Federal Investments and Opportunities to Advance Energy Storage Technologies

New Mexico Renewable Energy Transmission Authority
Energy Storage and Reliability Workshop
Santa Fe, NM, Oct. 23 – 24, 2023

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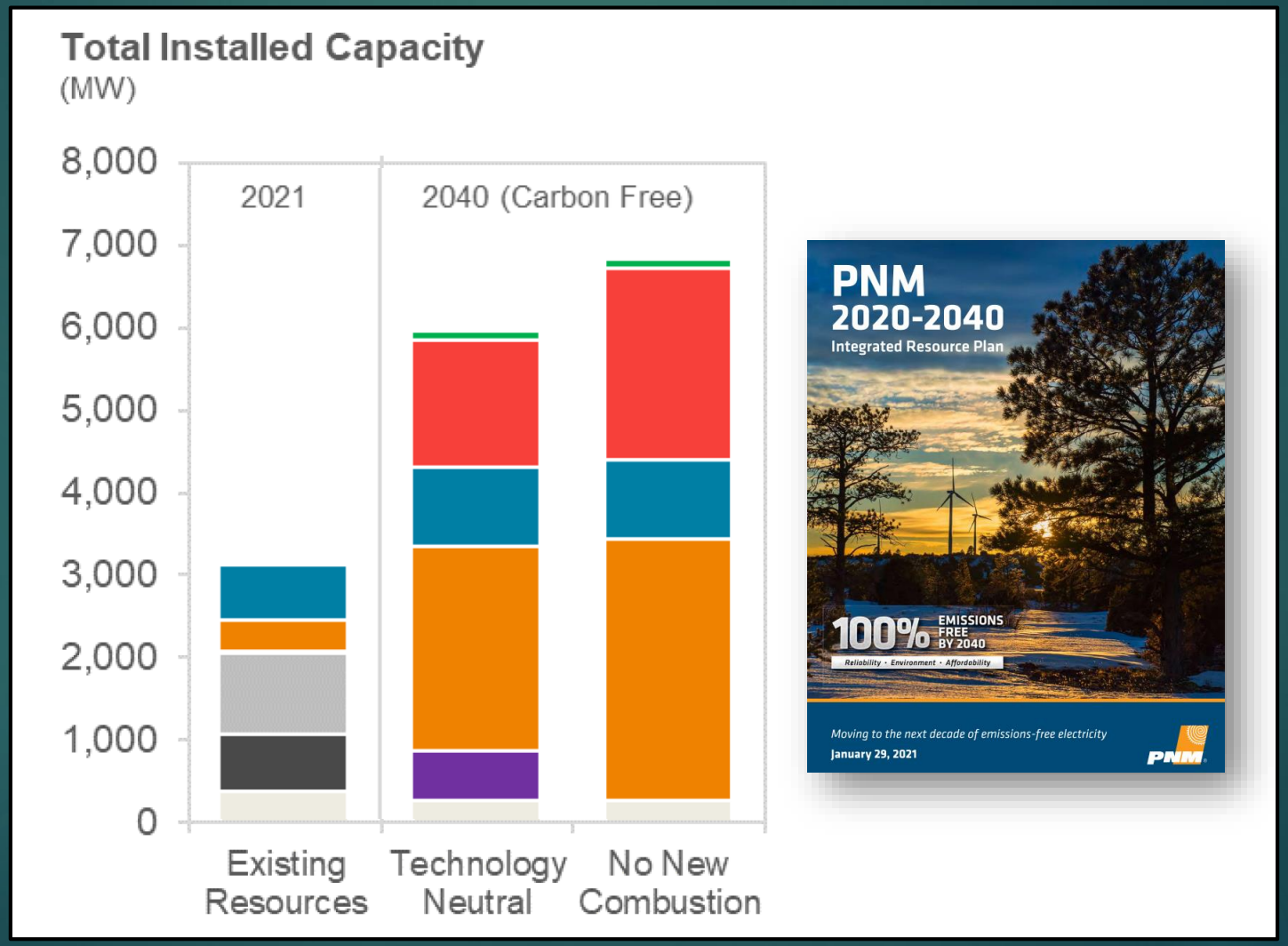
Overview

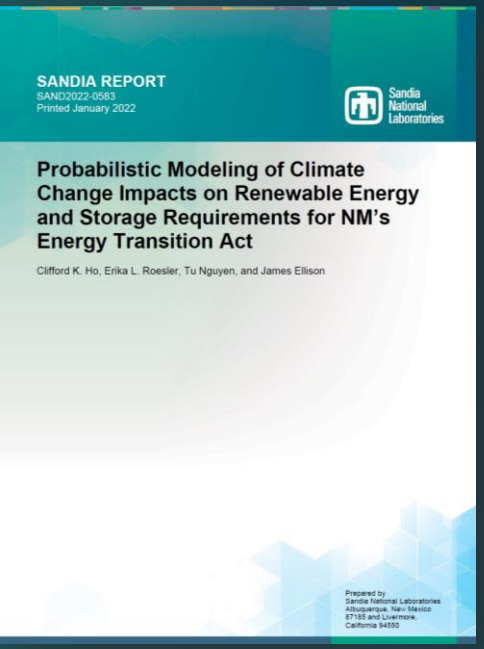
- Introduction – "Big" Energy Storage
- Federal Legislation and Investments
- Summary

Introduction – “Big” Energy Storage

How Much Energy Storage in NM?

- DSM
- Battery
- Wind
- Solar
- Geothermal
- Hydrogen
- Natural Gas
- Coal
- Nuclear





https://www.osti.gov/biblio/1855051

Planned PNM Battery Storage

(from PNM 2020-2040 Integrated Resource Plan)

Table 16. Summary of planned battery storage systems in PNM's No New Combustion, most cost-effective portfolio [1].

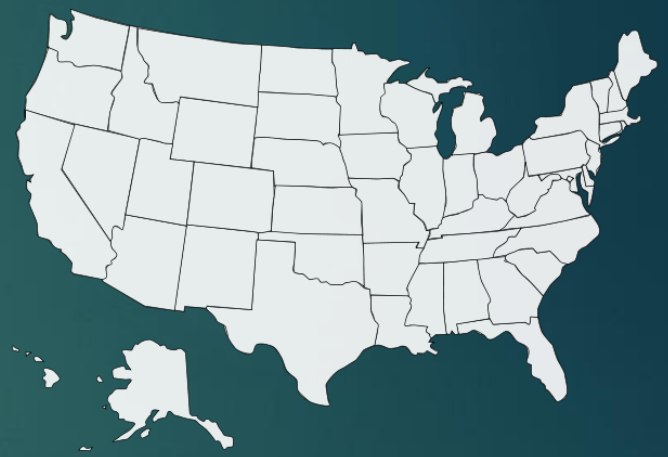
Storage System*	Nameplate Capacity (MW)			
	2021	2022	2030	2040
Arroyo Storage ESA (MW)	0	150	150	150
Jicarilla Storage ESA (MW)	0	20	20	20
Rockmont Storage ESA (MW)	0	30	30	30
San Juan Storage ESA (MW)	0	100	100	100
New Lithium Ion Battery (4 hr) (MW)	0	0	508	1025
New Lithium Ion Battery (8 hr) (MW)	0	0	262	391
New Flow Battery (10 hr) (MW)	0	0	0	590
New Pumped Storage (MW)	0	0	0	0
Total storage capacity (MWh)	**0**	**1200**	**5328**	**14328**

*ESA (Energy Storage Agreement) storage systems were assumed to be 4-hour Li-ion batteries for calculating energy capacity

https://www.osti.gov/biblio/1855051 (adapted from PNM 2020-2040 Integrated Resource Plan)

Energy Storage Needs in the U.S.?

- **The U.S. grid may need 225-460 GW of LDES capacity for a net-zero economy by 2050***
  - $330B in cumulative capital requirements
  - Results in $10-20B in annualized savings in operating costs and avoided capital expenditures



*DOE Long Duration Energy Storage (LDES) Commercial Liftoff Report

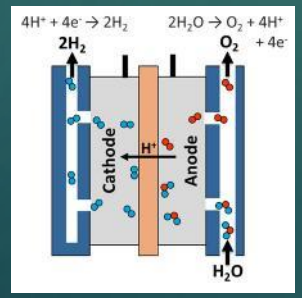
Carbon-Free Energy Ecosystem
(need to consider interdependencies)

Make → Move → Store → Use

Electrical

Thermal

Chemical



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Federal Legislation
Investments in Energy Storage

- Infrastructure Investment and Jobs Act (2021)
  - "Bipartisan Infrastructure Law" or "BIL"
- Inflation Reduction Act of 2022 ("IRA")
- CHIPS & Science Act of 2022

Federal Legislation

Provisions for Energy Storage

Sources: McKinsey & Co., DOE, ESTAP, Bipartisan Policy Center

	Infrastructure Investment and Jobs Act (2021)	Inflation Reduction Act of 2022	CHIPS & Science Act of 2022
Purpose			
Funding Amount Authorized for Energy Storage			
Funding Type			

Federal Legislation

Provisions for Energy Storage

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Funding Amount Authorized for Energy Storage	• $9B for hydrogen hubs and programs • $6B for battery R&D • $505 million for long duration storage	• Investment and production tax credits for energy storage	• $600M for electricity storage R&D (DOE BES) • R&D to advance critical mineral mining (NSF) • $1B for ARPA-E
Funding Type			

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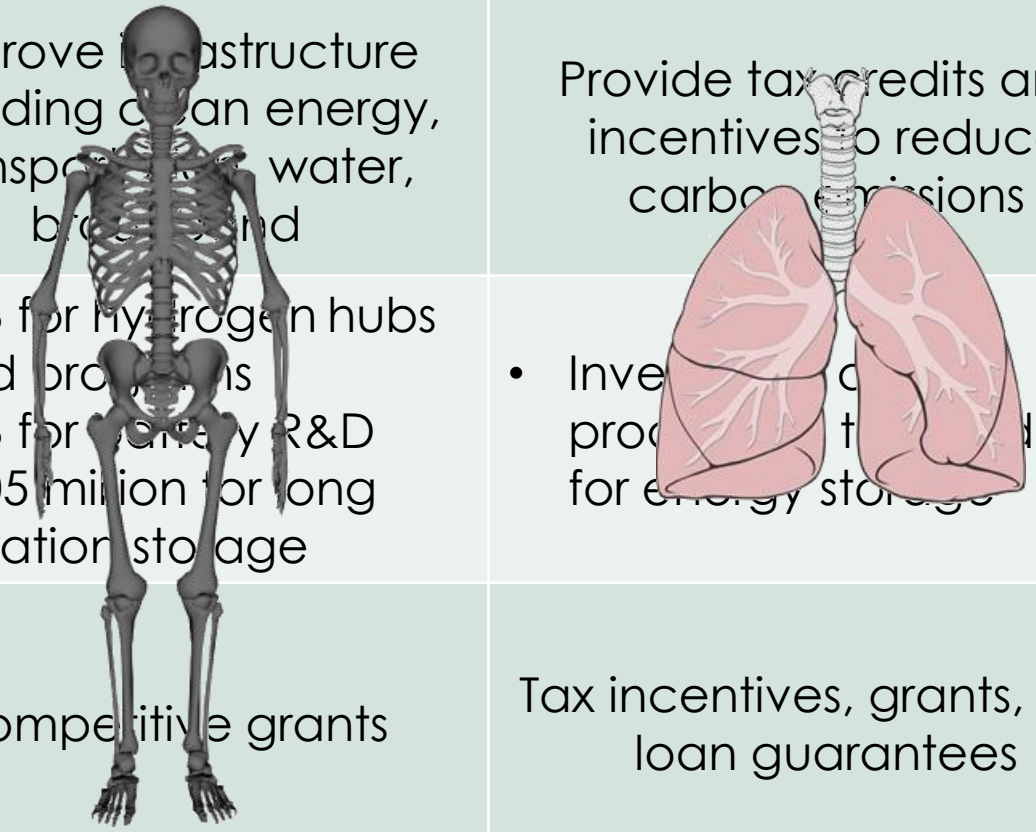


Infrastructure Investment and Jobs Act

- **Long Duration Energy Storage (>10 hours)**
  - $505 million for storage demonstrations
- **Hydrogen R&D**
  - $8 billion for FY22-26 for at least four regional **hydrogen hubs**
  - $500 million for FY22-26 for clean hydrogen **manufacturing** and **recycling** program
  - $1 billion for FY22-26 for **clean hydrogen** from **electrolyzers**

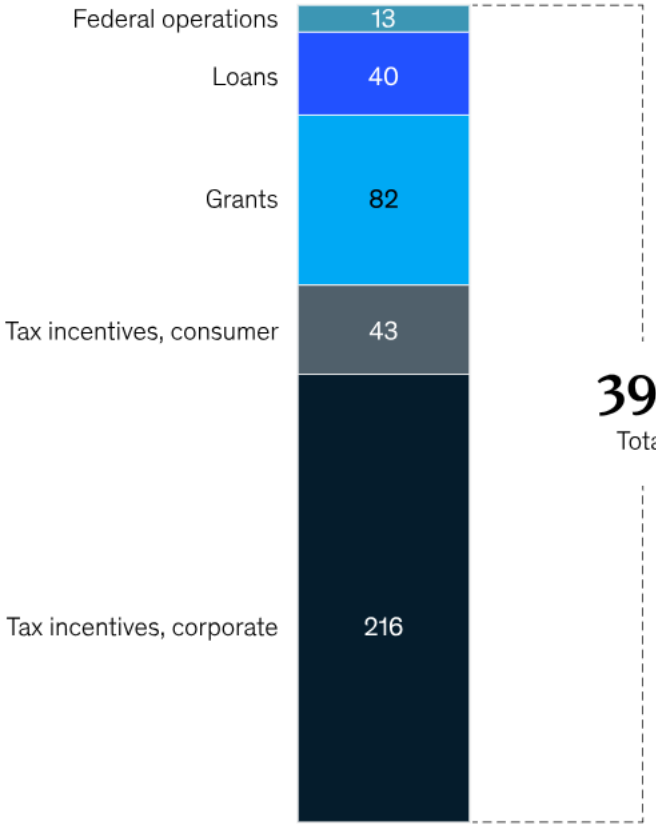
Infrastructure Investment and Jobs Act

- **Supply Chains for Clean Energy Technologies**
  - $3 billion for FY22-26 for **battery material processing** grants
  - $3 billion for FY22-26 for **battery manufacturing and recycling grants**
  - $100 million for FY21 – 24 for **critical mineral mining, recycling, and reclamation**

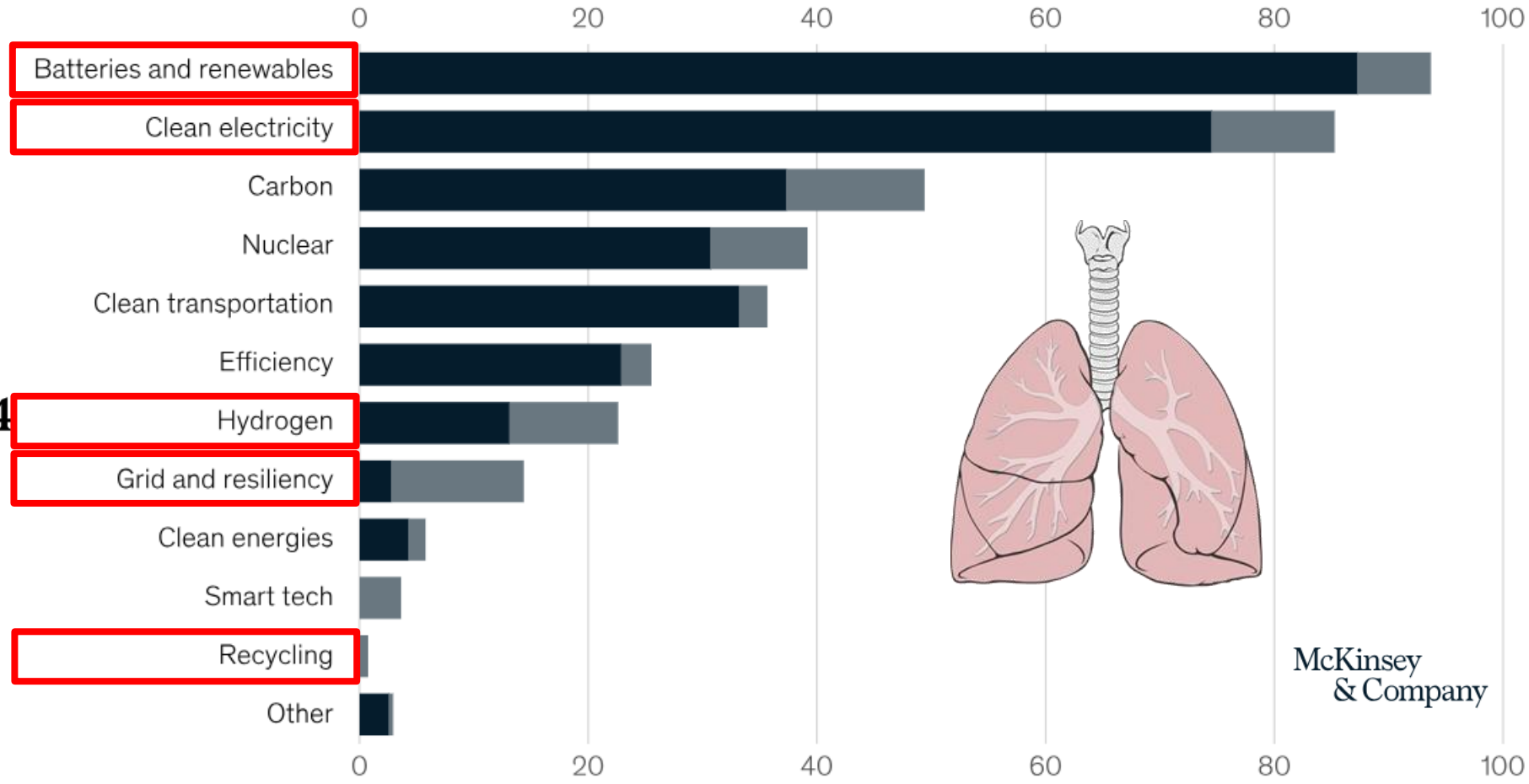
Inflation Reduction Act

https://www.mckinsey.com/industries/public-sector/our-insights/the-inflation-reduction-act-heres-whats-in-it

Energy and climate change funding by type, $ billion

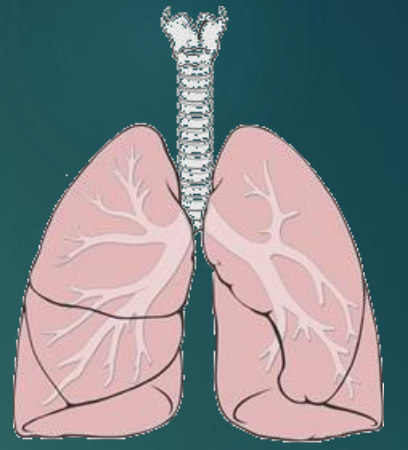


Energy funding by theme and source, $ billion



Note: This exhibit reflects analysis of the appropriation figures contained in the Inflation Reduction Act, as well as those reported by the Congressional Budget Office and Joint Committee on Taxation. This analysis may differ from other analyses due to differences in methodology.
Source: Inflation Reduction Act of 2022, H.R. 5376, 117th Cong. (2021–22); Infrastructure Investment and Jobs Act, H.R. 3684, 117th Cong. (2021–22)

Inflation Reduction Act
Clean Energy Tax Incentives



Energy Generation & Carbon Capture	Manufacturing	Vehicles	Fuels
§45,§45Y: Production Tax Credit for Clean Electricity	**§48C**: Investment Credit for Advanced Energy	**§45W**: Credit for Qualified Clean Vehicles	**§45V**: Production Tax Credit for Clean Hydrogen
§48,§48E: Investment Tax Credit for Clean Electricity	**§45X**: Production Credit for Advanced Manufacturing	**§30C**: Credit for Alternative Vehicle Refueling Property	**§45Z**: Production Tax Credit for Clean Fuels
§45Q: Credit for Carbon Oxide Sequestration			
§45U: Production Credit for Nuclear Power			

Adapted from https://www.irs.gov/pub/irs-pdf/p5817g.pdf

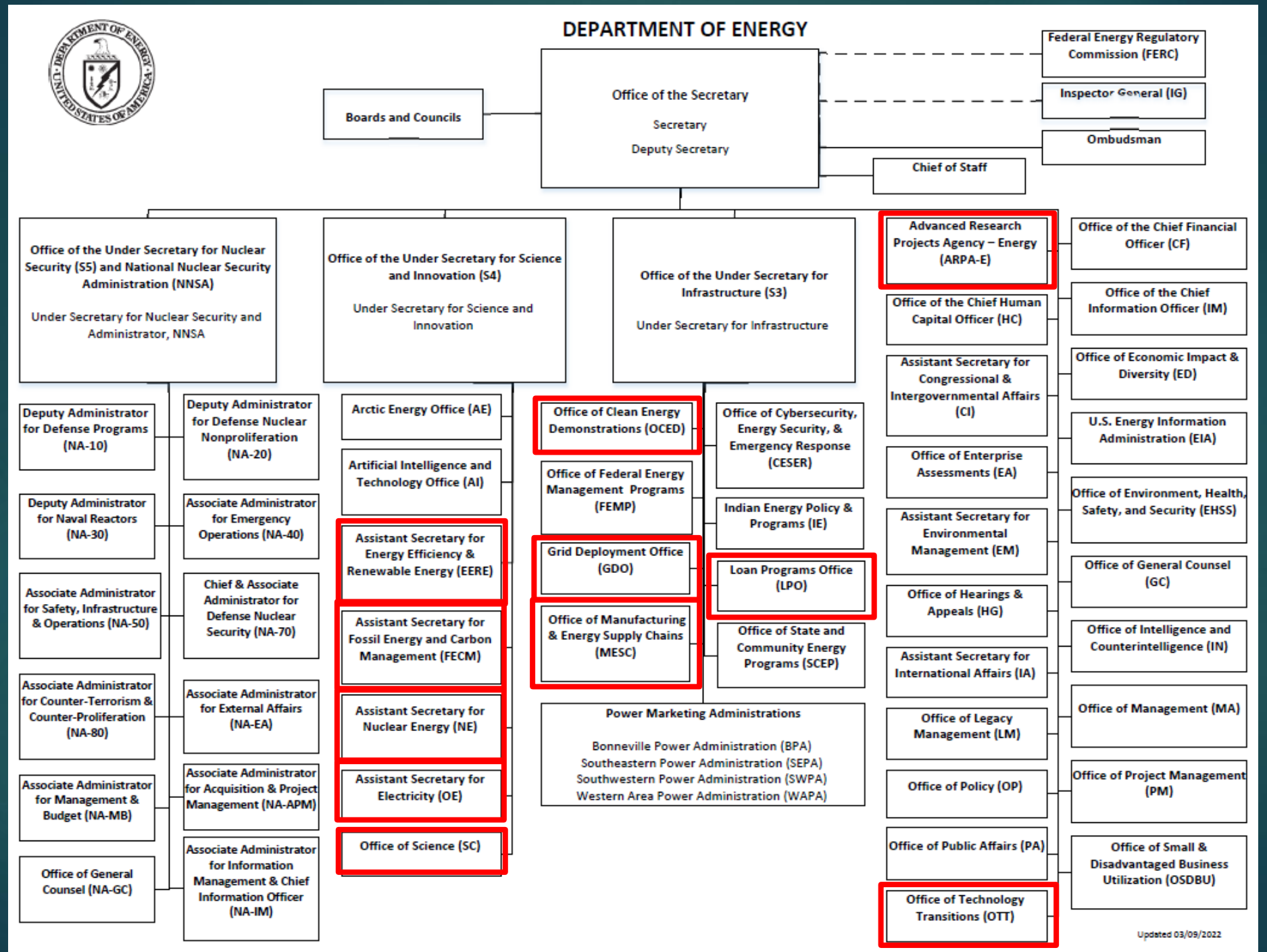
Bonus tax credits also available for domestic content, low-income, tribal, and energy communities

CHIPS & Science Act

- $600M for electricity storage R&D (DOE BES)
- R&D to advance critical mineral mining (NSF)
- $1B for Advanced Research Projects Agency-Energy
- $100M for Office of Technology Transitions (OTT)
  - Increases coordination among DOE offices for commercialization (OCED, OTT, LPO)

BES = Basic Energy Sciences, NSF = National Science Foundation, OCED = Office of Clean Energy Demonstrations, LPO = Loan Programs Office

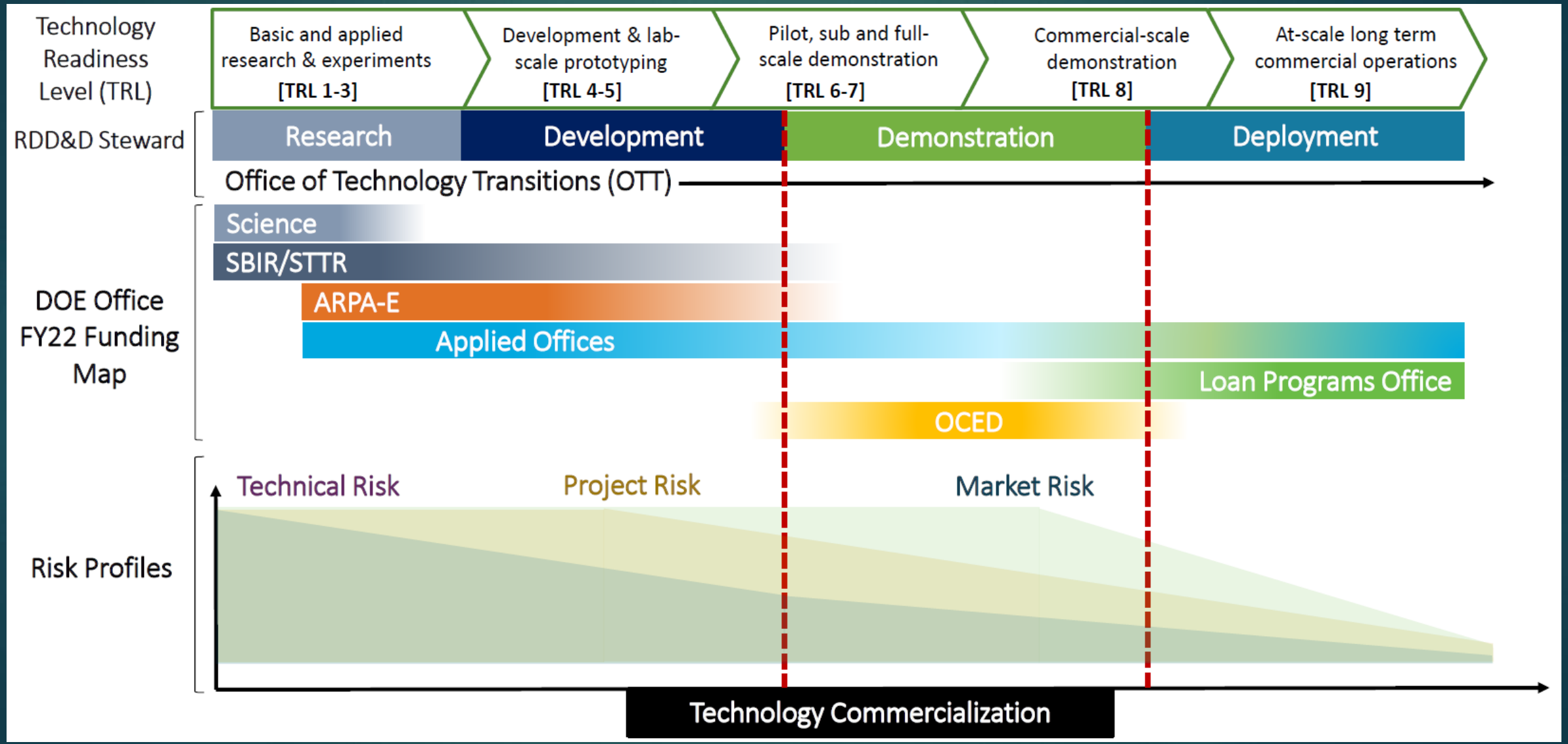
Funding Implementation – DOE



https://www.energy.gov/organization-chart

DOE Commercialization Pathway

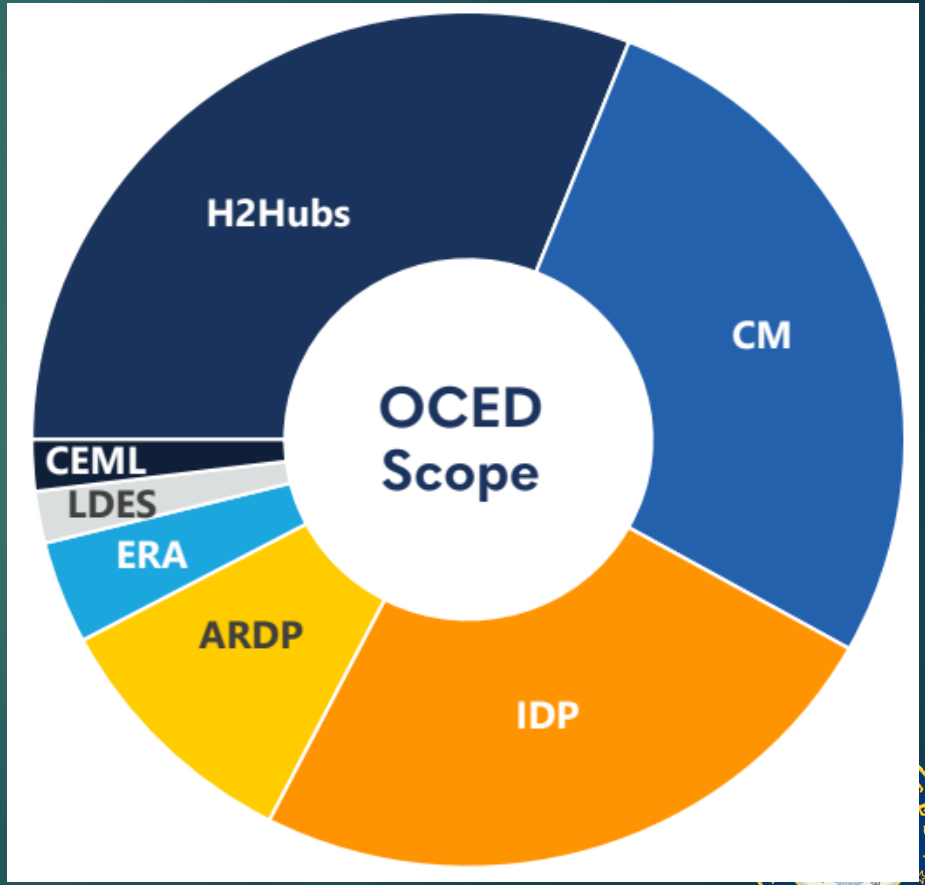
https://www.cesa.org/event/new-federal-funding-for-energy-storage/



Implementation of Federal Funding – OCED (DOE Office of Clean Energy Demonstrations)

Project Portfolio

- Regional Clean Hydrogen Hubs (H2Hubs) $8 billion
- Carbon Management (CM) Regional Direct Air Capture Hubs, Carbon-Capture Demos & Large-Scale Pilot Projects $7 billion
- Industrial Demonstrations (IDP) $6.3 billion
- Advanced Reactor Demonstration Projects (ARDP) $2.5 billion
- Energy Improvements in Rural or Remote Areas (ERA) $1 billion
- Long-Duration Energy Storage Demonstrations (LDES) $505 million
- Clean Energy Demonstrations on Mine Land (CEML) $500 million



https://www.energy.gov/sites/default/files/2023-06/OCED_IDP_0.pdf

NM Long Duration Energy Storage Awards
(announced Sep. 2023)

- **ReJoule, Santa Fe, NM**
  - Repurpose retired lithium-ion electric vehicle batteries into energy storage for the grid
  - Up to $10 million to repurpose retired electric vehicle batteries and provide energy storage for affordable housing developments in Santa Fe and California

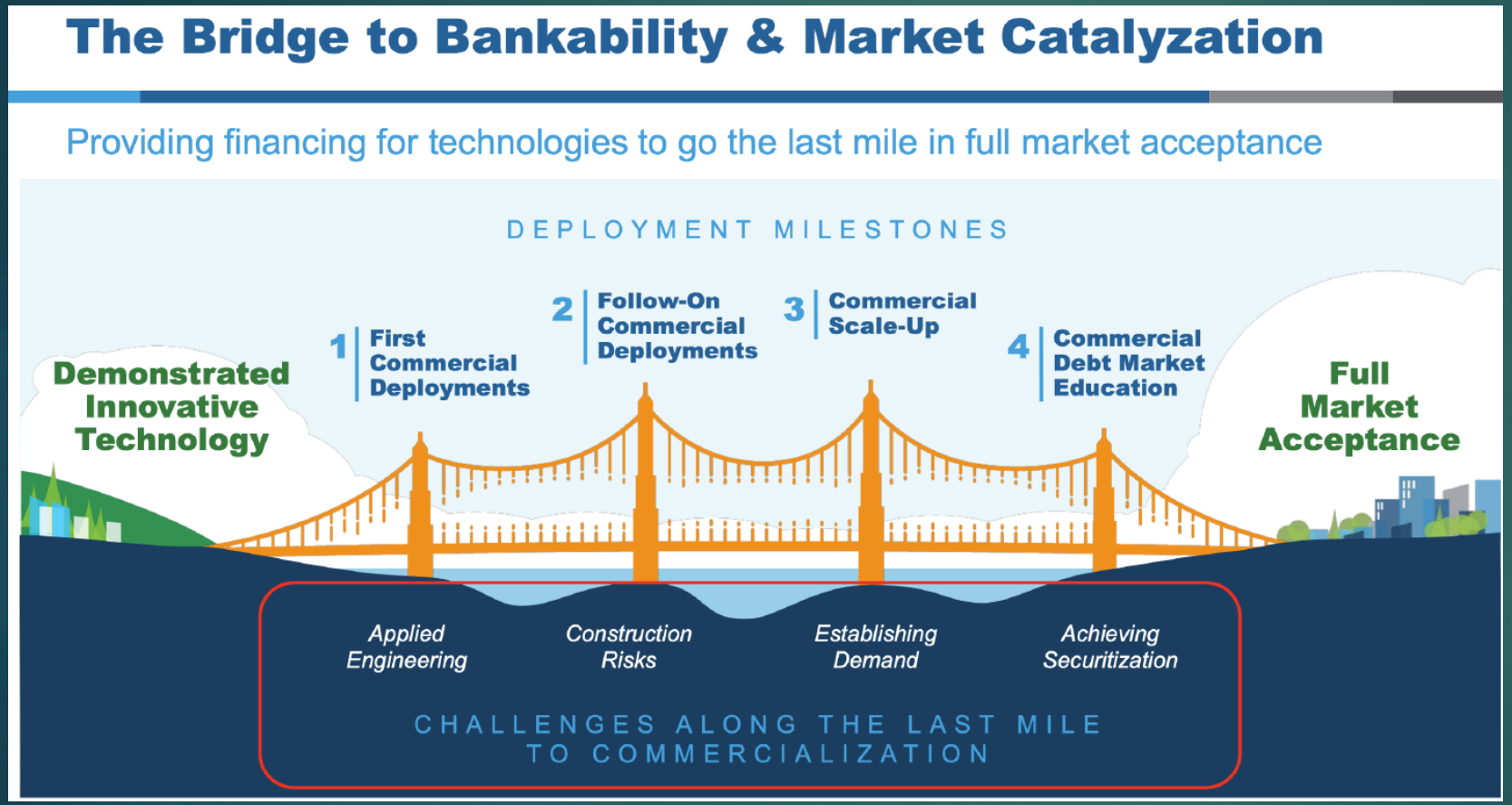
NM Long Duration Energy Storage Awards
(announced Sep. 2023)

- **Sandia National Laboratories**
  - Up to $4 million to demonstrate long-duration particle-based thermal energy storage
  - Up to $10 million to demonstrate long-duration zinc-based battery for critical facilities during outages
    - Partnership with E-Zinc, a large-scale zinc battery manufacturer
  - $7.5 million to lead the National Consortium for the Advancement of Long Duration Energy Storage

DOE "Energy Storage" Funding Opportunities
(partial list since October 2022)

- AMMTO - National Laboratory Call for Proposals Strengthening Domestic Capabilities in Solid-State and Flow Battery Manufacturing; $16M
- AMMTO/BTO/OE – Multi-Topic FOA; $52M
- BTO - Buildings Energy Efficiency Frontiers & Innovation Technologies (BENEFIT) – 2022/2023; $15-45M
- FEMP - Assisting Federal Facilities with Energy Conservation Technologies (AFFECT) 2022 Appropriations; $13M
- IEDO - National Laboratory Call for Reducing Embodied Carbon and Operational Energy Across the Built Environment; $6.2M
- IEDO - Industrial Efficiency and Decarbonization Office National Laboratory Call for Proposals; $9.2M
- IEDO - FY23 Multi-Topic FOA; $155M
- IEDO - Onsite Energy Technical Assistance Partnerships; $23M
- SC - Science Foundations for Energy Earthshots; $150M
- SC - Energy Innovation Hub Program: Research to Enable Next-Generation Batteries and Energy Storage; $125M
- SETO - Solar-Thermal Fuels and Thermal Energy Storage via Concentrating Solar-Thermal Energy; $30M
- SETO - Small Innovative Projects in Solar: Concentrating Solar Power and Photovoltaic (SIPS: CSP & PV) – Annual; $6.5M
- SETO - Operation and Planning Tools for Inverter-Based Resource Management and Availability for Future Power Systems (OPTIMA); $30M
- SETO - National Laboratory Call for Proposals (FY25-FY27); $56M
- OE - Energy Storage Grand Challenge Lab Coordinator; $600k
- OE/EERE - Storage Innovations 2030: Technology Liftoff; $15M
- OE - Rapid Operational Validation Initiative (ROVI) Flow Battery Lab Call
- OE - Energy Storage Demonstration and Validation; $15M
- OE - Underserved and Indigenous Community Microgrids; $14.7M
- OE - Increasing Utilization and Reliability of Electric Infrastructure with Grid-enhancing technologies (GETs); $6.5M
- OCED - Long Duration Energy Storage Demonstrations National Laboratory Call for Proposals; $30M
- OCED - Bipartisan Infrastructure Law: Long-Duration Energy Storage Demonstrations Funding Opportunity Announcement; $349M
- OCED - Bipartisan Infrastructure Law - Clean Energy Demonstration Program on Current and Former Mine Land Funding Opportunity Announcement; $450M
- OCED - Bipartisan Infrastructure Law Energy Improvement in Rural or Remote Areas; $300M
- OCED - Distributed Energy Systems Demonstrations Funding Opportunity Announcement; $50M
- OCED/OTT - Lab Call on Collaborative Alignment for Critical Technology Industries; $15M
- OTT - Technology Commercialization Fund – National Laboratory Call for Proposals Core Laboratory Infrastructure for Market Readiness; $17-$20M
- VTO - Battery Research and Development Consortium; $60M
- WPTO - Bipartisan Infrastructure Law Section 41006. Water Power Projects: Innovative Technologies to Enable Low Impact Hydropower and Pumped Storage Hydropower Growth; $14.5M

DOE Loan Program Office



https://www.cesa.org/event/new-federal-funding-for-energy-storage/

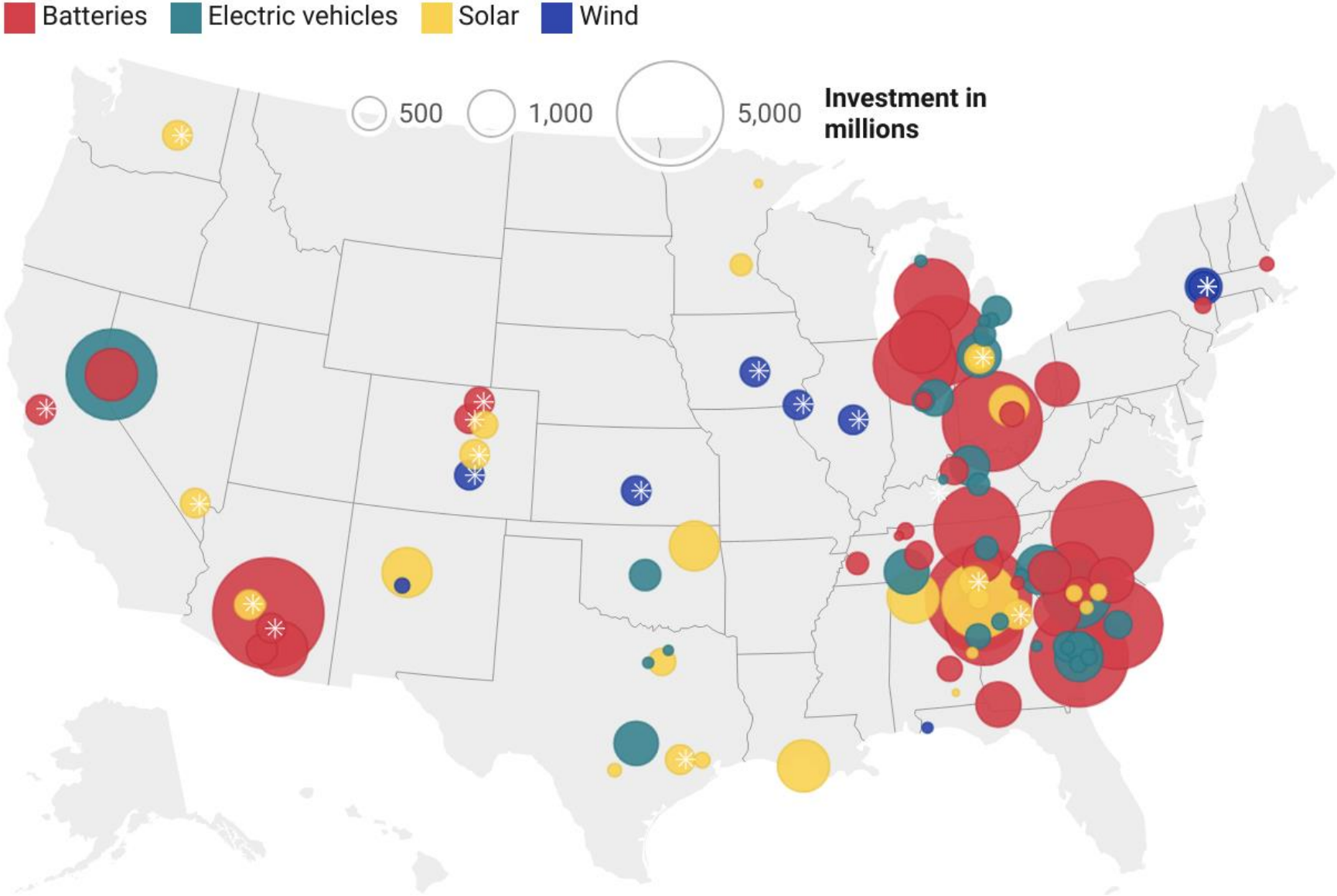
- By the end of 2022
  - 98 active applications
  - $98.7 billion in loans requested
  - 1.5 new applications per week
- Energy Storage
  - Residential through grid-scale
  - Management systems
  - Safety
  - EV charging
  - Up to $3B to Sunnova's project Hestia for VPP* (4/2023)

*Virtual Power Plant includes distributed solar and battery storage, and demand response

Impact of Recent Federal Legislation

Clean energy manufacturing projects announced since Inflation Reduction Act passage

New planned factories or expansions unveiled from August 2022 to August 2023



*Starred projects have not announced investment amounts

Source: Jack Conness, American Clean Power, and Canary media analysis of public announcements

Summary

Summary

- Recent federal legislation has authorized and appropriated billions of dollars for energy storage and grid reliability/resilience
- DOE is implementing funding opportunities
  - Sign up for notifications!
- Congress still needs to appropriate significant amounts of authorized funding

Fellowships

- Congressional Fellowships (S&T)
  - E.g., AAAS, ACS, ASME, AIP, IEEE, TechCongress, DOE
- Presidential Management Fellowships
- Presidential Innovation Fellowships

https://en.wikipedia.org/wiki/Authorization_bill#/media/File:CapitalBuilding_Moon_Reflecting Pool_12x18Print.jpg

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Backup Slides

Bulk Energy Storage Technologies

Storage Technology	Advantages	Challenges
Mechanical (Pumped Hydro)	▪ Mature technology ▪ Demonstrated large capacity (~GWh) ▪ >90% of U.S. grid energy storage ▪ Good reliability	▪ Unique geologic resources and water availability ▪ Large area required (low energy density)
Electrochemical (Flow Batteries)	▪ Long lifetime, minimal fire risk ▪ Scalability and long-duration ▪ Low self-discharge ▪ No detrimental effects of deep discharge	▪ Low energy density compared to Li-Ion ▪ Cost and availability of electrolyte (e.g., vanadium) ▪ Degradation of electrolytes
Chemical (Hydrogen)	▪ Can be stored in large capacities for long periods of time ▪ Can be used for grid, heat, and transportation	▪ Low round-trip efficiency of hydrogen production and storage ▪ Infrastructure for conveyance/storage ▪ Leakage and safety of hydrogen gas
Thermal (Sensible, Latent, Thermochemical)	▪ Sensible storage is mature ▪ Demonstrated large capacity with concentrating solar power (~GWh) ▪ Thermochemical: large energy density and potential for long-duration storage	▪ Heat losses during conveyance/storage ▪ Heat exchanger performance and cost ▪ Low maturity of thermochemical

ENERGY earthshots | Storage™
U.S. DEPARTMENT OF ENERGY

LONG DURATION STORAGE SHOT TARGET

Reduce storage costs by **90%** from a 2020 Li-ion baseline...

...in storage systems that deliver **10+** hours of duration

...in **1** decade

Affordable grid storage for clean power – any time, anywhere

DOE Energy Storage "Liftoff"

- Long Duration Energy Storage Commercial Liftoff Report (link)
  - Identifies challenges, solutions, benefits of LDES
  - "Liftoff" (self-sustaining market) by 2030
  - Needs: Technology development, market and regulatory mechanisms, and supply chain development
- In July 2023, DOE Office of Electricity launched Storage Innovations Technology Liftoff ($15M)

DOE ARPA-E

Advanced Research Projects Agency—Energy

- PROPEL-1K – up to $30 million (Sep. 2023)
  - Pioneering Railroad, Oceanic and Plane ELectrification (PROPEL-1K) program aims to develop energy storage systems with “1K” solutions achieving 1 Kilowatt-hour per and 1 Kilowatt-hour per liter