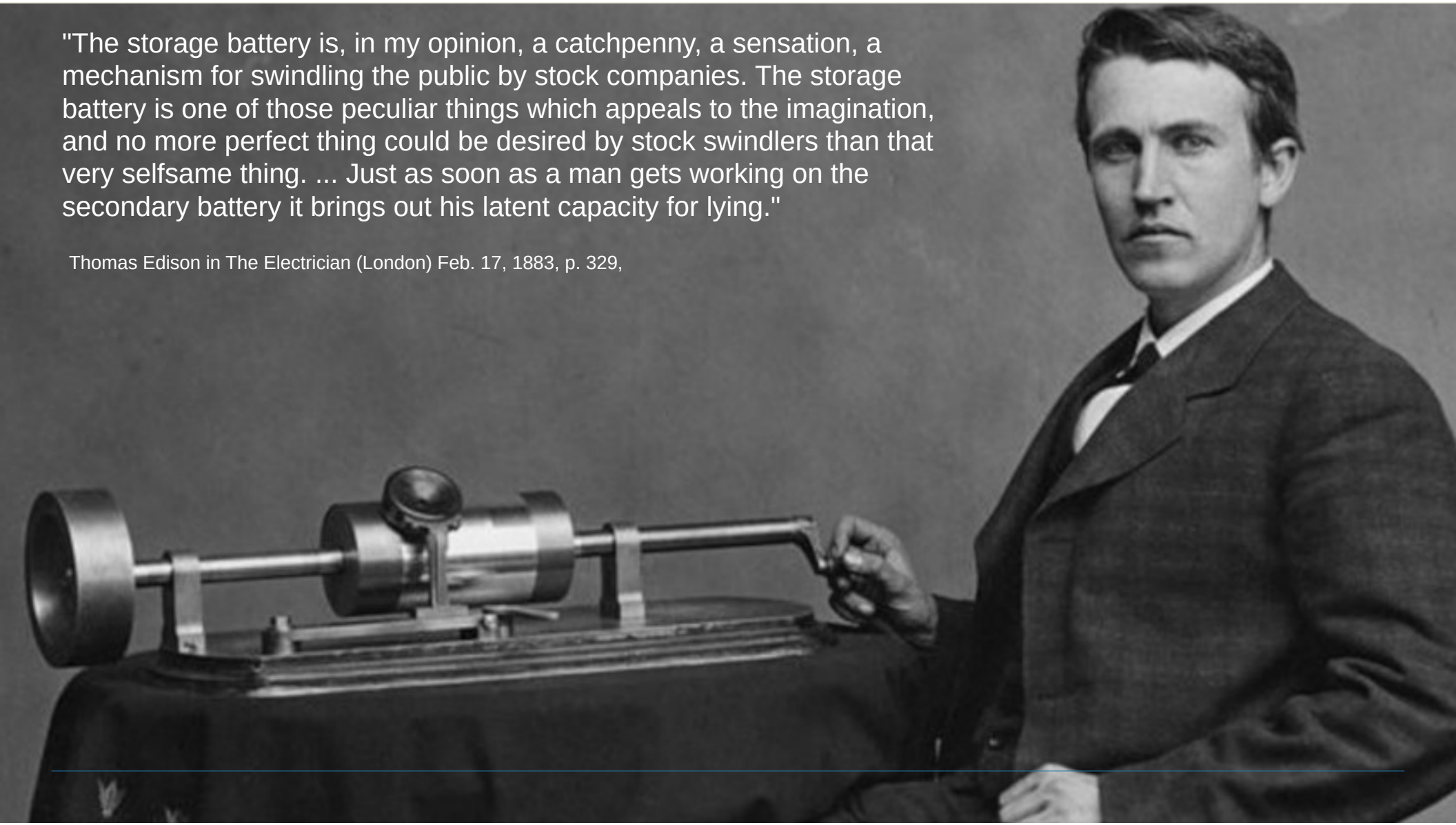
Energy Storage 2020

Eric Wesoff


"The storage battery is, in my opinion, a catchpenny, a sensation, a mechanism for swindling the public by stock companies. The storage battery is one of those peculiar things which appeals to the imagination, and no more perfect thing could be desired by stock swindlers than that very selfsame thing. ... Just as soon as a man gets working on the secondary battery it brings out his latent capacity for lying."
Thomas Edison in The Electrician (London) Feb. 17, 1883, p. 329,

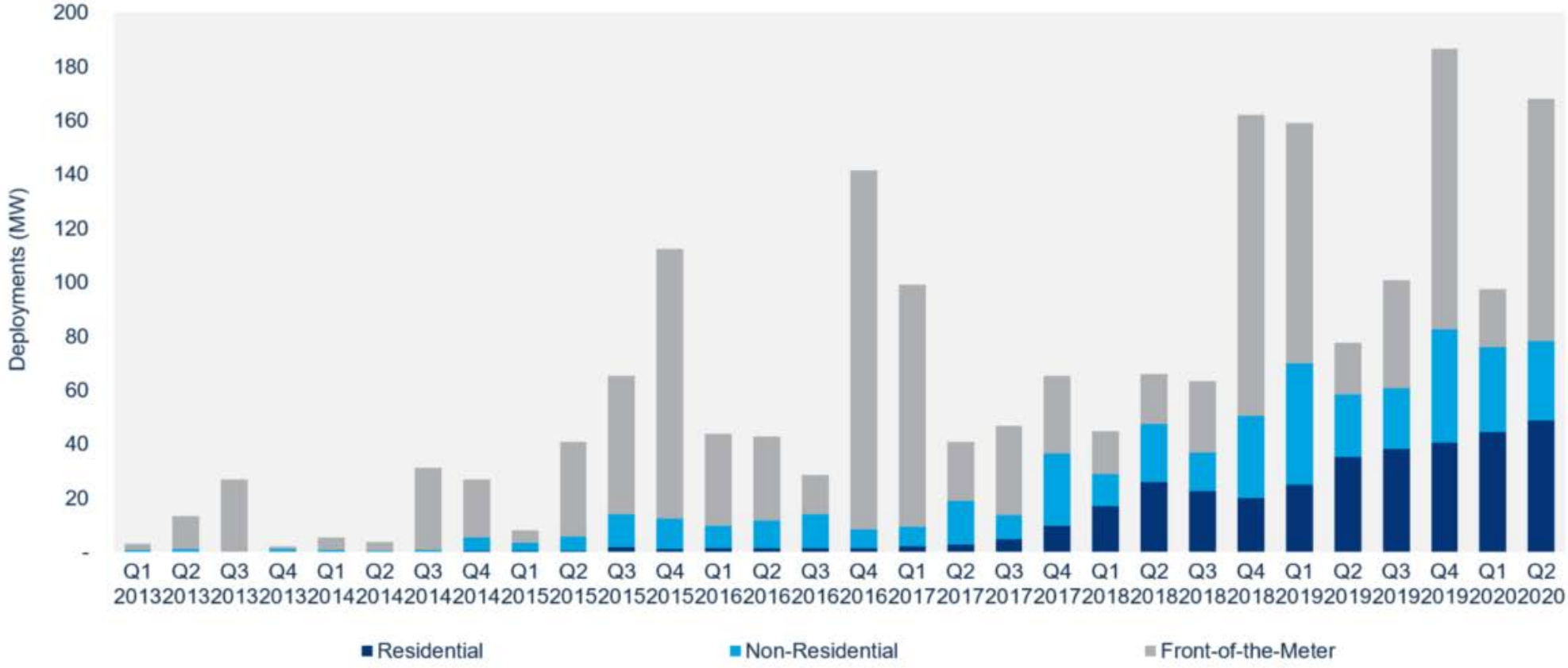
Markets
Applications
Regulatory matters
Technology

The U.S. energy storage market is forecast to grow from 523 MW in 2019 to 7.3 GW in 2025.

Wood Mackenzie

U.S. Q2 2020 deployments reached 168 MW

The strongest Q2 on record for deployments; Covid-19 pandemic has not hampered the downstream market



Source: Wood Mackenzie Power & Renewables

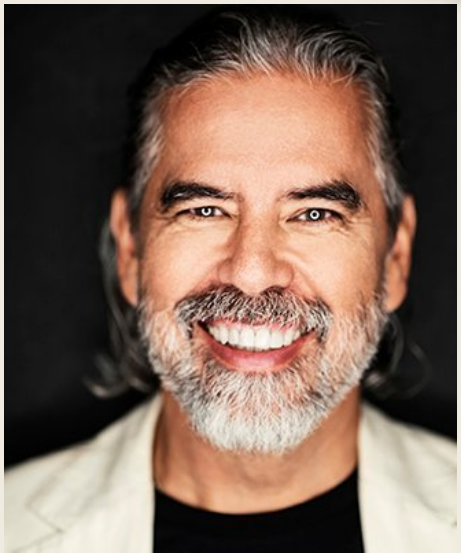

sunrun
TESLA
TESLA

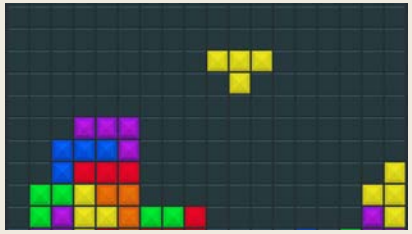

LG


POWERVAULT


BLUE ION

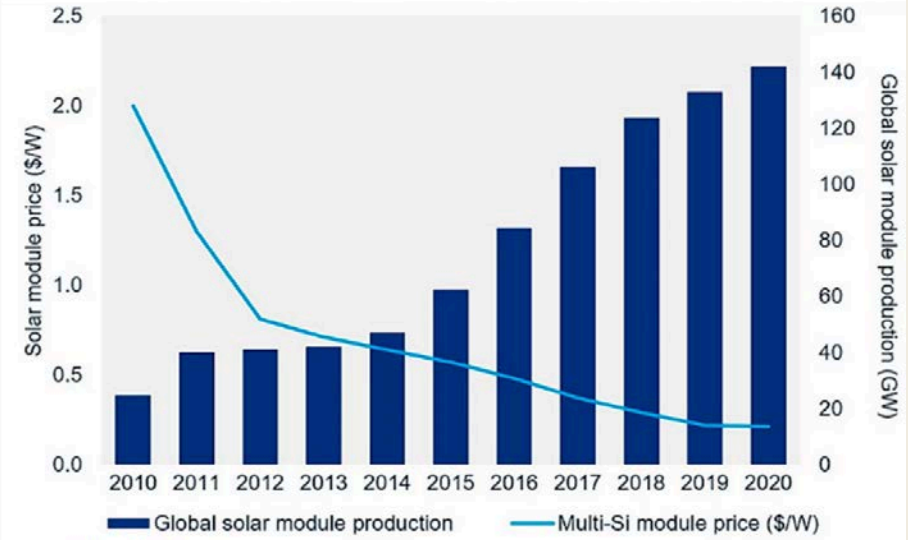

BLUE ION



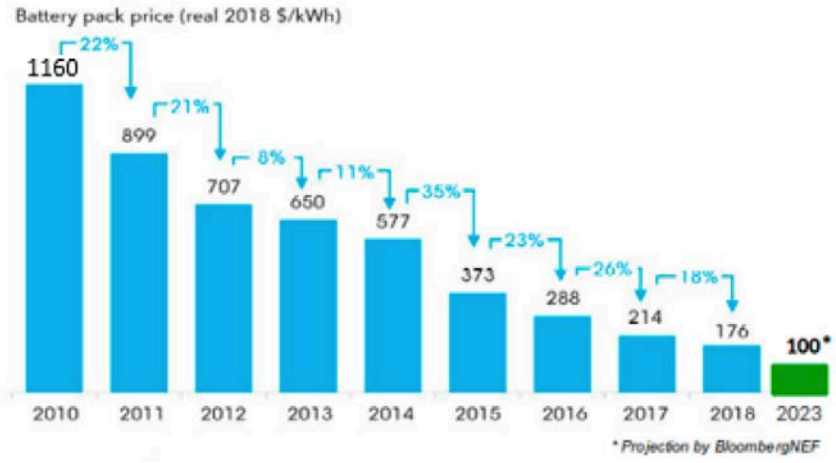



TESLA

Figure 3. Plummeting prices of (**a**) PV modules [31]; (**b**) lithium-ion battery pack [32].



(a)

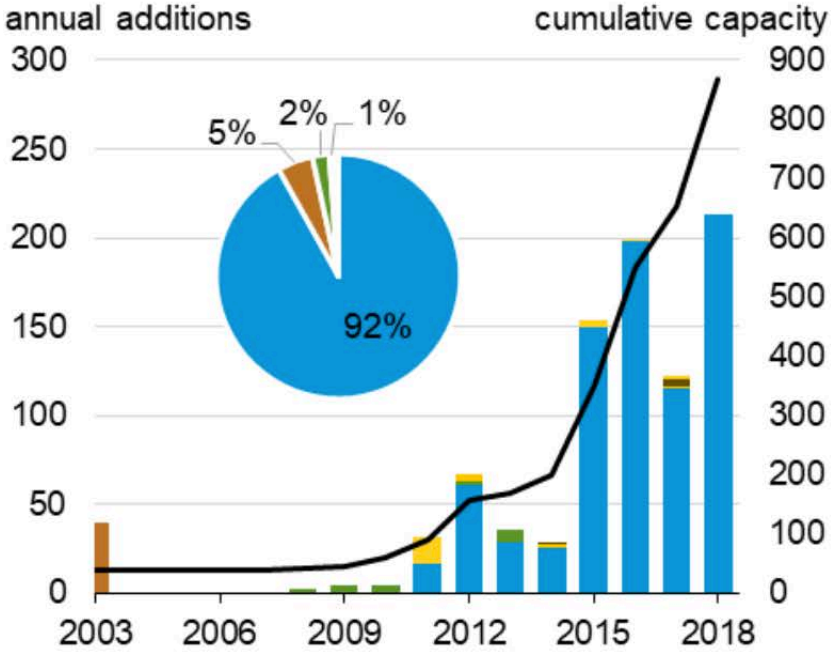


Solar-Storage parallels

Figure 6. Large-scale battery storage capacity by chemistry (2003–2018)

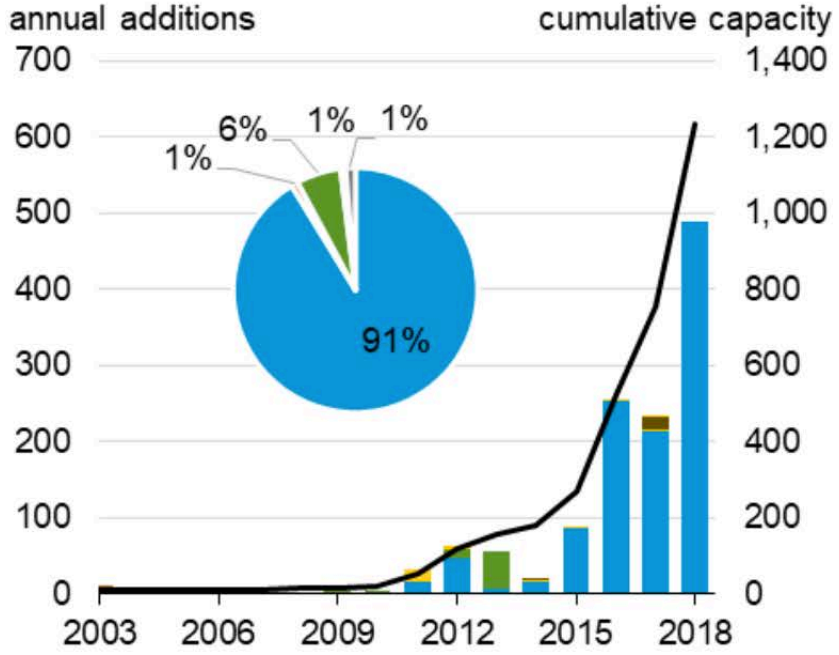
power capacity

megawatts



energy capacity

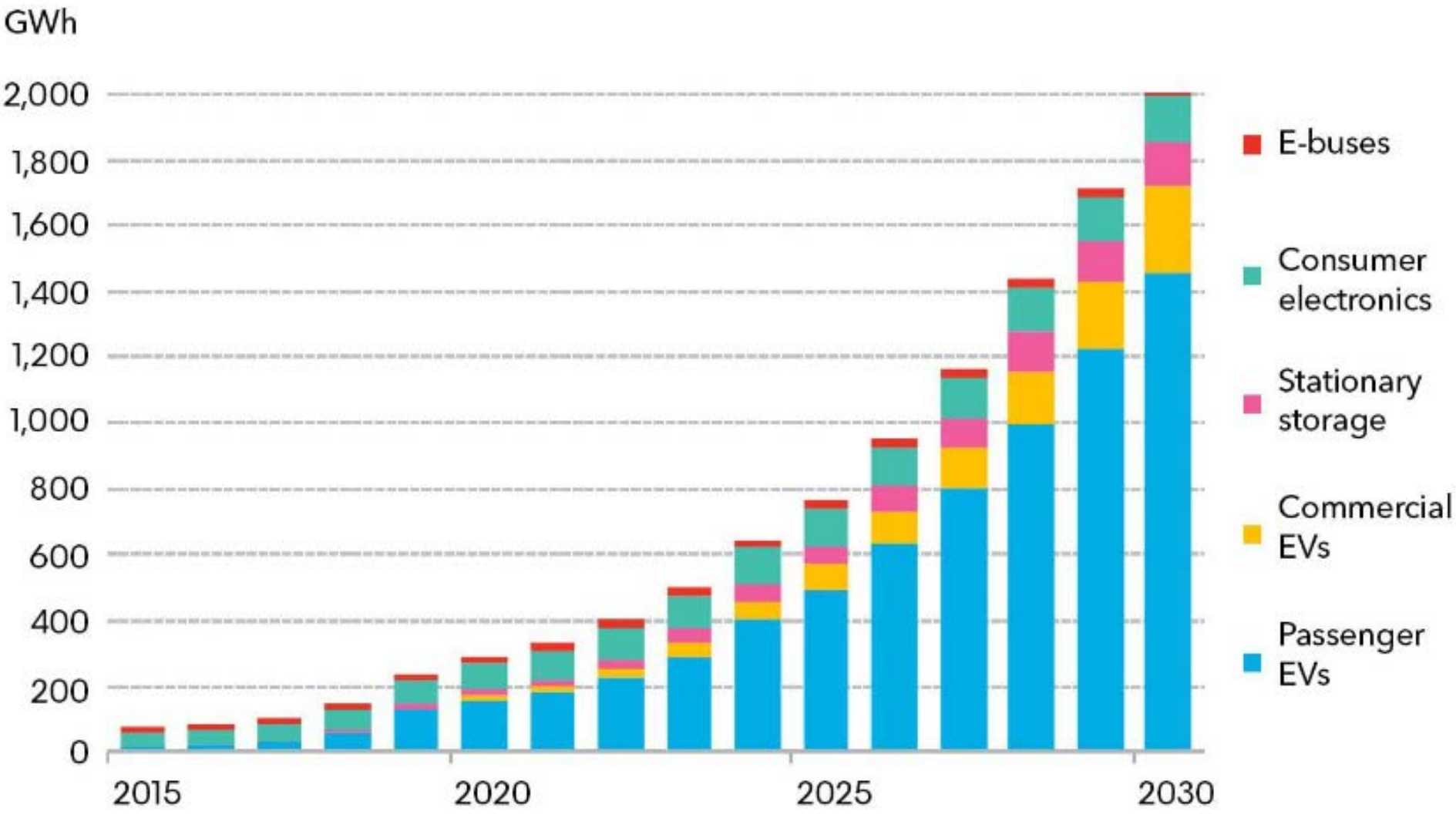
megawatthours

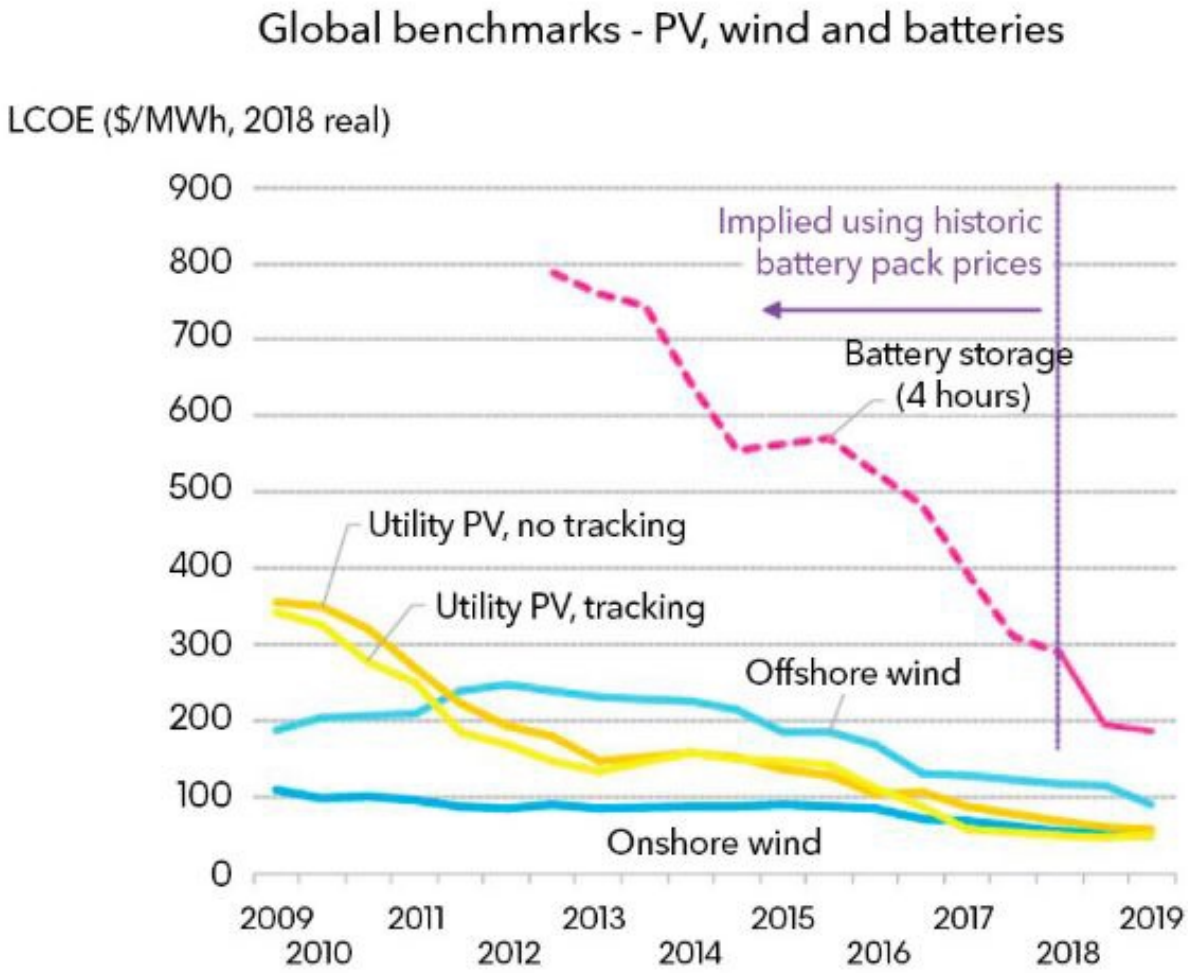


lithium-ion
nickel-based
sodium-based
lead-acid
other

Source: U.S. Energy Information Administration, Form EIA-860, *Annual Electric Generator Report*

Annual lithium-ion battery demand

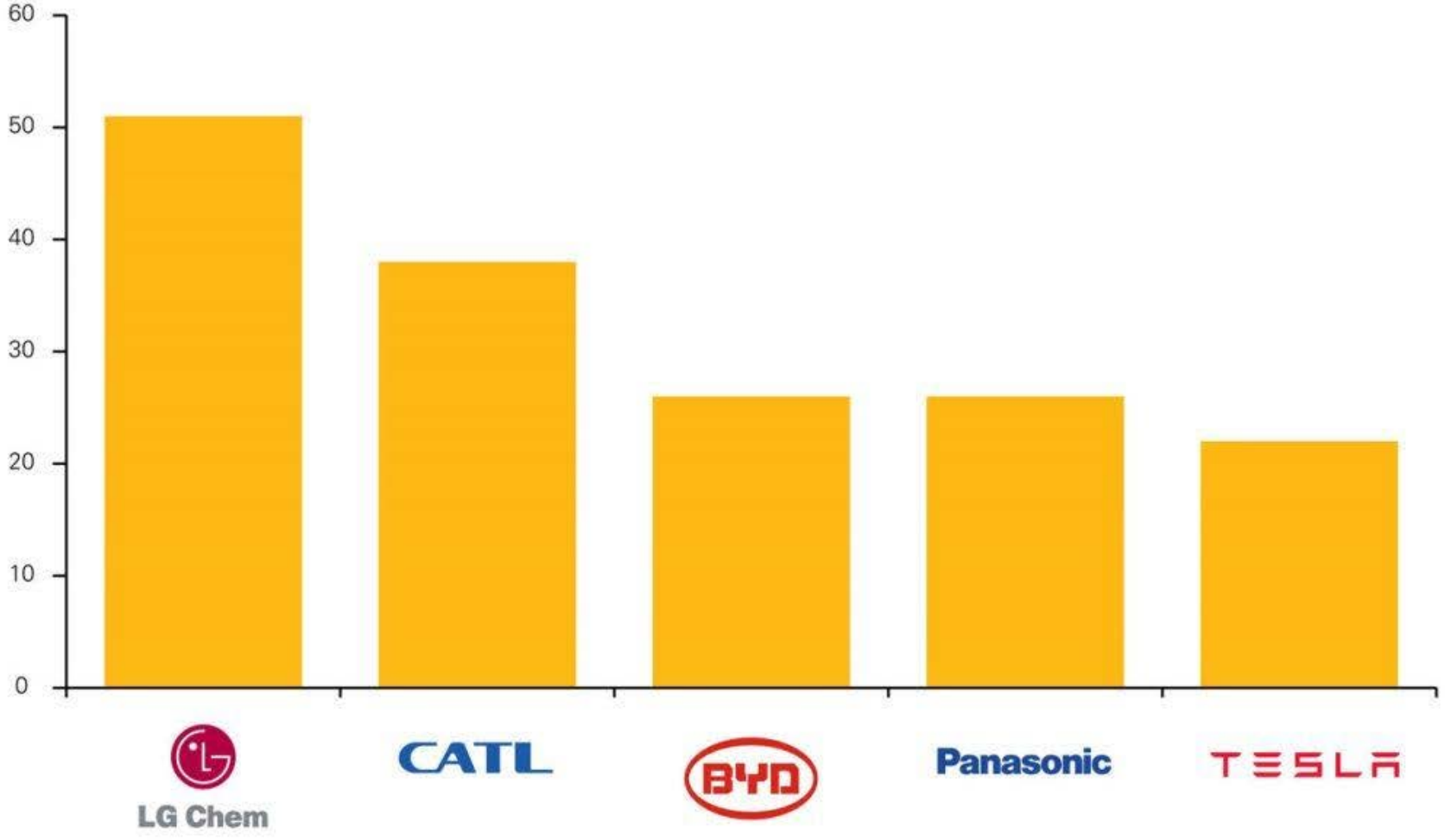




Source: BloombergNEF. Note: The global benmark is a country weighed-average using the latest annual capacity additions. The storage LCOE is reflective of a utility-scale Li-ion battery storage system running at a daily cycle and includes charging costs assumed to be 60% of whole sale base power price in each country.

Battery storage pricing vs wind and utility PV

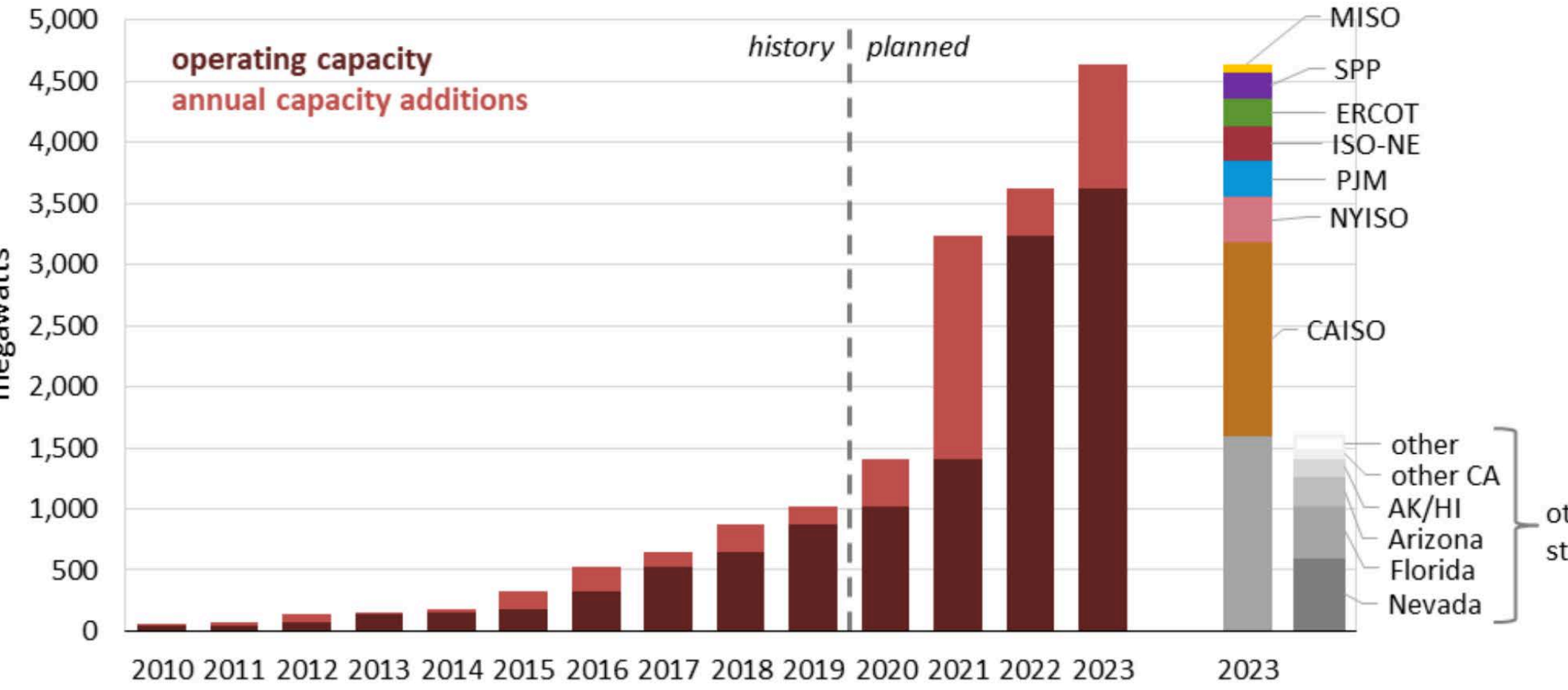
Top 5 Lithium ion Battery Producers by Capacity



Source: Benchmark Mineral Intelligence

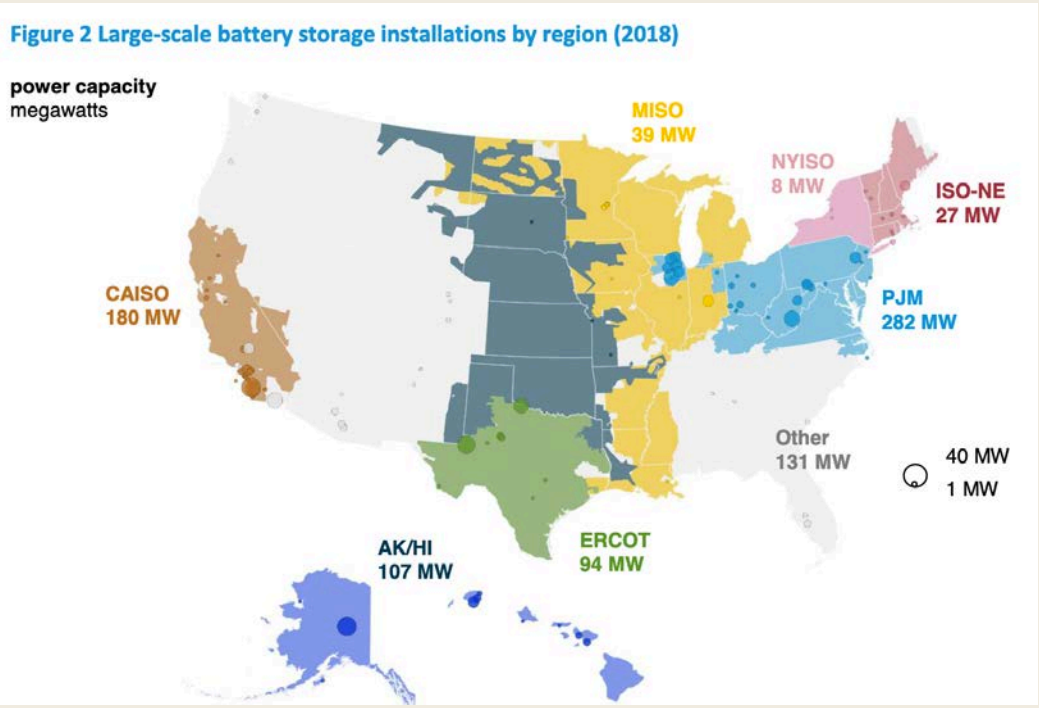
BENCHMARK MINERAL INTELLIGENCE

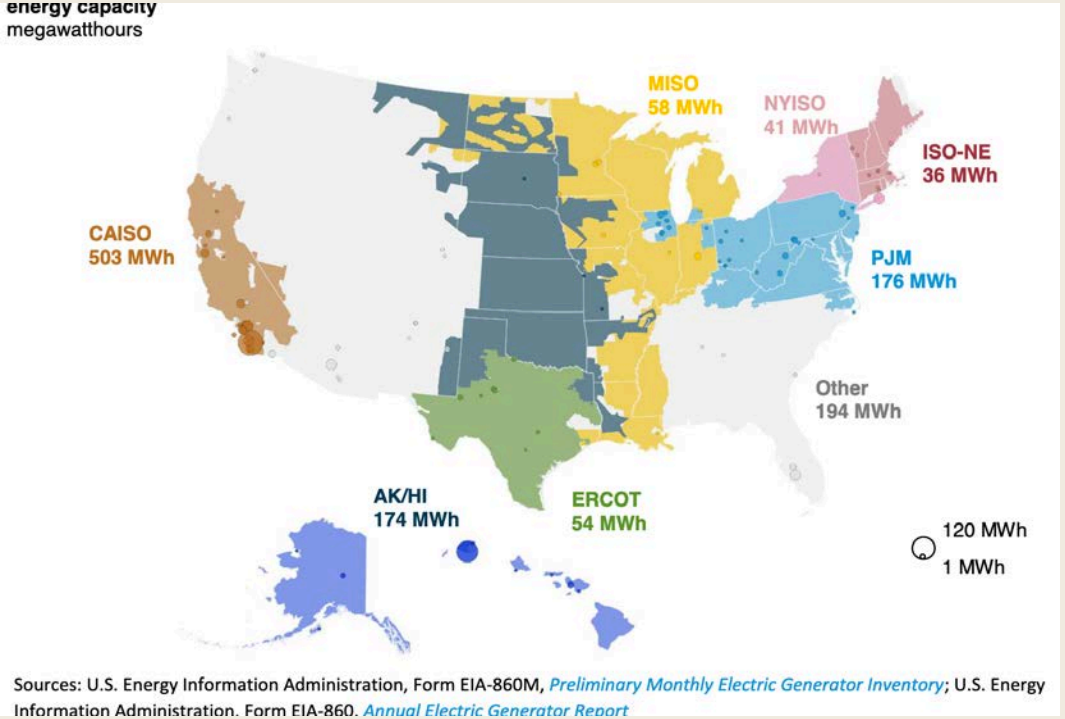
re 12. Large-scale battery storage cumulative power capacity (2010–2023)



e: U.S. Energy Information Administration, Form EIA-860M, *Preliminary Monthly Electric Generator Inventory*

Moving from power applications to energy applications



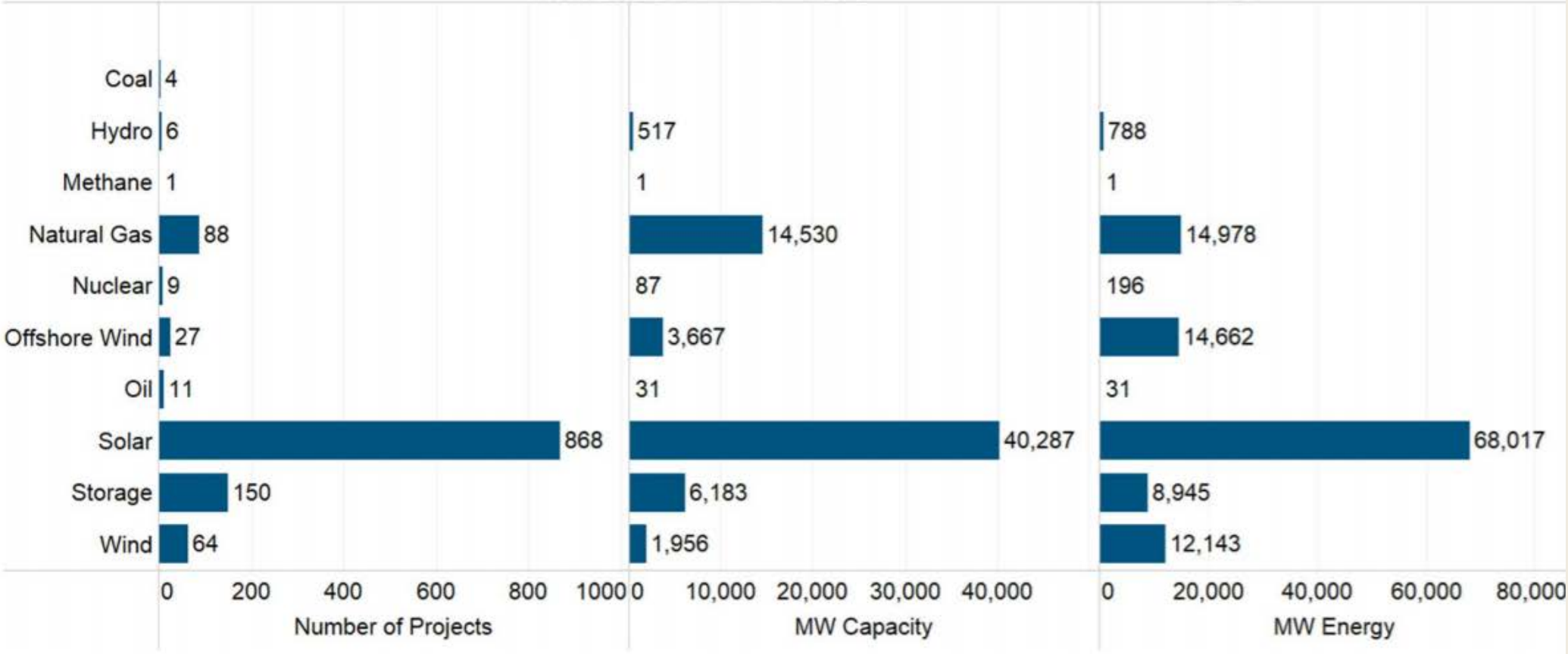


Sources: U.S. Energy Information Administration, Form EIA-860M, *Preliminary Monthly Electric Generator Inventory*; U.S. Energy Information Administration, Form EIA-860, *Annual Electric Generator Report*

ERCOT Interconnection Queue
July, 2020

Source	Power (GW)
Solar	75.3
Wind	25.5
Battery	14.5
Gas	5.4
Coal	0.4
Other	0.4
Nuclear	0.0
Total	**121**

Active Projects in the Queue
Fuel Type Distribution



Largest operational storage projects

Energy Storage Project	Tech	Power	Duration	Country
Hornsdale Power	Li-ion	150 MW	1.2 hours	Australia
Stocking Pelham	Li-ion	50 MW	1 hour	UK
Jardelund	Li-ion	48 MW	1 hour	Germany
Minamisoma substation	Li-ion	40 MW	1 hour	Japan
Nishi-Sendai substation	Li-ion	40 MW	0.25 hour	Japan
Laurel AES	Li-ion	32 MW	0.25 hour	US
Escondido substation	Li-ion	30 MW	4 hours	US
Pomona substation	Li-ion	20 MW	4 hours	US

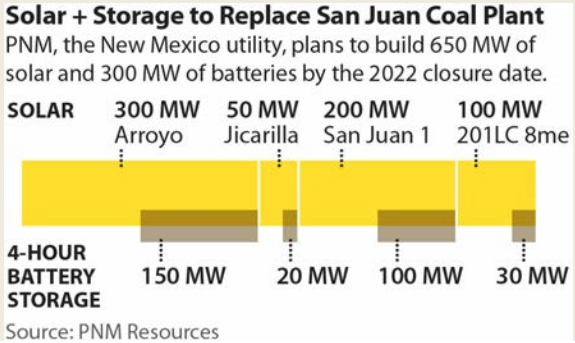
DOE storage database, Wikipedia

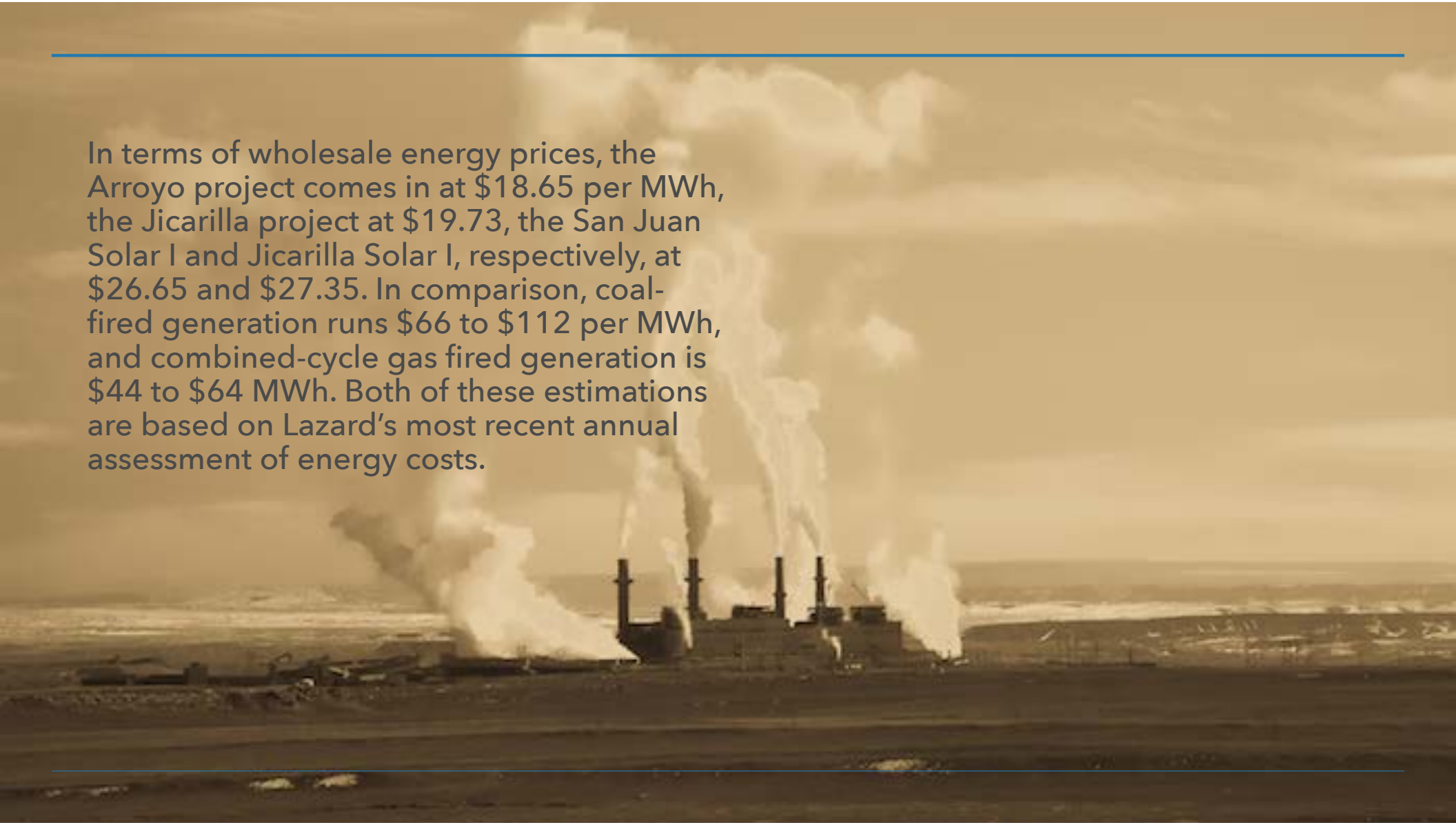
Moss Landing

VISTRA BATTERY AT PG&E'S ELKHORN FACILITY
1,500 MW/6,000 MWH
SUBSTITUTING FOR NATURAL GAS IN AN OLD POWER PLANT TURBINE BUILDING

Coal-fired San Juan Generating Station closes in June 2022

SOLAR AND STORAGE WILL REPLACE SJGS
NEW MEXICO'S SINGLE LARGEST POLLUTER
CARBON-CAPTURE RETROFIT ENCHANT ENERGY UNLIKELY





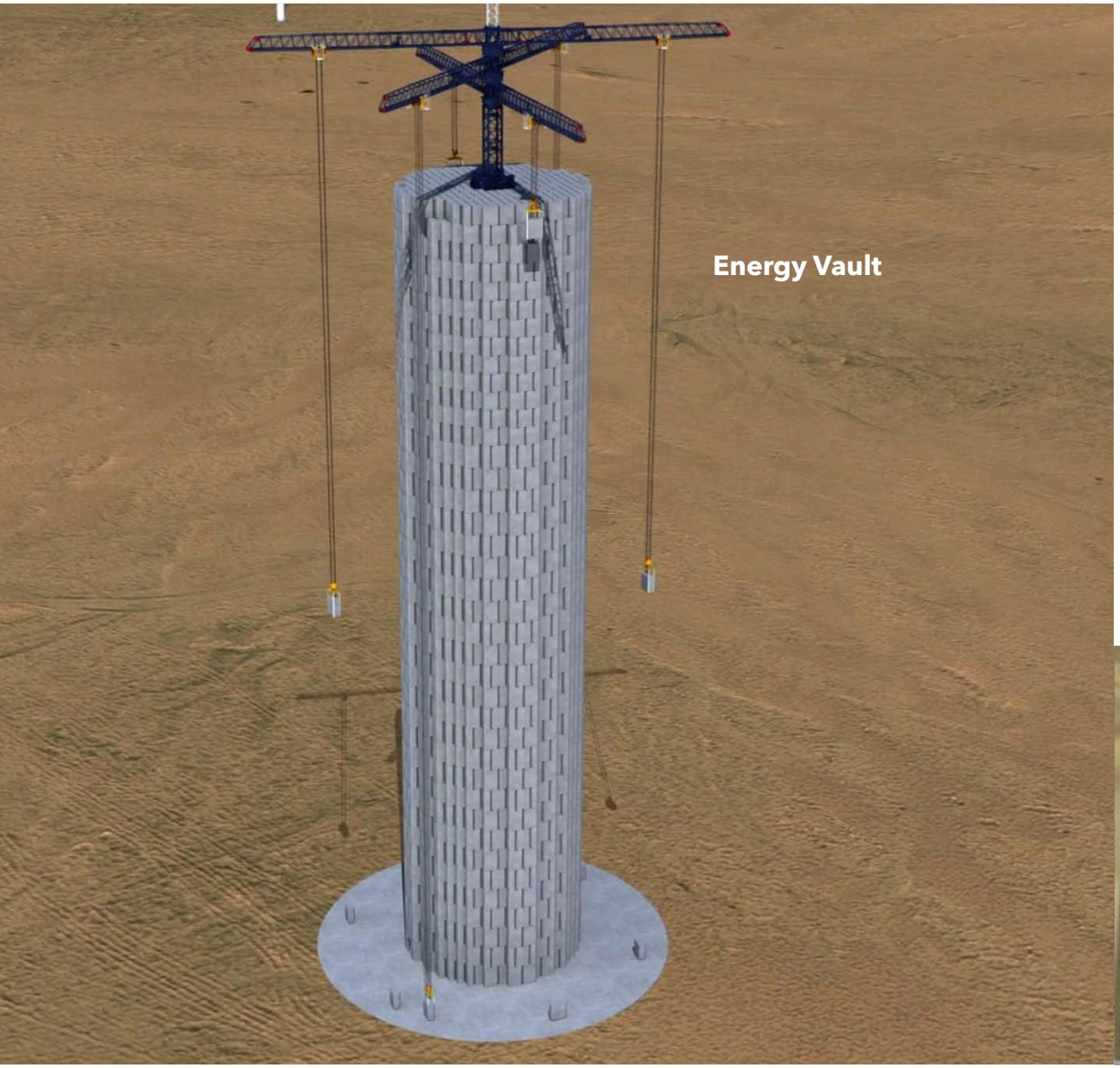
In terms of wholesale energy prices, the Arroyo project comes in at $18.65 per MWh, the Jicarilla project at $19.73, the San Juan Solar I and Jicarilla Solar I, respectively, at $26.65 and $27.35. In comparison, coal-fired generation runs $66 to $112 per MWh, and combined-cycle gas fired generation is $44 to $64 MWh. Both of these estimations are based on Lazard's most recent annual assessment of energy costs.

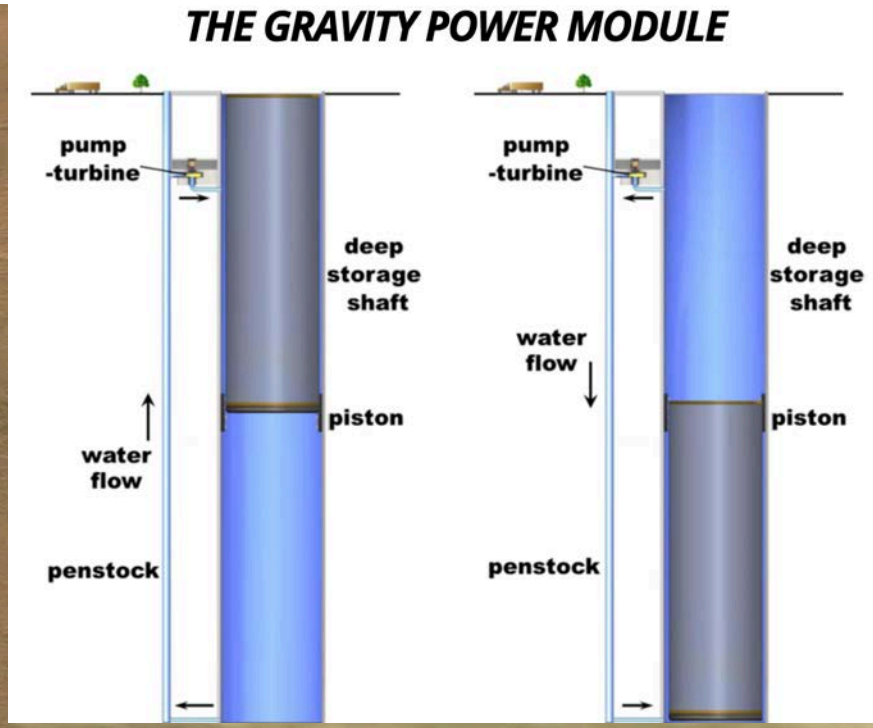
The AES Lāwai solar-plus-storage facility on Kauai

Hornsdale Tesla Big Battery

100MW/129MWH


Long Duration Storage


Energy Vault


THE GRAVITY POWER MODULE
pump
-turbine
deep
storage
shaft
piston
water
flow
penstock
pump
-turbine
deep
storage
shaft
water
flow
piston
penstock


ARES

Long Duration Energy Storage

- Thermal - ceramics aluminum, molten salt
- New electrochemistries
- Flow batteries
- Mechanical - pressurized water underground

FERC Order 2222 opens up wholesale grid markets to distributed energy resources. A huge opportunity for solar, batteries, EVs and other DERs – and a challenge to integrate utility grid operations with bulk energy markets.

Allows full-scale market participation by batteries, EV chargers, smart appliances and more – but the rules for making that happen will be complicated

Energy storage market growth depends on regulatory action, good and bad

FERC ORDER 841

REG D

ORDER 2222

RESOURCE ADEQUACY

SGIP