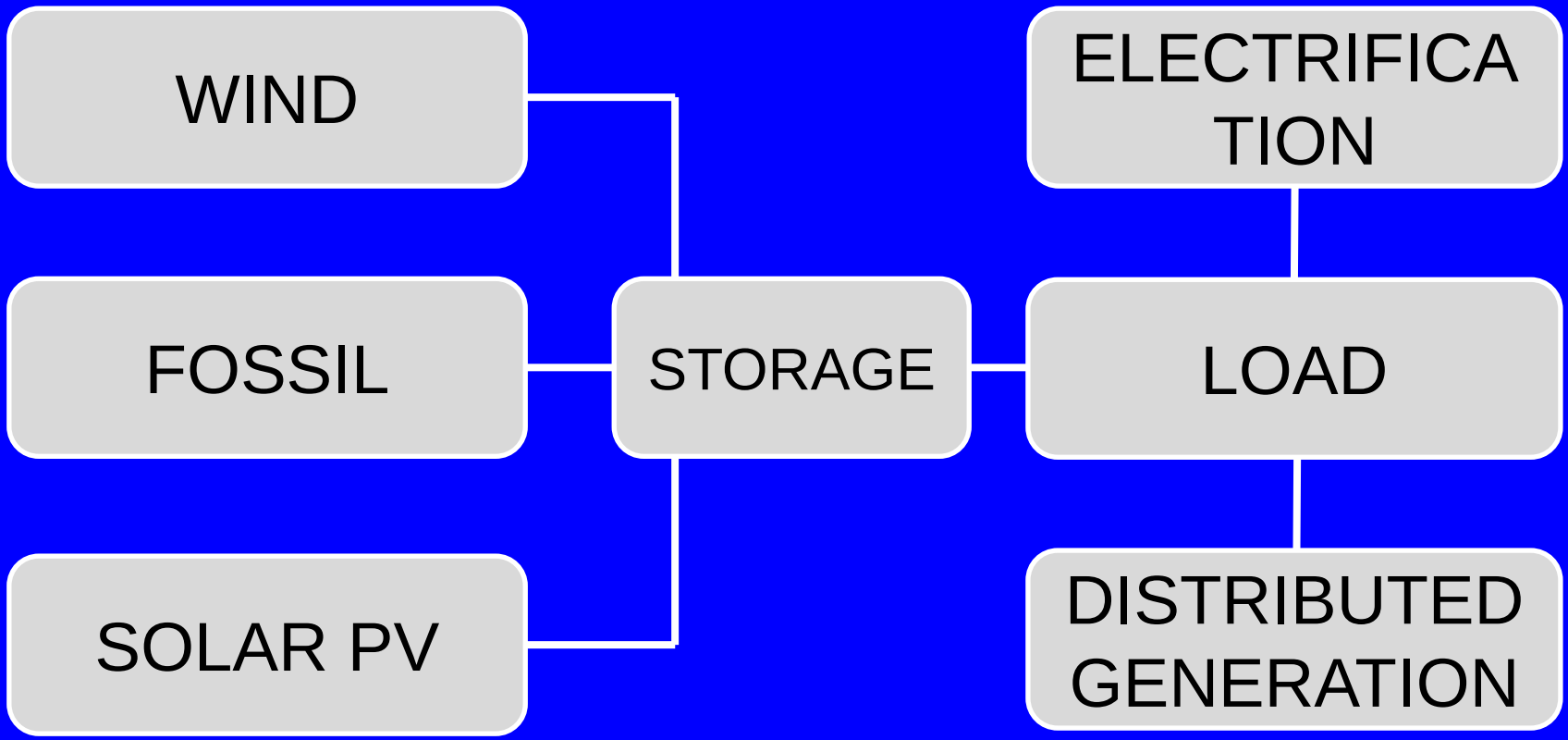
Broad Range of R&D, Deployment, and Analysis Efforts
Materials – Devices – Systems – Analysis – Standards – Policy

Teaming with Sandia, PNNL, ORNL
to work with Industry, States, and Utilities.

10 R&D 100 Awards, 2 EPA Green Chemistry Awards

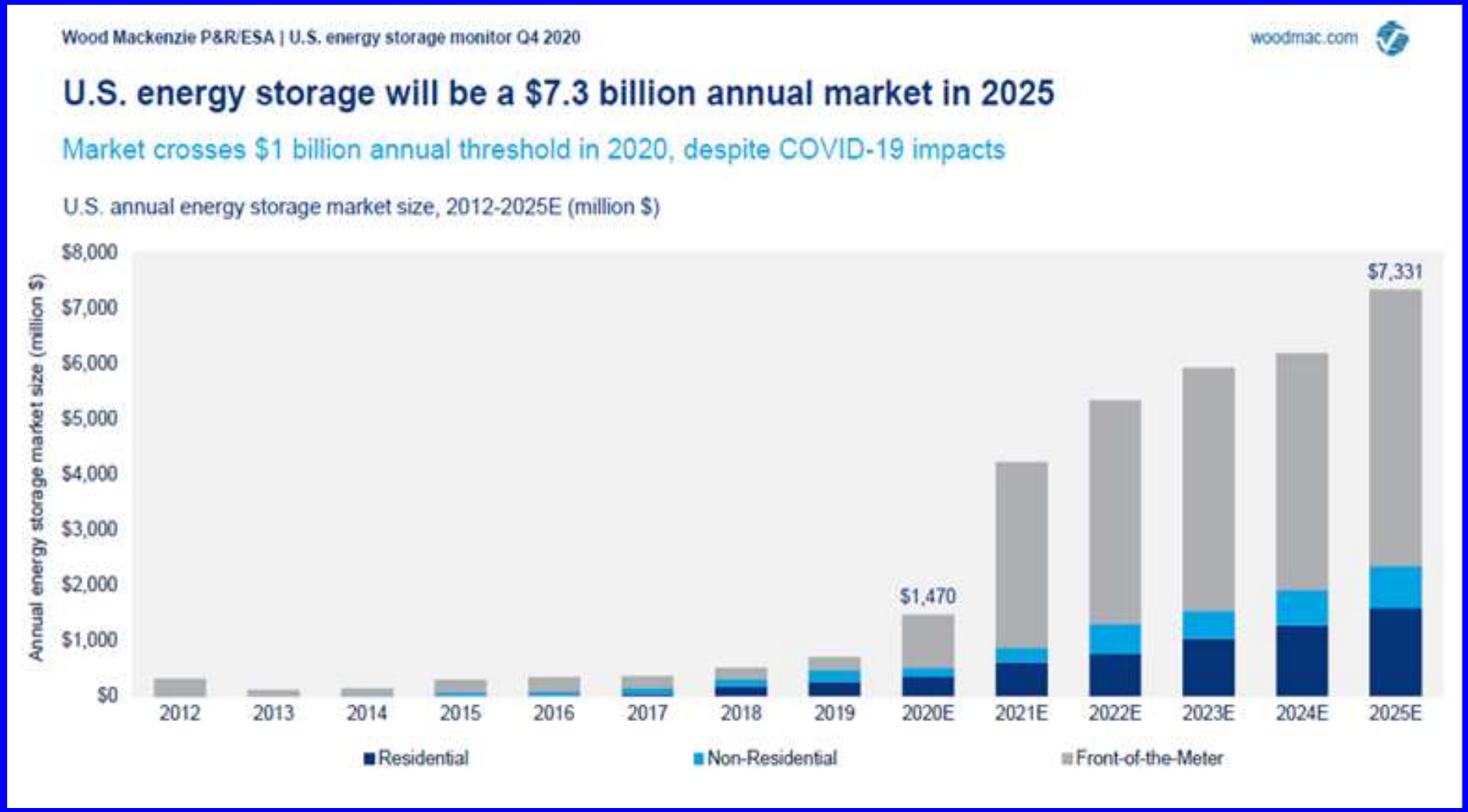
The grid used to be Simple and Deterministic!

Generation and Load are now Variable



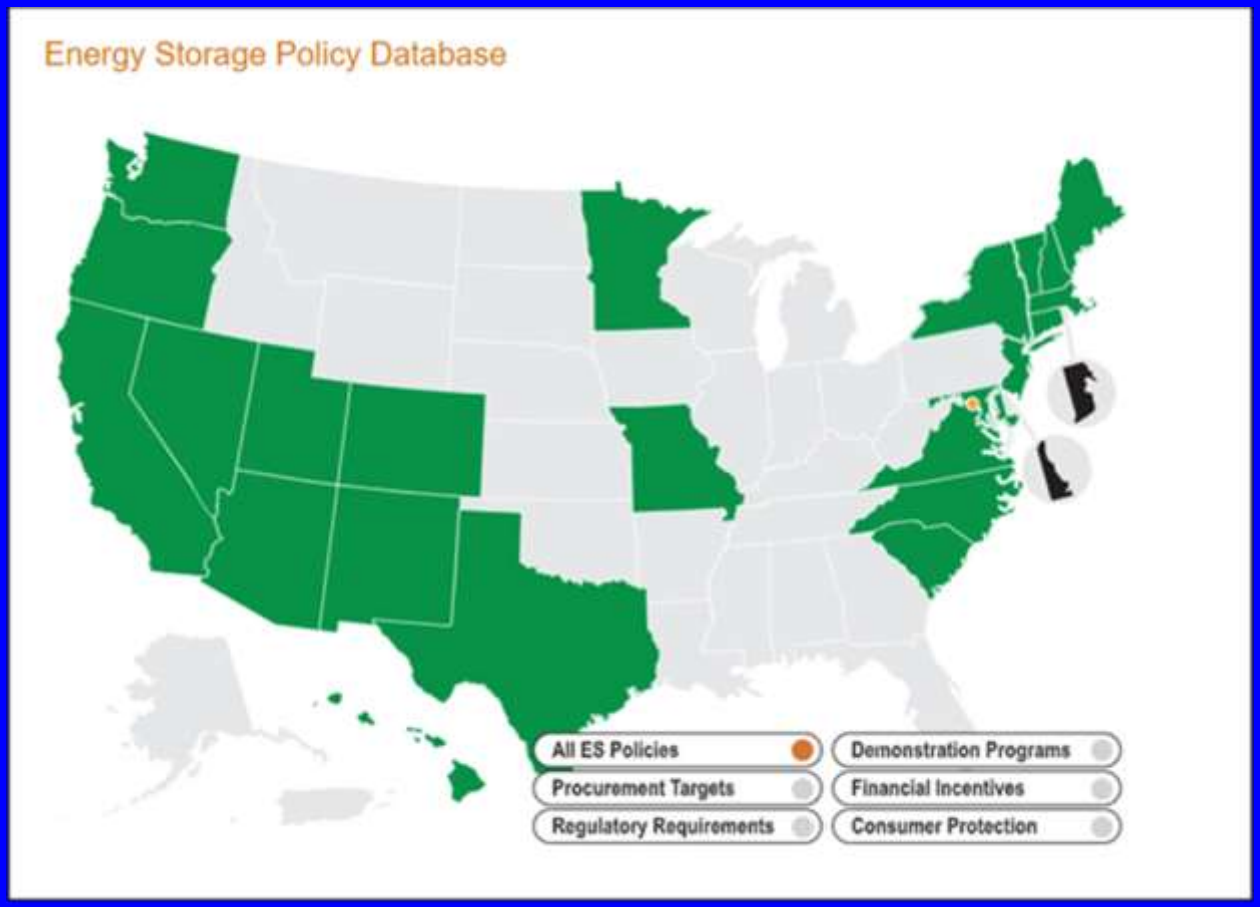
The grid has become stochastic!

Energy Storage has become a Resounding Success!



Despite Covid 2020, has seen extraordinary growth of ES

Energy Storage Policy Data Base



https://energystorage.pnnl.gov/regulatoryactivities.asp

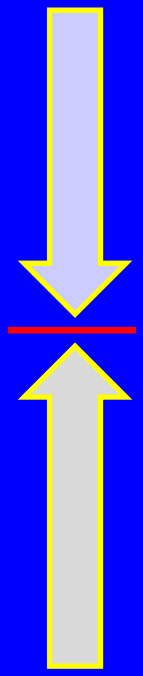
Many Applications have been identified,
Valuation Models have been developed.
Business Cases with multiple
Benefit Streams have been established.

Global Energy Storage Data Base
at Sandia.gov/ess

DOE-OE Storage Program Is Building and Validating Business Cases through Innovative Pilot Projects:

Resilience, Sustainability, Grid Stability

Storage Economics:



The **Cost** of a Storage System depends on the Storage Device, the Power Electronics, and the Balance of Plant

The **Value** of a Storage System depends on Multiple Benefit Streams, both monetized and unmonetized

LCOE depends on Application!

- Power Electronics 20-25%
- Energy Storage Device 25-50%
- Facility 20-25%

- Arbitrage
- Frequ. Reg.
- Dem. Charges month, year
- Resiliency

QuESt a Tool for Valuation– Sandia/DOE
(Deregulated Utilities)

- QuESt: An open source Python tool for Energy Storage evaluation
- QuESt Valuation: Stacking services in an electricity market
- QuESt BTM: Bill reduction for time-of-use/net metering customers
- QuESt: Data Manager: Data Acquisition

Sandia.gov/ess-ssl/tools/quest

Sterling, MA: Microgrid/Storage Project

Sterling Municipal Light Department. / DOE-Sandia

$1.5M Grant from MA Community Clean Energy Resiliency Initiative (Dept. of Energy Resources) + DOE

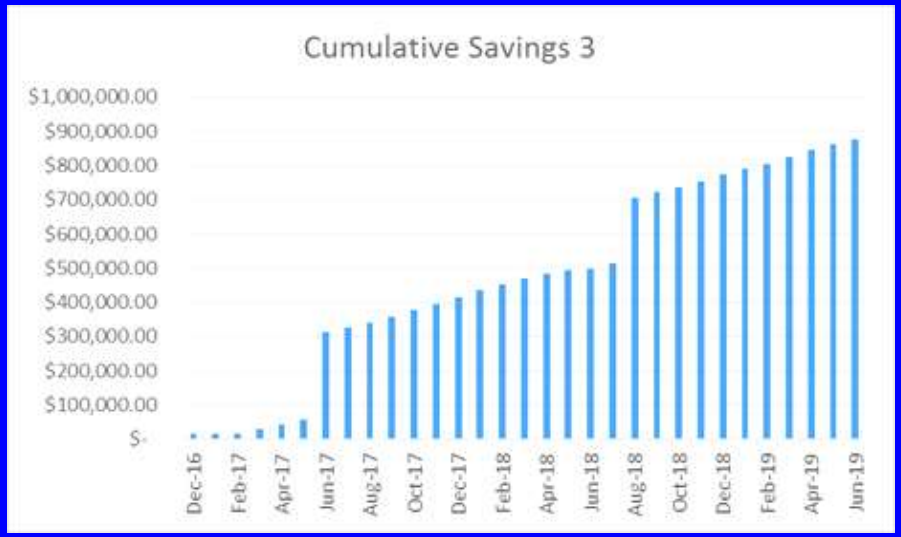
2MW/2hr storage with existing 3.4 MW PV to provide resiliency for Police HQ and Dispatch Center. Li-ion batteries provided by NEC.

Sterling, MA, October 2016

Sterling, MA, December 2016

2016 Dec. till **2017** Nov.
Actual Savings:

- Arbitrage $11,731
- Monthly Peaks $143,447
- Annual Peak $240,660
- Total $395,839



Sean Hamilton

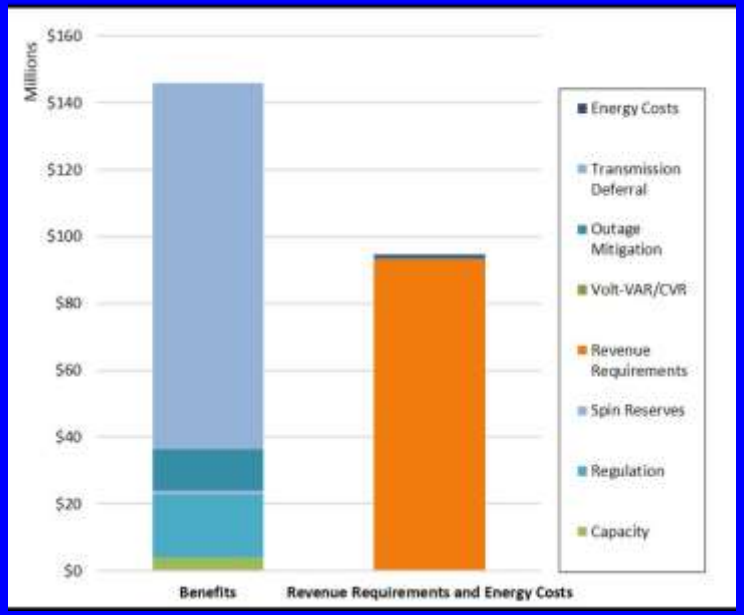
Chart: Carina Kaainoa

Dec. 2016 - April 2019: 1 million Avoided Cost!

Visitors: Germany, Switzerland, Denmark, Sweden, England, Ireland, Australia, Japan, Malaysia, Taiwan, Brazil, Chile, …. Thailand

Nantucket – National Grid, Tesla, PNNL/DOE

71 MW Submarine Cables



Analytics: Balducci et al. PNNL

$110 million Deferral Value + $36 million Operational Benefits

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

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.

Ribbon Cutting: Oct. 8, 2019. Return on Investment: 1.55

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

Innovative Pilots under Development

- Alliant Energy, Decorah, IA, 2.5MW / 2.915MWh
  Accommodating more solar
- ABQ Public Schools, NM: 500KW /2000kWh. Demonstrate ES economic & resilience benefits. 13 high schools, 140 campuses.
- Poudre Valley (NRECA), CO: Remote community developing microgrid to enhance reliability, expand essential services
- Ellsworth Air Force Base, SD: Resiliency for critical military missions.
- ES residential project with Navajo Tribal Utility Authority to deploy 3 25kW/10hr Zn-MnO_2 batteries for resilience.
- Puerto Rico: Large Microgrid for 5 Central Mountain Utilities

Emergence of Storage Ecologies

California: Mandate, CEC, PUC, Utilities

New York: BEST, NYSERDA, CCNY

Northwest (WA, OR, AK): PNNL, WA Clean Energy, PUCs, Senate

New Mexico: Sandia, Congressional/State Support, Projects

Northeast (MA, VT): DOER, Projects, National Grid, Universities

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Congressional and State Support, Regulatory Structure,
National Laboratories, Universities, Utilities, Real Projects

Issues:

- Safety
- Social Equity
- Sustainability

Safety

Incumbent Lithium-Ion Technology:

Sourcing, Ecological, and Sociological Issues

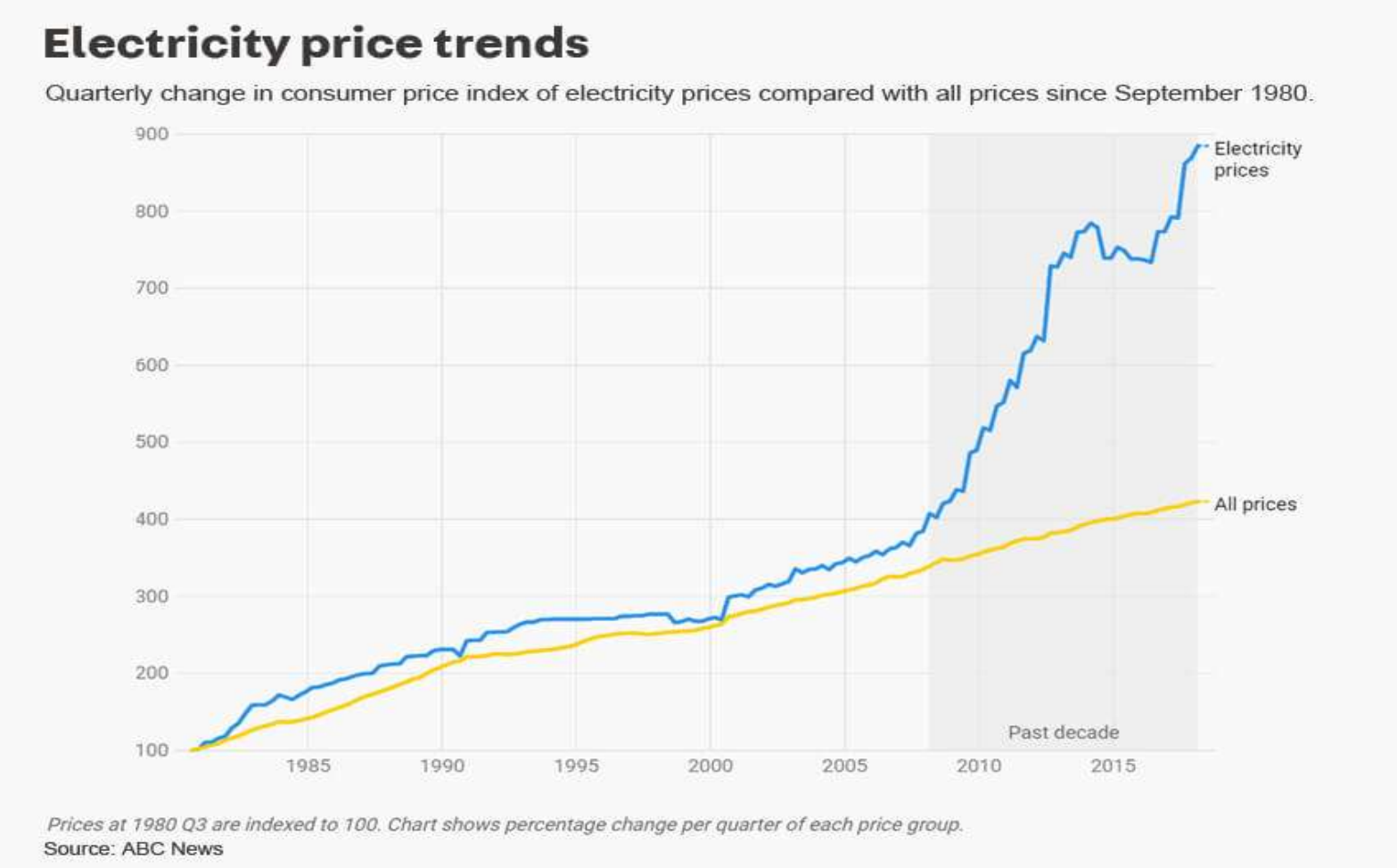
Safety, Reliability,

Re-Use, Recycling, Disposal

To achieve real Sustainability
we would Ultimately like
to have a Circular Technology
Based on
Earth Abundant and Inexpensive
Materials!

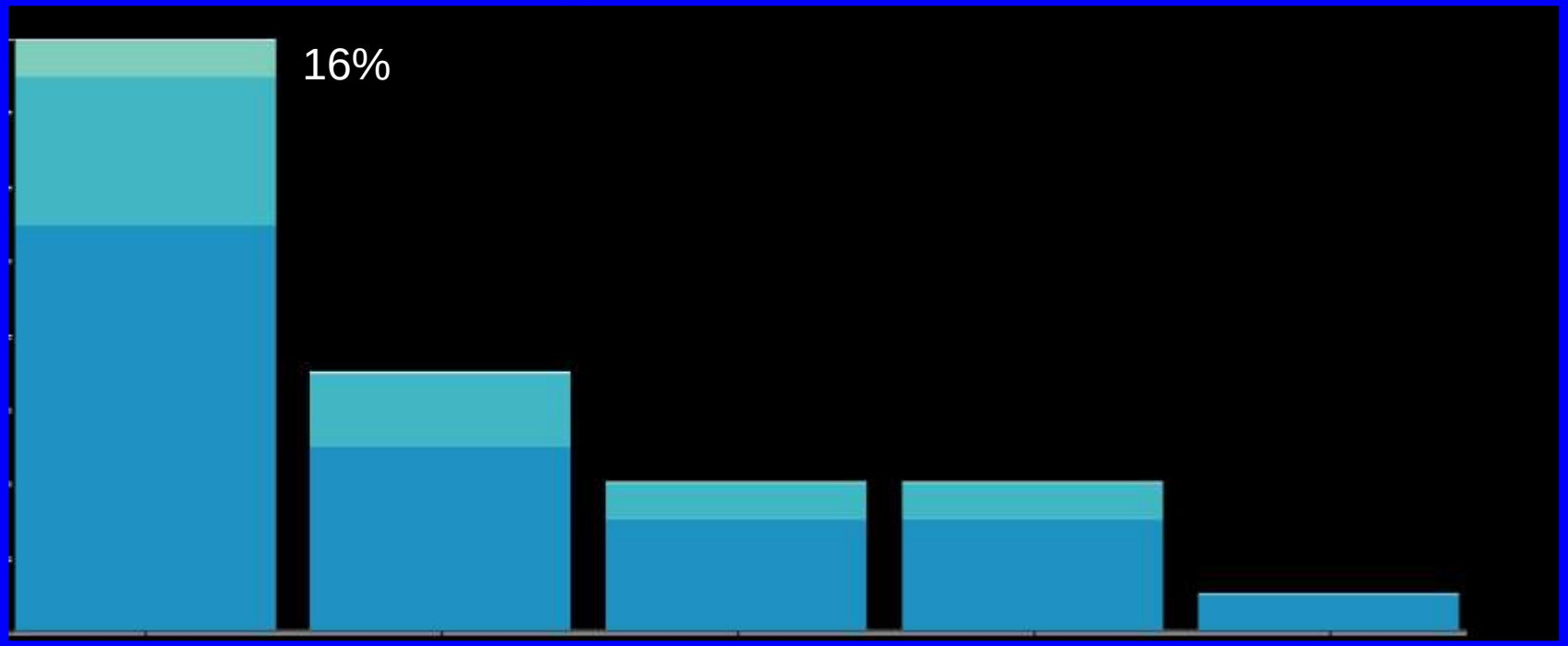
Supply Chain and Waste Stream
Must be part of the design!

Social Equity



For the past decade electricity prices have been rising substantially

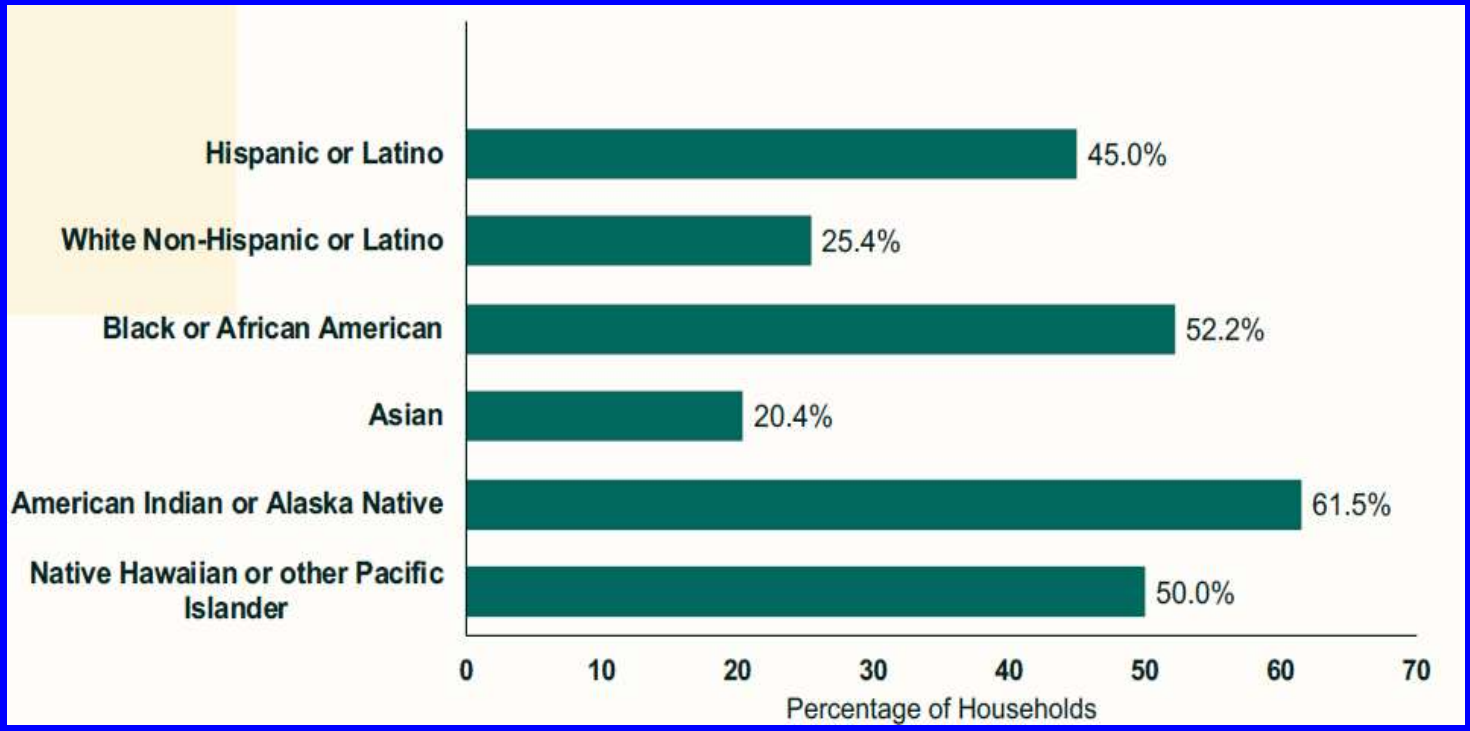
Average Energy Burden (% of Income)



Poorer (AMI) Richer

From S. Baker/Yale

Households Experiencing Energy Insecurity (2015)



From: S. Baker/Yale

Lower income households are disproportionally non-white

Outages tend to be more frequent
in poor areas and take longer to mitigate

Electricity Assets are often located
In the least affluent neighborhoods
leading to health issues.

Resiliency Measures like rooftop solar
and behind the meter storage tend to
be installed by the more affluent

Electrification (e.g. EV) benefits the
more affluent, but infrastructure costs
are borne by all

Sustainability

An Urgent Situation!

30 states, Washington, D.C., and 3 territories have adopted Renewable Portfolio Standards:

CA 100% by 2045, CO 100% by 2050
DC 100% by 2032, HI 100% by 2045
NM 100% by 2045, NY 100% by 2040
VT 75% by 2032, WA 100% by 2032

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As Penetration of Renewable Generation
Continues to increase,
Incremental Solutions
will no longer be sufficient

Longer Duration Storage
is urgently required!

8 Hours – 12 Hours – Days – Seasons

Meanwhile:
Storage Cost will go down,
Safety and Reliability will increase

With every successful Project
the Value Propositions will
also continue to increase!

More jobs will be created!!

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