

# FY 2022 Request Overview Briefing

June 2021




# FY 2022 Request Strategy

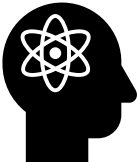
Accelerate the research, development, demonstration, and deployment of technologies and solutions to equitably transition America to a carbon pollution-free electricity sector by 2035 and a economy by no later than 2050, creating good-paying jobs with the free and fair chance to join a union, and ensuring the clean energy economy benefits all Americans, especially workers and communities impacted by the energy transition and those historically underserved by the energy system and overburdened by pollution.




## Keys to Ensure the Greatest Impact




Environmental  
Justice and Equity



Diversity in STEM



Workforce  
Development



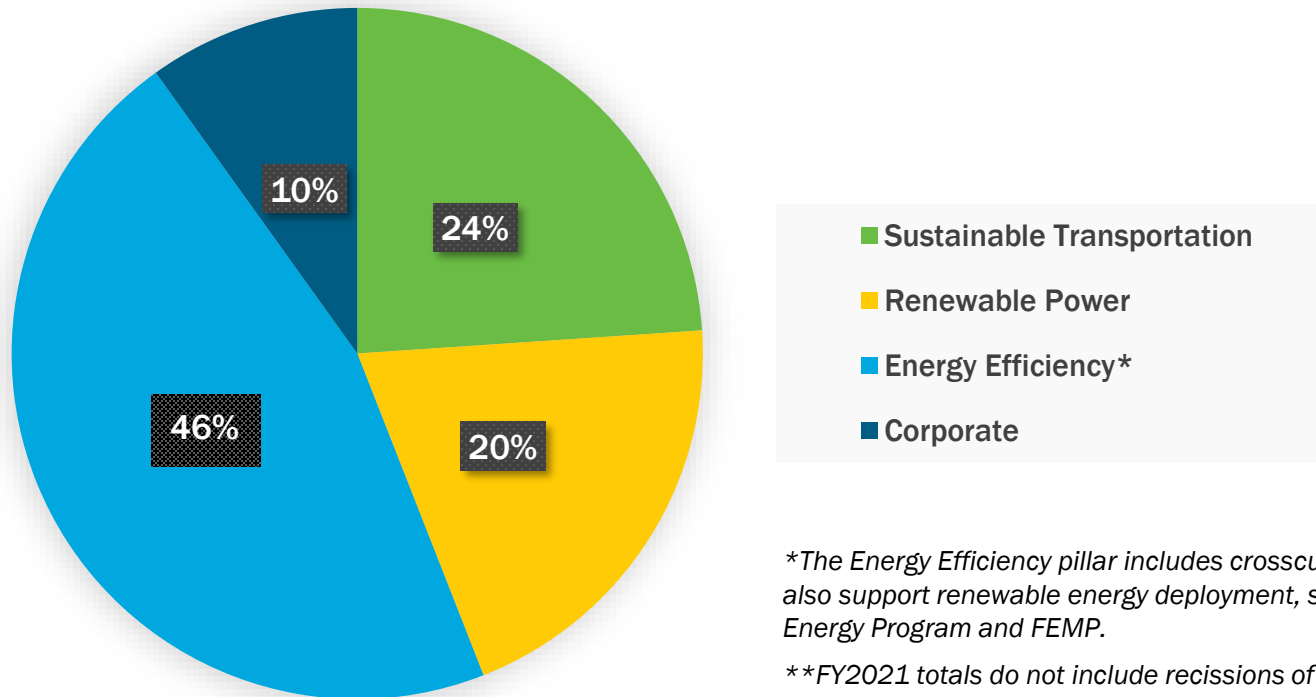
State and Local  
Partnerships

### EERE Program Priorities

Decarbonizing the electricity sector	Decarbonizing transportation across all modes
Decarbonizing energy-intensive industries	Reduce the carbon footprint of buildings
Decarbonizing the agriculture sector, specifically focused on the nexus between energy and water	

# EERE FY 2022 Request Summary

EERE Programmatic Pillar (dollars in thousands)	FY 2021 Enacted	FY 2022 Request	Increase/ Decrease	Percent Increase
Sustainable Transportation	805,000	1,132,500	327,500	41%
Renewable Power	646,000	951,765	305,765	47%
Energy Efficiency	1,103,500	2,179,150	1,075,650	97%
Corporate Support Programs	309,500	468,585	159,085	51%
<b>Total, EERE</b>	<b>2,864,000</b>	<b>4,732,000</b>	<b>1,868,000</b>	<b>65%</b>

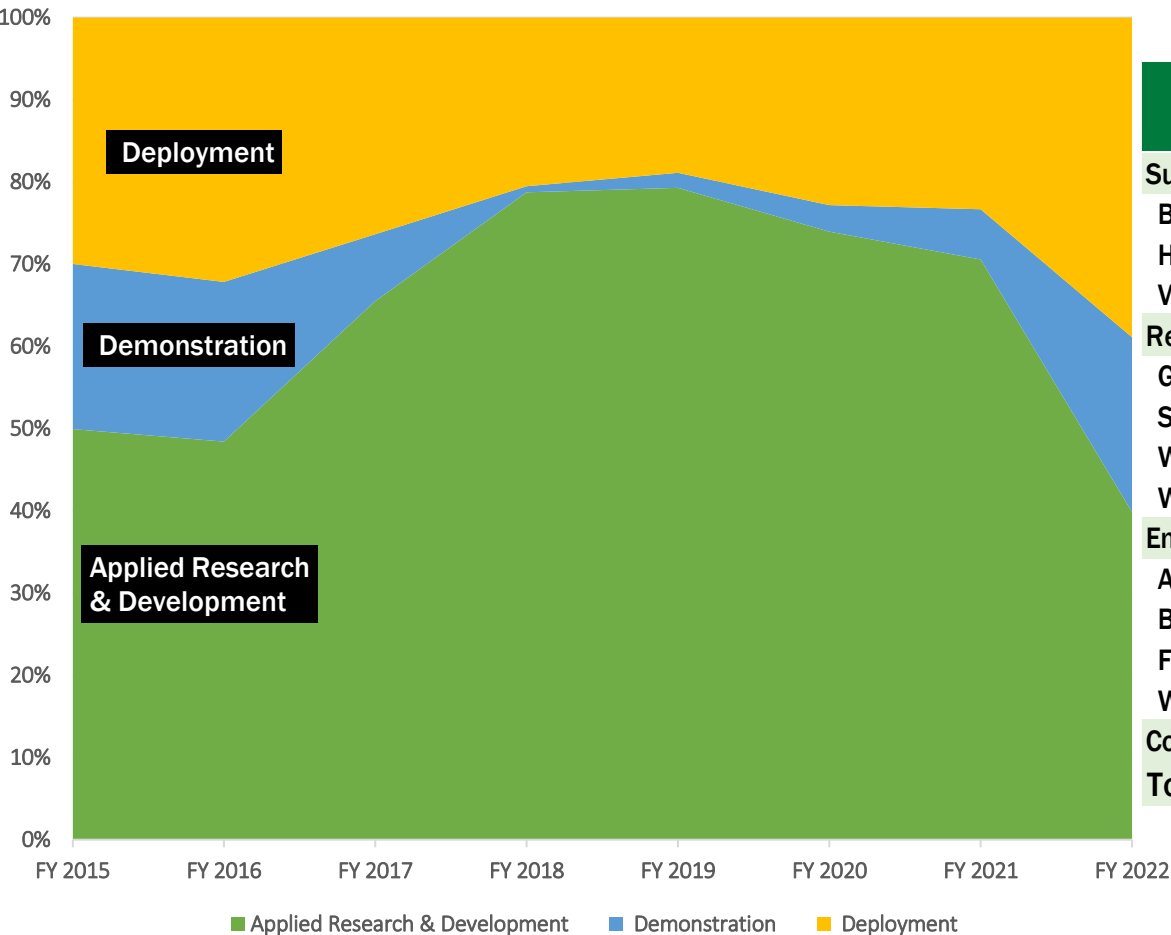


\*The Energy Efficiency pillar includes crosscutting programs that also support renewable energy deployment, such as the State Energy Program and FEMP.

\*\*FY2021 totals do not include rescissions of prior year balances

# EERE's FY 2022 Request prioritizes demonstration & deployment

Character of EERE Program Support  
FY 2015 – FY 2022



EERE Budget Program	FY 2022 Request (dollars in thousands)		
	Deployment	Demonstration	Applied Research & Development
Sustainable Transportation	51,760	354,660	726,080
Bioenergy Technologies	1,200	110,350	228,450
Hydrogen and Fuel Cells	1,000	88,600	107,900
Vehicle Technologies	49,560	155,710	389,730
Renewable Power	155,197	250,589	545,979
Geothermal Technologies	11,875	48,625	103,260
Solar Energy Technologies	57,850	66,250	262,475
Wind Power Technologies	70,472	36,303	98,095
Water Power Technologies	15,000	99,411	82,149
Energy Efficiency	1,450,977	301,131	427,042
Advanced Manufacturing	62,298	241,000	247,202
Building Technologies	142,029	60,131	179,840
Federal Energy Management Program	438,150	-	-
Weatherization and Intergovernmental Programs	808,500	-	-
Corporate Support Programs	NA	NA	NA
Total, EERE	1,657,934	906,380	1,699,101

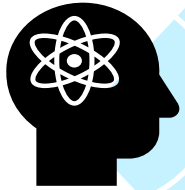
# EERE Emphasis Areas to Ensure the Greatest Impact

## Including Examples from FY 2022 Request Investments



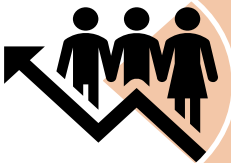
### Energy and Environmental Justice

- *Hydrogen* - Analytical research that assesses regional impacts of hydrogen and fuel cell technologies (e.g., criteria pollutants, water), to inform environmental justice goals and support energy communities
- *Wind* - Research to understand socioeconomic impacts of wind energy development to develop solutions to promote equity and benefits, especially for energy communities
- *EERE-wide*: Multi-office energy transition initiative (ETI) that specifically looks to support clean energy transition in underserved and energy communities through long term, community driven approaches



### Diversity in STEM

- *EERE-Wide* - Coordinated workforce training for clean energy technologies including solar and expansion of successful training models nationwide
- *EERE-Wide* - efforts to expand STEM pipeline development programs and new research partnerships among underutilized Minority Serving Institutions across the country.
- *Buildings* - Initiate a Minority-Serving STEM R&D Consortium focused on next generation lighting technologies



### Workforce Development

- *Advanced Manufacturing* - Workforce Development activity that supports participants at varying career levels, engages underserved and energy communities and integrates activities across AMO programs and partner offices
- *Vehicles* - The EcoCAR Mobility Challenge, a university student competition that provides science and technology training for the future advanced automotive workforce

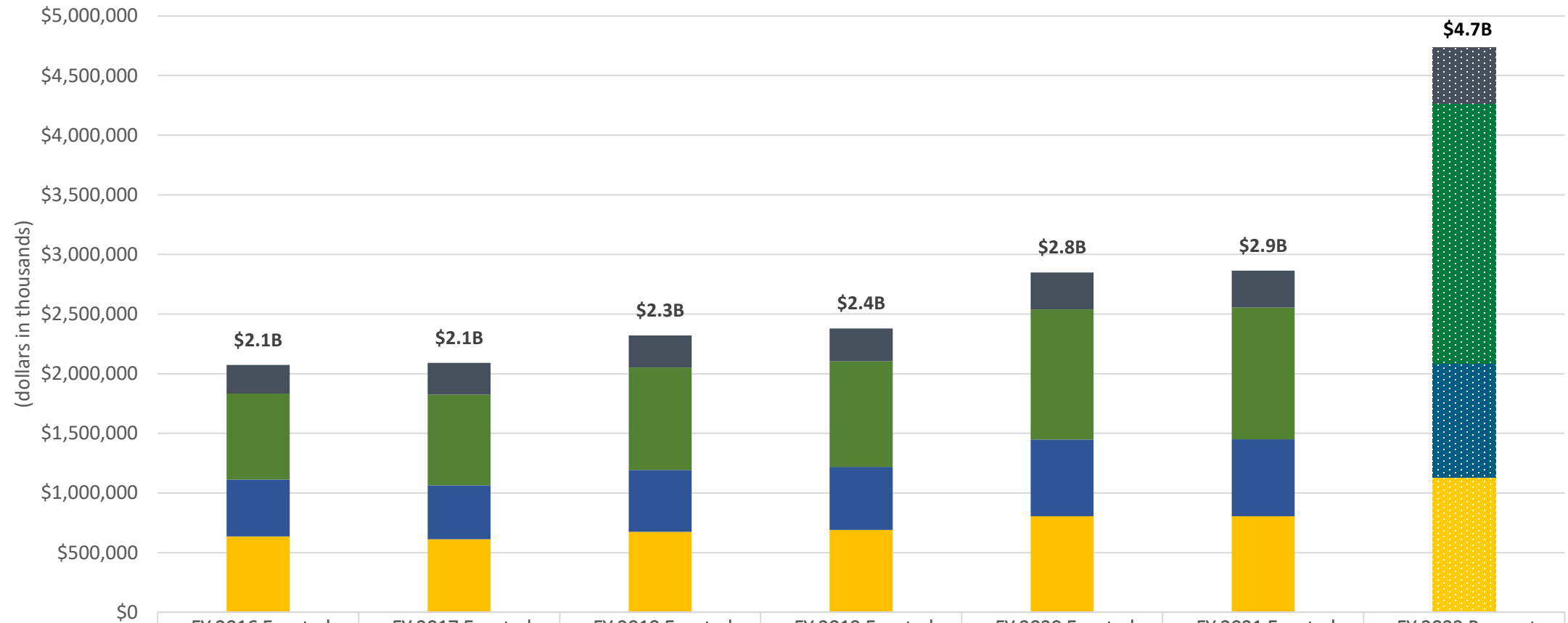


### State & Local Partnerships

- *EERE-wide* - Clean Energy for Local Governments program to provide competitive awards to support the development and deployment of transformative clean energy programs of qualifying local governments, such as disadvantaged and energy communities
- *Solar* - The National Community Solar Partnership, which provides technical assistance to businesses, non-profit organizations, and state, local and tribal governments to expand access to affordable community solar, especially in energy communities



# EERE Appropriations by Sector, FY 2016 – FY 2022



	FY 2016 Enacted	FY 2017 Enacted	FY 2018 Enacted	FY 2019 Enacted	FY 2020 Enacted	FY 2021 Enacted	FY 2022 Request
■ Corporate Support	\$238,000	\$264,500	\$268,000	\$273,500	\$309,500	\$309,500	\$468,585
■ Energy Efficiency	\$721,000	\$761,641	\$858,727	\$888,000	\$1,091,000	\$1,103,500	\$2,179,150
■ Renewable Power	\$478,050	\$451,040	\$519,306	\$527,500	\$642,000	\$646,000	\$951,765
■ Sustainable Transportation	\$635,450	\$612,959	\$674,045	\$690,000	\$805,500	\$805,000	\$1,132,500
<b>Total, EERE</b>	<b>\$2,072,500</b>	<b>\$2,090,140</b>	<b>\$2,320,078</b>	<b>\$2,379,000</b>	<b>\$2,848,000</b>	<b>\$2,864,000</b>	<b>\$4,732,000</b>

*EERE totals do not include recissions of prior year balances.*

# Budget Summary

EERE Programs	FY 2020 Enacted (\$K)	FY 2021 Enacted (\$K)	FY 2022 Request (\$K)
<b>Sustainable Transportation</b>	<b>805,500</b>	<b>805,000</b>	<b>1,132,500</b>
Vehicle Technologies	396,000	400,000	595,000
Bioenergy Technologies	259,500	255,000	340,000
Hydrogen and Fuel Cell Technologies	150,000	150,000	197,500
<b>Renewable Power</b>	<b>642,000</b>	<b>646,000</b>	<b>951,765</b>
Solar Energy Technologies	280,000	280,000	386,575
Wind Energy Technologies	104,000	110,000	204,870
Water Power Technologies	148,000	150,000	196,560
Geothermal Technologies	110,000	106,000	163,760
<b>Energy Efficiency</b>	<b>1,091,000</b>	<b>1,103,500</b>	<b>2,179,150</b>
Advanced Manufacturing	395,000	396,000	550,500
Federal Energy Management Program	40,000	40,000	438,150
Building Technologies	285,000	290,000	382,000
Weatherization and Intergovernmental Programs	371,000	377,500	808,500
<b>Corporate Support</b>	<b>309,500</b>	<b>309,500</b>	<b>468,585</b>
Program Direction	165,000	165,000	250,000
Strategic Programs	14,500	14,500	43,585
Facilities and Infrastructure (NREL)	130,000	130,000	175,000
<b>Subtotal, EERE</b>	<b>2,848,000</b>	<b>2,864,000</b>	<b>4,732,000</b>
Rescission of Prior Year Balances*	(58,000)	(2,240)	
Energy Program Rescission*	(12,723)		
<b>Total, EERE</b>	<b>2,777,277</b>	<b>2,861,760</b>	<b>4,732,000</b>

\*Note: Rescissions affect Prior Year Balances rather than FY 2020 Enacted Budgetary Authority

# **Selected EERE-Wide Investments**



# EERE-Wide Investments: Energy Storage Grand Challenge

## What

- A comprehensive program to accelerate the development, commercialization, and utilization of energy storage technologies at the scale necessary for the U.S. to reach its decarbonization goals.
- Demonstrate and validate existing technologies for new uses, and develop, prove safe and effective, and commercialize and scale up manufacturing for new technologies within the next 5-10 years.

## Why

- Energy storage technologies are critical to decarbonizing the energy sector, whether for the power sector, transportation, buildings, or industrial end use; they are also critical to strengthen the reliability and resilience of the grid.
- Attain and sustain global leadership in energy storage manufacturing, utilization, and exports, with a secure, resilient domestic supply chain

## How

- Promote coordination across DOE to address challenges from a system-level, rather than a technology-specific perspective; leverage DOE and National Lab capabilities
- Leverage a variety of funding strategies to accelerate innovation across a range of storage technologies based on three concepts: Innovate Here, Make Here, Deploy Everywhere. Address associated scale up challenges.

(dollars in thousands)	FY 2021 Enacted	FY 2022 Request	FY 2022 vs. FY 2021
Energy Storage Grand Challenge	327,292	457,900	+130,608

*Participating EERE Offices: Advanced Manufacturing, Building Technologies, Geothermal Technologies, Hydrogen and Fuel Cell Technologies, Solar Energy Technologies, Strategic Programs, Vehicle Technologies, Water Power Technologies, Wind Energy Technologies*

# EERE-Wide Investments: Grid Modernization Initiative

## What

- Work across the U.S. Department of Energy to help create the modern grid of the future.
- Focus on efforts to support new architectural concepts, tools, and technologies to measure, analyze, predict, protect, and control the grid of the future, and on enabling the institutional conditions that allow for more rapid development and widespread adoption of these tools and technologies.
- Efforts to integrate the nation’s electricity to improve reliability, resiliency, security, affordability, sustainability, and flexibility.

## Why

- Our extensive, reliable power grid has fueled the nation’s growth since the early 1900s; however, the grid we have today does not have the attributes necessary to meet the demands of the 21st century and beyond.

## How

- Since 2013 over \$330M of research funding has been highly coordinated and implemented across multiple offices, using a multi-year strategy as a guiding roadmap to grid modernization efforts.
- Under GMI, the Grid Modernization Laboratory Consortium (GMLC) was established as a strategic partnership between DOE and the national labs to bring together leading experts, technologies, and resources to collaborate on the goal of modernizing the nation’s grid.

(dollars in thousands)	FY 2021 Enacted	FY 2022 Request	FY 2022 vs. FY 2021
Grid Modernization Initiative	188,950	299,110	+110,160

*Participating EERE Offices: Advanced Manufacturing, Building Technologies, Hydrogen and Fuel Cell Technologies, Solar Energy Technologies, Vehicle Technologies, Water Power Technologies, Wind Energy Technologies*

# EERE-Wide Investments: Critical Minerals Initiative

## What

- A federal strategy for advancing transformational RD&D across the entire critical materials supply chain; strengthening America’s critical mineral supply chains and defense industrial base; and growing the American critical minerals workforce.
- Partnership with government agencies, National Labs, industry stakeholders, and academia (EERE serves as the DOE co-chair of the National Science & Technology Council (NSTC) Critical Minerals Subcommittee (CMS))

## Why

- Critical materials are used in many products important to the American energy economy, including clean energy technologies, but the U.S. imports most of our critical mineral commodities.
- The United States lacks downstream domestic processing and manufacturing capabilities for critical materials.
- To develop a sustainable and robust supply chain in the United States, we must innovate to reduce the costs of the materials and reduce the environmental impacts of production.

## How

- DOE’s R&D strategy for addressing critical materials has three pillars: diversify supply, develop substitutes, and drive recycling, reuse, and more efficient use of critical minerals.
- Leverage the expertise related to this area across the DOE National Laboratory complex as well as encompass all efforts across the Applied Energy Offices and the Office of Science.
- EERE is leading interagency efforts to develop an R&D roadmap to enhance scientific and technical capabilities across the entire critical materials supply chain.

(dollars in thousands)	FY 2021 Enacted	FY 2022 Request	FY 2022 vs. FY 2021
Critical Minerals Initiative	104,300	160,150	+55,850

*Participating EERE Offices: Advanced Manufacturing Office, Geothermal Technologies, Hydrogen and Fuel Cell Technologies, Vehicle Technologies*

# EERE-Wide Investments: Energy-Water Nexus

## What

- An initiative encompassing technology RDD&D, modeling and assessment tools, technical support, informed policy, planning tools, and workforce development to replace America’s outdated and deteriorating water infrastructure across municipalities, industry, utilities, agriculture, and resource extraction with one that is more sustainable, climate adaptive, and equitable for the 21st century and beyond.

## Why

- Our Nation's large scale, centralized water infrastructure based on a linear model of fresh water served us well in the 20th century, but it is breaking down under new pressures, due to climate change, increased competition for water resources, an aging water infrastructure, and regulatory hurdles.

## How

- Launch desalination technologies that deliver cost-competitive clean water.
- Transform the energy sector’s produced water from a waste to a resource.
- Achieve near-zero water impact for new thermoelectric power plants, and significantly lower freshwater use intensity within the existing fleet.
- Double resource recovery from municipal wastewater.
- Develop small, modular energy-water systems for urban, rural, tribal, national security, and disaster response settings.

(dollars in thousands)	FY 2021 Enacted	FY 2022 Request	FY 2022 vs. FY 2021
Energy-Water Nexus	66,350	78,500	+12,150

**EERE Participating Offices:** Advanced Manufacturing Office, Bioenergy Technologies, Solar Energy Technologies, Water Power Technologies, Weatherization and Intergovernmental Programs

# Sustainable Transportation (ST)

# Sustainable Transportation

RDD&D efforts to decarbonize transportation across all modes—Enable **vehicle electrification**, commercially viable **hydrogen fuel cell trucks**, sustainable **aviation fuel** from biomass, and waste carbon resources. Low-GHG options for **off-road vehicles, rail, and maritime**.

(dollars in thousands)	FY 2021 Enacted	FY 2022 Request	\$ Change	% Change
Vehicle Technologies	400,000	595,000	195,000	49%
Bioenergy Technologies	255,000	340,000	85,000	33%
Hydrogen and Fuel Cell Technologies	150,000	197,500	47,500	32%

**Key EERE Priorities Enabled:**

Transportation  
Industry  
Agriculture  
Buildings

**Deployments or demonstration to show viable commercial paths in time to allow for major 2030 commercial activity and 2035 large scale transition to the new technology to enable (considering fleet turnover) full decarbonization by 2050.**

- Initiate EV community partner demonstration programs that provide templates for larger scale EV and charger deployments
- Demonstrate smart vehicle charging to enable vehicle-to-grid integration
- Demonstrate sustainable bio-energy pathways including biosolids to energy in rural communities
- Increased heavy duty fuel cell truck demonstration through SuperTruck III funding
- Increased support for pilot and demo-scale biofuel projects from multiple feedstocks

**Achieve cost targets on batteries, hydrogen, fuel cells and biofuels to support market pull without major long-term subsidies.**

- New battery technology and recycling RD&D; domestic supply chain development
- RD&D to reduce greenhouse gases from existing biofuels

**Hydrogen use for industrial decarbonization and energy storage as well as sustainable biomass to achieve reduced GHG from the Agricultural sector.**

- Funding to demonstrate lower cost hydrogen production through electrolyzers and integration of hydrogen with energy storage to support renewable power
- RD&D to decarbonize steel and ammonia production through hydrogen



# Vehicle Technologies – FY 2022 Request



Vehicle Technologies accelerates the implementation of affordable and clean vehicle technology through a portfolio of research, development, demonstration, and deployment while also improving mobility options for all Americans.

Subprogram (dollars in thousands)	FY 2021 Enacted	FY 2022 Request	FY 2022 vs. FY 2021	% Change
Battery and Electrification Technologies	178,700	248,700	+70,000	+39%
Advanced Engines and Fuel Technologies	70,000	30,000	-40,000	-57%
Materials Technology	40,000	60,000	+20,000	+50%
Energy Efficient Mobility Systems	45,000	70,000	+25,000	+56%
Technology Integration	60,300	180,300	+120,000	+199%
Data, Modeling, and Analysis	6,000	6,000	0	-
<b>Total</b>	<b>400,000</b>	<b>595,000</b>	<b>+195,000</b>	<b>+49%</b>

## FY 2022 Emphasis Areas:

- Demonstrate and deploy technologies that enable transportation opportunities for all communities, with an emphasis on those that are currently underserved, and accelerate electric vehicle adoption at the community level.
- Target-driven approach to achieve the performance and cost needed to advance technology in which industry can deploy in a broad range of affordable, efficient, and clean transportation choices to move people and goods across America.
  - Leverage industry partnerships (U.S. DRIVE/21st Century Truck) for relevant technical and market expertise.
  - Leverage interagency collaborations (DOD, DOC, DOT, EPA) for strategic stewardship of Federal investments.
- Advanced Battery R&D for EVs and batteries across clean energy applications including the Energy Storage Grand Challenge, aiming to reduce the cost of electric vehicle battery cells.
- In accordance with Executive Order 14008: Tackling the Climate Crisis at Home and Abroad, deemphasize support for RDD&D designed to expand the use of fossil-fueled internal combustion engines.

# Vehicle Technologies – Alignment to EERE Priorities



EERE Program Priority	FY 2021 Enacted (\$K)	FY 2022 Request (\$K)	Description of Support
Decarbonize transportation across all modes	400,000	595,000	Focus on rapid, widespread deployment of electric vehicle charging stations nationwide, RDD&D in electric vehicle drive systems and batteries, supporting the growth of a domestic battery supply chain, and the development and deployment of the technologies and infrastructure necessary to decarbonize light-, medium-, and heavy-duty transportation, shipping, rail and aviation. These and other investments are crucial towards putting the U.S. on a path to a net-zero carbon economy by 2050.

# Vehicle Technologies – FY 2022 Highlights and Major Changes



- **Advanced Nationwide Adoption and Deployment of Electric Vehicles (EV) and EV Infrastructure (\$100M):** Improve equitable access to the benefits of electrified transportation, considering plug-in electric vehicles (PEVs) and charging infrastructure availability for mobility choices such as personal vehicle ownership, car sharing, ride sharing, school transport, and public transit. Work to increase charging infrastructure, PEV cost parity with conventional vehicles, education, and workforce training to facilitate widespread PEV adoption. Such activities also support the Administration’s goal to deploy 500,000 PEV charging stations throughout the Nation.
- **New Advance Battery R&D (\$75M):** Support many significant objectives associated with decarbonization, both in transportation directly, and in energy storage more broadly to support decarbonization of the electricity sector. Initiate laboratory and cooperative agreements for projects aimed at achieving the following new objectives: reducing electric vehicle (EV) battery cell cost by 50 percent to \$60/kWh by 2030 to achieve EV cost parity with internal combustion engine vehicles; eliminating dependence on critical materials such as cobalt, nickel, and graphite, reducing battery supply chain vulnerabilities by 2030; and establishing a lithium battery recycling ecosystem to recover 90 percent of spent lithium batteries and re-introducing 90 percent of key materials into the battery supply chain by 2030.
- **Expand SuperTruck 3 (\$30M):** Fund projects to electrify medium- and heavy-duty freight trucks. Additional investment will boost vehicle efficiency and expand EV infrastructure. Work will advance the Administration’s goal of achieving carbon pollution-free transport and to deliver an equitable, clean energy future, and put the United States on a path to achieve net-zero emissions, economy-wide, by no later than 2050 (in accordance with Executive Order 14008: Tackling the Climate Crisis at Home and Abroad).
- **Clean Energy Mobility Solutions for Underserved Communities (\$20M):** Support for robust local and regional partnerships including the Clean Cities activity to ease barriers and promote the use of new transportation technologies with a focus on addressing the barriers to light-, medium-, and heavy-duty plug-in electric vehicle (PEV) deployment, especially in underserved communities (e.g., low-income, rural, and other demographics that currently have minimal access to PEVs).
- **Reduction to Internal Combustion Engine RDD&D (-\$40M):** Deemphasize support for RDD&D designed to expand the use of fossil-fueled internal combustion engines (in accordance with Executive Order 14008: Tackling the Climate Crisis at Home and Abroad).

# Vehicle Technologies Office – FY 2020 - 2021 Accomplishments

- **Battery Cost Reduction:** Reduced the cost of EV reduced cost of lithium-ion battery packs from \$268 in 2015 to \$143/kWh in 2020 (~50% cost reduction).
- **Battery500 Research Consortium:** Demonstrated lab scale cell that achieved 350 Wh/kg (>2X Improvement over commercial Li-Ion when scaled) & > 500 cycles (10X Improvement over 2016 baseline Li-Metal)
- **Completed Phase II of the Lithium-Ion Battery Recycling Prize** focused on building industry partnerships to design, simulate, and prototype a proof-of-concept end-to-end recycling solution. The seven Phase II winners will each receive a \$357,000 cash prize and advance to the third and final Pilot Scale Demonstration and Validation” phase of the competition.
- **Electric Drive Cost Reduction:** Reduced the cost of electric traction drive systems to \$8/kW, a 33% reduction from 2015 baseline.
- **Vehicle Weight Reduction:** Demonstrated a carbon fiber composite underbody that achieved an 18% weight reduction (10.5 kg reduction) compared to the baseline steel underbody.
- **Engine Efficiency Improvement:** Demonstrated a fuel economy of 43.0 MPG (20% improvement over 2016 baseline) with a Low-Temperature Gasoline Combustion (LTGC) engine.
- **Energy Efficient Mobility Systems:** Established baseline Mobility Energy Productivity (MEP) metric for 5 different cities/regions.

# Bioenergy Technologies – FY 2022 Request



Bioenergy Technologies supports Research and innovation to convert domestic biomass and waste resources to cost-effective, low-carbon biofuels and bioproducts.

Subprogram (in thousands)	FY 2021 Enacted	FY 2022 Request	FY 2022 vs. FY 2021	% Change
Feedstock Technologies	40,000	50,000	+10,000	+25%
Advanced Algal Systems	40,000	35,000	-5,000	-13%
Conversion Technologies	110,000	110,000	-	0%
System Development and Integration	60,000	135,500	+75,500	+126%
Data, Modeling and Analysis	9,500	9,500	-	0%
<b>Total</b>	<b>259,500</b>	<b>340,000</b>	<b>+80,500</b>	<b>+31%</b>

## FY 2022 Emphasis Areas

- Decarbonizing transportation, industry and agriculture – Creating high-quality jobs, particularly in rural America
- Decarbonizing difficult to electrify modes of transportation – Sustainable Aviation Fuels (SAF); Rail, Maritime and heavy-duty trucks
- Spurring innovation in high-value bioproducts and renewable chemicals - Expanding the bioeconomy and support the transition to net-zero emissions
- Community-based solutions – Addressing environmental, economic, and social challenges at the regional, state and local levels to ensure equity, inclusion and environmental justice

# Bioenergy Technologies – Alignment to EERE Priorities



EERE Program Priority	FY 2021 Enacted (\$K)	FY 2022 Request (\$K)	Description of Support
Decarbonize transportation across all modes	255,000	340,000	RD&D of technologies and production pathways that convert domestic biomass and other waste resources into low-carbon biofuels and bioproducts. Objectives include lowering cost, improving performance, and reducing risks in scale-up. Focuses on modes of transportation that are difficult to electrify and likely to rely on liquid fuels.
Decarbonizing energy-intensive industries	15,500	24,000	Developing valuable chemicals and materials that can provide renewable alternatives to petrochemicals and enable the production of biofuels. This work includes R&D on bioderived polymers and other co-products that provide performance advantages to traditional materials.
Decarbonizing the agriculture sector, specifically focused on the nexus between energy and water	4,000	24,000	Reducing upstream agricultural lifecycle emissions associated with biomass feedstock production, harvesting and logistics in coordination with USDA. Objectives include improving sustainability of biomass supply chain, enabling net-negative feedstocks, developing and demonstrating agricultural waste management solutions.



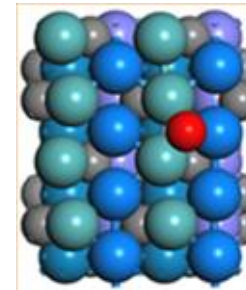
# Bioenergy Technologies – FY 2022 Highlights & Major Changes



- **Scale-up of Integrated Biorefineries (\$75M):** Increasing emphasis on enabling scale-up of low-carbon fuels through demonstration of cost-effective production pathways with an emphasis on Sustainable Aviation Fuels (SAF). Demonstrating new SAF pathways is urgently needed in order to enable wide-spread production needed for a 2050 net-zero economy.
- **Improving Lifecycle GHG emissions from Existing Biofuel Production (\$15M):** New initiative to demonstrate solutions that can reduce CO<sub>2</sub> emissions from “traditional” biofuels facilities from 40 percent, to over 70 percent, compared with petroleum through sustainable agriculture, fuel switching, productivity enhancements, and/or conversion-efficiency measures.
- **Community Organic Waste Management Solutions (\$10M):** New community-scale, public-private partnerships to reduce harmful emissions and other environmental issues from operations that produce manure and other wet wastes that disproportionately affect disadvantaged communities in rural areas. Funding will support engineering, construction, and operation of up to 2 pilot-scale projects that employ advanced technologies suitable for various community circumstances to demonstrate overall potential.
- **Healthy Forest Management, Sustainable Agriculture, Biogenic Carbon Drawdown (\$13M):** New RD&D program on sustainable agriculture practices and help farmers maximize profits on marginal lands while providing valuable feedstocks for bioenergy production. Funding will develop sensors and tools for soil carbon monitoring and soil carbon enhancement via biochar while enabling carbon credit banking markets and other activities requiring verifiable carbon emission data.

# Bioenergy Technologies – FY 2020 - FY 2021 Accomplishments

- Lowered Feedstock costs:
  - Improved Fall seasonal *algae productivity* by 28.7%
  - Improved harvesting and logistics *short-rotation woody crops*
- Developed, licensed and demonstrated technologies with industry partners:
  - *Licensed 3 catalyst advances to industrial partners*, including ethanol to jet fuel
  - Piloted a *novel process to make drop-in fuels from organic waste* capable of \$3/gallon
  - LanzaJet formed to focus on *commercializing sustainable aviation fuel*
- Advanced bioproducts to grow the bioeconomy, build the biomass supply chain:
  - Identified *11 new bioproducts with better performance than petroleum* incumbents
  - *Scaled up renewable carbon fiber technology* to convert sugars to bio-based acrylonitrile
- Launched new efforts to address global energy and environmental challenges:
  - BOTTLE Consortium (w/ AMO) for *cost-effective recycling, upcycling, and increased energy efficiency for plastics*
  - CO<sub>2</sub> Utilization efforts to produce “*e-fuels*” and *chemicals from CO<sub>2</sub> and renewable power*
  - *Lifecycle analyses of jet fuel pathways* to support international efforts to decarbonize



LanzaJet

CORSA



# Hydrogen and Fuel Cell Technologies – FY 2022 Request



The Hydrogen and Fuel Cell Technologies Office (HFTO) focuses on research, development, and demonstration of hydrogen and fuel cell technologies across multiple sectors enabling innovation, a strong domestic economy, and a clean, equitable energy future.

Subprogram (in thousands)	FY 2021 Enacted	FY 2022 Request	FY 2022 vs. FY 2021	% Change
Fuel Cell Technologies	25,000	35,000	+10,000	+40%
Hydrogen Technologies	71,000	78,500	+7,500	+11%
Systems Development and Integration	51,000	81,000	+30,000	+59%
Data, Modeling and Analysis	3,000	3,000	-	-
<b>Total</b>	<b>150,000</b>	<b>197,500</b>	<b>+47,500</b>	<b>+32%</b>

## FY 2022 Emphasis Areas

- Expand beyond early-stage R&D, include later-stage and demonstration efforts for H<sub>2</sub> and fuel cells with a focus on hard-to-decarbonize sectors (e.g., steel manufacturing, heavy duty transport), energy storage, and achieving H<sub>2</sub>@Scale
- Supports Administration goals including: a carbon-free grid by 2035 and net-zero carbon economy by 2050,
- Accelerate electrolyzer RDD&D, demonstrate H<sub>2</sub> energy storage and end use (including offshore wind, steel and ammonia production), and H<sub>2</sub> fuel cells for heavy duty trucks as part of the SuperTruck program,
- Priorities include addressing environmental justice and disadvantaged/underserved communities, workforce development, DEI and STEM, and collaboration across offices (e.g., Fossil, Nuclear, Science, Wind, Solar, Advanced Manufacturing, Vehicles, etc.)

# Hydrogen & Fuel Cell Technologies – Alignment to EERE Priorities



EERE Program Priority	FY 2021 Enacted (\$K)	FY 2022 Request (\$K)	Description of Support
Decarbonize transportation across all modes	132,000	141,500	Includes H2 technologies, fuel cells for transportation, SuperTruck, systems development and integration and all activities except H2 blending, steel/ammonia and grid energy storage.
Decarbonizing the electricity sector	125,000	160,500	Includes H2 technologies, reversible fuel cells, systems development and integration, ARIES and grid integration with nuclear, offshore wind energy storage
Decarbonizing energy-intensive industries	114,000	148,500	Includes H2 technologies, fuel cell durability for stationary applications, systems development and integration, and steel/ammonia production
Reduce the carbon footprint of buildings	63,000	92,000	Fuel cell R&D relevant to stationary power and hydrogen technologies including H2 blending in NG, safety, codes, standards (20%)
Decarbonizing the agriculture sector, specifically focused on the nexus between energy and water	34,000	71,000	Includes H2 technologies relevant to clean H2 production, delivery, and storage and ammonia production for fertilizer (for decarbonizing agriculture). Note- USDA does not work on clean H2/or decarbonizing ammonia



## **Enable Affordable, Clean Hydrogen Technologies (\$78.5M):**

- Emphasizes H2NEW consortium for electrolyzers, HydroGEN for advanced water-splitting
- Includes materials/carriers for hydrogen storage/delivery, and materials compatibility (e.g., H-Mat consortium) and infrastructure technologies

## **Develop Affordable, Reliable Fuel Cell Technologies (\$35M)**

- Focuses on Million Mile Fuel Cell Truck Consortium (M2FCT) and fuel cells for SuperTruck III
- Includes materials (catalysts, membranes, electrodes, etc.) and components and systems development to meet cost, efficiency, and durability metrics with crosscutting impact potential (transportation and stationary applications)

## **Accelerate Demonstrations for Hard-to-Decarbonize Sectors through Systems Development and Integration (\$81M)**

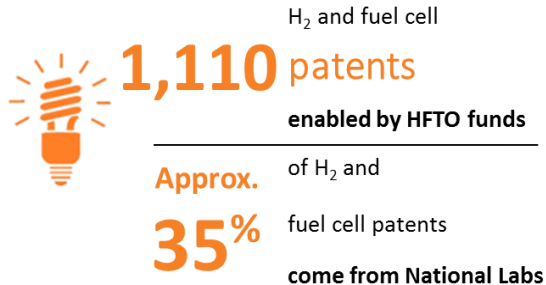
- Includes demos for medium/heavy duty trucks, energy storage (e.g., offshore wind), grid integration, and end uses
- Includes clean hydrogen demos for decarbonizing industry/chemicals (e.g., steel and ammonia)
- Continues safety, codes, standards, workforce development and training to ensure safety and harmonized codes and standards



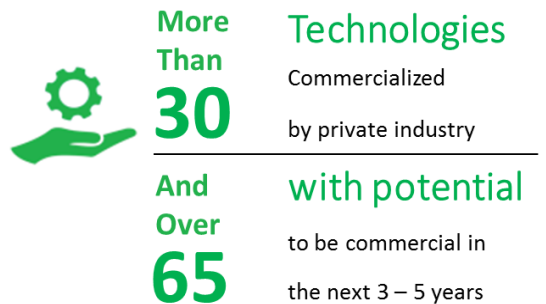
# Hydrogen and Fuel Cell Technologies – FY 2020 – FY 2021 Accomplishments

## Impact through 2020

### Innovation



### Market Impact



Can be traced back to HFTO R&D

## Significant Advances in Energy Innovation, Integration and Affordability

- Established two new major RD&D Consortia with labs, industry, academia to accelerate progress:
  - H2NEW targeting >80% cost reductions in electrolyzers
  - M2FCT advancing durable, affordable fuel cells for heavy duty transportation
- Initiated first-of-a-kind industry-led H2@Scale integrated system demonstrations in H<sub>2</sub> for data centers (WA), maritime applications (CA), and steel production (CA, MO), including 250 kW high temperature electrolyzer for nuclear integration (CT, ID)
- Validated the dynamic response of electrolyzers as an enabler for nuclear/renewable hybrid energy systems (through public/private partnership projects)
- Demonstrated use of electrolyzers in minimizing demand spikes in battery electric vehicle (BEV) charging while producing value-add H<sub>2</sub> coproduct
- Launched three new SBIR projects to assess offshore wind to hydrogen feasibility
- Achieved an 85% improvement in PGM-free cathode membrane electrode assembly performance over the 2016 baseline
- Reduced projected cost of 700 bar Type IV compressed hydrogen system by ~30% since 2013



# Energy Efficiency (EE)

# Energy Efficiency

**Key EERE Priorities Enabled:**

Industry  
Buildings  
Grid

RDD&D focused on the **resilience of homes and buildings** and strengthening U.S. manufacturing competitiveness.

(dollars in thousands)	FY 2021 Enacted	FY 2022 Request	\$ Change	% Change
Advanced Manufacturing	396,000	550,500	+154,500	39%
Federal Energy Management Program	40,000	438,150	+398,150	995%
Building Technologies	290,000	382,000	+92,000	32%
Weatherization and Intergovernmental Programs	377,500	808,500	+431,000	114%

**Increase energy efficiency, demand flexibility and grid-connectivity for the 125 million U.S. homes and commercial buildings.**

- Launch next generation of Connected Communities scaling low-carbon building solutions to support renewables integration & provide demand flexibility.
- Advancement of building energy codes and appliance standards.

**Reduce energy burden for low-income households across the U.S.**

- Increased funding to weatherize at least 50,000 homes per year and create a new Weatherization Readiness Fund to enable more low-income Americans to receive Weatherization Assistance by providing funds to address structural and health and safety issues.
- Launch a Build Back Better Challenge Grants (\$300M) supporting novel clean energy deployment approaches in communities through the State Energy Program.
- Initiate competitively awarded technical assistance grants for local governments.

**Lead by example in reducing the carbon footprint of federal government buildings.**

- Increased investments for deep retrofits of federal buildings and facilities smart building technologies, and geothermal installations.
- Technical assistance to transition federal agencies to carbon-free electricity and for federal fleet electrification, including procurement and installation of charging infrastructure.

**Reduce carbon impacts from energy intensive industries through improved processes and materials while ensuring the U.S. manufacturing sector is competitive**

- Substantial increase for industrial decarbonization efforts including industrially relevant RDD&D of emerging zero-carbon technologies for steel, cement, and chemical manufacturing as well as funding for two new Clean Energy Manufacturing Institutes.
- Support to revitalize the U.S manufacturing sector to be agile, resilient, and responsive through a new emphasis on infrastructure for agile manufacturing and support for workforce development activities.



# Advanced Manufacturing – FY 2022 Request

AMO invests in applied research, development, and demonstration (RD&D) in crosscutting, platform technologies to decarbonize the industrial sector and promote the development and growth of a resilient manufacturing sector for multiple emerging energy fields.

Subprogram (in thousands)	FY 2021 Enacted	FY 2022 Request	FY 2022 vs. FY 2021	% Change
Materials	80,559	85,059	+4,500	+6%
Manufacturing Innovations	233,644	367,643	+133,999	+57%
Energy Systems	46,500	50,500	+4,000	+9%
Manufacturing Enterprise	35,297	47,298	+12,001	+34%
<b>Total</b>	<b>396,000</b>	<b>550,500</b>	<b>+154,500</b>	<b>+39%</b>

## FY 2022 Emphasis Areas

- AMO is focusing on industrial sector decarbonization to address the climate crisis.
- AMO is also investing in the innovations required to manufacture at scale the clean energy technologies needed to decarbonize other sectors, including transportation, buildings, and the electric grid.
- Targeted investments in demonstration activities are used to address key scale-up and manufacturing challenges in order to accelerate deployment and broad adoption, especially in decarbonization of energy-intensive industries.
- Equitable access to technical assistance and career opportunities, with a focus on underserved communities, energy communities, and tribal communities.

# Advanced Manufacturing– Alignment to EERE Priorities



EERE Program Priority	FY 2021 Enacted (\$K)	FY 2022 Request (\$K)	Description of Support
Decarbonizing the electricity sector	-	169,500	Funding for projects that overcome the manufacturing barriers of innovative integrated energy storage systems that meet the performance requirements for a decarbonizing grid reliant on variable renewables. Additionally, support includes investments in manufacturing processes for high strength lightweight materials used in wind turbines and work to increase the resilience of critical materials supply chains serving wind turbines and photovoltaics.
Decarbonizing energy-intensive industries	24,000	486,000	AMO will support concurrent pathways of energy efficiency, electrification, low carbon fuels, and carbon capture, utilization & storage (CCUS) to reach industrial emissions targets by 2050. AMO efforts will support research, development, demonstration, and deployment of emerging technologies accompanied by expanded technical assistance resources for commercial deployment in the most carbon-intensive industrial sectors such as steel, cement, and chemicals. AMO will assist manufacturers in reducing their energy use intensity and incorporating resiliency systems into their operations. AMO will promote the adoption of energy management programs and the identification of targets for energy efficiency, productivity, and waste/water use reduction practices. AMO will work to develop a more secure and resilient manufacturing supply chain through advanced manufacturing and materials to enable U.S. manufacturers to address current market needs while continuing to reduce lifecycle energy use and costs.
Decarbonize transportation across all modes	-	183,000	Funding for projects that drive down cost and overcome the manufacturing barriers of innovative integrated energy storage systems that meet the performance requirements for electric vehicles as well as other RD&D on motor and battery manufacturing, and lightweight materials for vehicles. AMO will work to increase the resilience of critical materials supply chains serving electric vehicles.

# Advanced Manufacturing – FY 2022 Highlights & Major Changes



- **Industrial Decarbonization Demonstrations (\$80M)**
  - supporting industrially-relevant testbeds and demonstrations in energy- and carbon- intensive sectors (e.g., steel, cement, chemicals)
- **Critical Minerals (\$70M)** – Support new lab-industry consortium to de-risk and validate successful technology innovations for critical minerals, including test-bed facilities to scale up technology solutions around identified gaps such as metal conversion or magnet manufacturing.
- **Energy Storage Grand Challenge (\$41M)** – Collaborate with multiple offices, including the Office of Electricity, the Vehicle Technologies Office, and the Hydrogen and Fuel Cell Technologies Office on projects that overcome the manufacturing barriers of innovative integrated energy storage systems that meet the performance requirements for multiple applications, including grid, vehicle, and industry.
- **Workforce Development (\$33.5M)** - Strengthen / expand existing workforce development programming to increase diversity at all levels, improve career paths, and further support entrepreneurship.
- **Manufacturing USA Institutes (\$42M)** - continue support for a seventh Institute, establish additional Institutes to support the U.S. manufacturing sector in industrial decarbonization, reducing their energy use intensity, and incorporating resiliency systems into their operations.

# Advanced Manufacturing – FY 2020 & FY 2021 Accomplishments

- DOE launched the Industrial Technology Validation (ITV) pilot to support industry in testing innovative technologies in dynamic, industrial environments. The pilot's results will be shared widely to encourage industry uptake of technologies with the potential to generate significant operational efficiency improvements for U.S. industry, including water / wastewater treatment facilities. DOE plans to announce pilot selections and launch the full-scale initiative in summer 2021.
- DOE awarded more than \$50 million in funding for 15 projects focused on field validation and demonstration, as well as next-generation extraction, separation, and processing technologies, for critical materials. Projects selected reduce both the costs of critical materials and the environmental impacts of production.
- In a roundtable with students, faculty, and manufacturers, Secretary Granholm announced up to \$52.5 million for the next cohort of Industrial Assessment Centers that help American manufacturers and wastewater treatment facilities improve their efficiency, save money, and reduce their carbon footprint. These university-based training programs also create a pipeline for students looking to join the growing clean energy economy. DOE plans to announce selections mid-summer 2021.
- DOE announced new cohorts in its Lab-Embedded Entrepreneurship Programs who will leverage the National Laboratories' expert mentorship and world-class facilities over two years to advance their energy and manufacturing technologies from concepts to products.
- DOE selected the University of Texas – San Antonio to lead the Cybersecurity Manufacturing Innovation Institute (CyManII), a public-private consortium to bolster U.S. manufacturing competitiveness, energy efficiency, and innovation. CyManII will focus on research and development (R&D) to advance cybersecurity in energy-efficient manufacturing.



# Federal Energy Management Program – FY 2022 Request



FEMP provides technical assistance, technology integration and demonstration and partners with the Council on Environmental Quality and the Office of Management and Budget in the formulation of policy and guidance and Federal Facility rulemaking to support Federal agencies efforts to meet Executive Orders and statutory energy and water management-related requirements

Subprogram (dollars in thousands)	FY 2021 Enacted	FY 2022 Request	FY 2022 vs. FY 2021	% Change
Federal Energy Management Program	40,000	438,150	+398,150	+995%
<b>Total</b>	<b>40,000</b>	<b>438,150</b>	<b>+398,150</b>	<b>+995%</b>

## FY 2022 Emphasis Areas:

- **Lead by Example: Upgrade Federal energy and water infrastructure**
  - Leverage Performance Contracting
  - Demonstrate and deploy energy efficient, sustainable, resilience and secure technologies to ensure continuous mission operations across the USG
- **Technical Assistance: Support Federal agency implementation of Executive Orders and statutory related energy and water requirements**
  - Federal building stock decarbonization
  - Federal Fleet Electrification
  - Technology Integration
- **Regulatory and Statutory Requirements: EO and statutory reporting requirements**
- **Workforce Development: Support efforts to prepare the next generation of federal energy and water professionals needed to create a low-carbon building stock and an electrified federal fleet**

# Federal Energy Management Program– Alignment to EERE Priorities



EERE Program Priority	FY 2021 Enacted (\$K)	FY 2022 Request (\$K)	Description of Support
Decarbonize transportation across all modes	40,000	433,150	• Includes support to provide technical assistance to Federal agencies for fleet electrification
Decarbonizing the electricity sector	36,272	433,150	• AFFECT facilitates critical Federal Agency infrastructure projects utilizing performance contracting the AFFECT Grant Program and UESC and ESPC performance contracting and Reporting and Statutory requirements in support of tracking and implementing energy and water management goals and objectives. • Provide Technical Assistance to Agencies for fleet electrification, facility and fleet optimization, federal smart buildings accelerator and energy and water climate mitigation/adaptation. • Support CEQ in the tracking and implementation of effective energy and water management throughout the Federal Government
Reduce the carbon footprint of buildings	40,000	433,150	• FEMP's activities will contribute to EERE Strategic Priority to reduce the carbon footprint in the US building stock.

FEMP will Collaborate across EERE to address federal agencies need for technology innovation, development and deployment



## **AFFECT (\$400M):**

- Significantly increase to Federal Energy Efficiency Fund (FEEF) Program (+ \$387 million)
- Provides direct funding to Federal agencies for the development of energy and water efficiency projects and processes that address climate change mitigation and/or adaptation.
  - Leverage performance contracting
  - Generate private sector resources that will significantly exceed the initial grant investments.

## **Workforce Development (\$2.3M):**

- Continue to provide free accredited training to energy and management professionals and participate in the EERE wide workforce EMPOWER FOA.

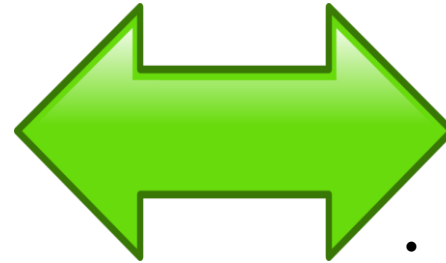
## **Technical Assistance (\$31.7M):**

- Federal Agency Fleet Electrification—increased funding will support technical assistance for charging and fleet electrification including development, validation, and deployment.
- Federal Smart Buildings —increased funding will support technical assistance to accelerate the adoption and use of smart building technologies and practices through validation, demonstration, and deployment across the Federal building stock.
- Partner with the National Park Service and the Department of Energy to demonstrate viability of electrification and decarbonization energy and water management strategies utilizing integrated FEMP services approach.
- PCNRC will be operational, providing training and resources to State and Local governments to expand performance-based contracting in their respective markets.

# Federal Energy Management Program – FY 2020 - 2021 Accomplishments

## FEMP Accomplishments:

- Selected 16 federal agency projects to receive the Assisting Federal Facilities with Energy Conservation Technologies (AFPECT) grant
  - FY20: combined total of \$11 million in AFPECT funding.
  - Grants will lead to total investment of over \$439 million.
- Awarded \$842M in private financing through the FEMP-Managed Performance Contracting mechanism (DOE IDIQ)
- Launched Technical Resilience Navigator a tool to assist agencies in systematically evaluating risk and infrastructure to facilitate resilience posture and mission assurance
- Executed over 20 50001 Ready Cohort trainings across the USG on strategic energy and water management
- Provide 35,000 hours training to the energy and water community.
- Established the Performance Contracting National Resource Center for Federal and MUSH market workforce development.



## FEMP Drives Success:

- \$1.2 billion: Total Federal Investment in Facilities Infrastructure Energy Efficiency Government-Wide in FY2019
  - Direct funding investment: \$224 million in FY 2019
  - Energy Saving Performance Contract (ESPC) investment: \$901 million
  - Utility Energy Saving Contract Investment: \$83 million
  - 2.4 trillion British Thermal Units (Btu) per year: Estimated Annual Energy Savings from FY 2019 Investment
  - \$65 million: Estimated Annual Energy Cost Savings from FY2019 Investment
- DOE IDIQ FY19 awards will result in:
  - Reductions of greenhouse gas emissions of over 106,000 metric tons CO<sub>2</sub>, once implemented
  - \$1.7 billion in energy and water cost savings over the contract term and decreased utility costs for Federal Agencies infrastructure
  - 6,734 Job-Years Created for the FY 2020 investment

# Building Technologies – FY 2022 Request



Building Technologies supports R&D, deployment, regulatory, other investments to increase the energy efficiency and demand flexibility of homes and commercial buildings – and thus significantly decarbonize them.

Subprogram (dollars in thousands)	FY 2021 Enacted	FY 2022 Request	FY 2022 vs. FY 2021	% Change
Emerging Technologies	145,000	174,000	+29,000	+20%
Commercial Buildings Integration	50,000	74,000	+24,000	+48%
Residential Buildings Integration	40,000	72,000	+32,000	+80%
Equipment and Buildings Standards	55,000	62,000	+7,000	+13%
Total	290,000	382,000	+92,000	+32%

## FY 2022 Emphasis Areas

- R&D and deployment activities focus on breaking down barriers and identifying opportunities to innovate the energy efficient technologies that impact the largest energy demands within buildings: lighting, space conditioning, refrigeration, water heating, appliances, and miscellaneous electric loads, as well as the building envelopes (including windows, insulation, etc.) themselves.
- RDD&D on advanced and grid-interactive controls and strategies (including thermal energy storage) to strengthen the body of knowledge to support industry to develop and deploy grid-interactive efficient buildings capable of connecting with the power grid in new, increasingly adaptive manners to help overall energy system efficiency, reliability, environmental performance, energy affordability; these capabilities are an integral part of a decarbonized power system.
- Emphasis on developing market transformation initiatives focused on accelerating the transition to a low-to-no-net carbon energy economy. Investing in “locking in” savings that have been realized by RDD&D and market transformation via appliance and equipment standards and building energy codes.
- Spur energy equity by developing and deploying solutions that address needs of disadvantaged populations by reducing utility bills and first cost of energy-saving technologies. This work is essential to ensuring that all Americans can benefit from affordable, high-performing homes and commercial buildings.

# Building Technologies – Alignment to EERE Priorities



EERE Program Priority	FY 2021 Enacted (\$K)	FY 2022 Request (\$K)	Description of Support
<b>Decarbonizing the electricity sector</b>	<b>290,000</b>	<b>300,000</b>	BTO plans to use a multi-pronged strategy that includes competitive FOAs, prizes, challenges, and campaigns. BTO's activities re: energy efficiency, demand flexibility, grid-interactivity/interoperability, and energy storage are key to affordably, reliably using variable renewables to decarbonize the power grid.
<b>Reduce the carbon footprint of buildings</b>	<b>290,000</b>	<b>382,000</b>	The entire BTO work is attributable to this area, as buildings consume 74% of US electricity and BTO's work helps make that power usage more efficient (thus easier to meet via new renewables) and more flexible (thus helping integrate variable renewables). BTO plans to use multi-pronged strategy that includes competitive FOAs, prizes, challenges, campaigns.

# Building Technologies – FY 2022 Highlights & Major Changes



- **Appliance & Equipment Standards and Building Codes (\$62M):** meet its statutorily mandated deadlines for covered appliances and equipment and building energy codes.
- **Grid Interactivity & Modernization and Renewables Integration (\$82M):** focus on research and development to improve the state of technology, deploy data and best practices, and demonstrate examples that support industry efforts to connect with the power grid in new and increasingly adaptive manners.
- **Advanced Building Construction (ABC) (\$20M):** transform the U.S. market for modernized, highly-productive, modular & prefabricated, low-carbon building construction and renovation by collaborating with key building industry stakeholders to inform ongoing R&D projects, and to prime the market for the integration of high efficiency solutions and evolving approaches in new construction and renovation.
- **E3 Initiative for Better Energy, Emissions, and Equity (\$10M):** support research, development and demonstration (RD&D) for new and existing, affordable greenhouse gas (GHG)-free heating and cooling solutions and market transformation activities to accelerate the adoption of grid-interactive heat pump (HP) technologies and deploy strategies and resources to reduce emissions attributed to building equipment including fossil-fueled equipment and refrigerants.
- **Climate and Clean Energy Partnerships for Local Governments: (\$20M)** partner with Weatherization and Intergovernmental Programs Office (WIP), provide competitive awards and various types of technical assistance (e.g., onsite capacity, peer exchanges) to local governments to support the development and deployment of transformative clean energy programs, with an emphasis on small to medium jurisdictions and disadvantaged communities.
- **Workforce Development & Education (\$25M):** prepare next generation of professionals, tradespersons and others needed to create a low-carbon, modernized U.S. building stock by augmenting training programs to improve skills of tradespersons and professionals, build interest in these careers (especially w/under-represented groups), streamline pathways from education and training to viable careers. Additional focus on providing opportunities to those in communities w/greatest employment needs, incl. those from legacy energy jobs.



# Building Technologies – FY 2020 - FY 2021 Select Accomplishments

**Modernizing Grid:** though Grid-interactive Efficient Buildings (including Connected Communities FOA) made significant contributions to grid-interactivity thought, research and analysis leadership. Contributed to demonstrating capacity of real-world, smart neighborhood field validation testbeds to deliver results on defining characteristics of GEB functionality, including efficiency (44% savings in kWh), flexibility (34% reduction in peak kW), and resilience.

**Advancing Building Construction:** launched ABC Collaborative and funding ~40 R&D projects to develop new solutions to advance both new construction and energy upgrades – incl. prefabricated solutions Four stakeholder workshops, inaugural ABC Collaborative Summit and national building typology study is informing overall strategy and R&D.

**Driving Energy Efficiency:** Home Performance with Energy Star (HPwES) sponsors completed 70,525 home upgrades in CY20, securing >\$500M lifetime energy savings for consumers, avoiding 3 MMT CO<sub>2</sub>. Total HPwES home upgrades to date: >970,000.

**Advancing Building Energy Modeling:** BTO's flagship building energy modeling engine EnergyPlus has long supported traditional EE use cases like design and code compliance and included a simple

scripting facility to enable more advanced use cases. In FY20, BTO upgraded to full support for the popular scripting language Python, enabling advanced applications including hardware-in-the-loop simulation, model-predictive-control, and real-time interaction.

**Investing in Buildings' Workforce of the Future:** held Solar Decathlon design and build competitions, JUMP into STEM programs for college students, funded projects under EMPOWERED FOA (w/SETO, VTO) targeting emergency responders and code officials, collaboration with 40 partners on the Better Buildings Workforce Accelerator, an assortment of smaller projects that maintain guidelines for high-quality training and certification programs.

**Driving Electricity Savings through Building Consumption Research and Analysis:** Columbia U. project collected detailed submetering and feedback to the occupants on their energy use data for 100s of apartments throughout pandemic stay-at-home period. Optimized occupant feedback spurred electricity savings of 16%, ~2x feedback effectiveness seen in past studies. Project quantified increased consumption patterns and grid strain due to shelter-in-place orders. High-profile results.

# Weatherization & Intergovernmental Programs – FY 2022 Request

Weatherization and Intergovernmental Programs Office (WIP) partners with state and local organizations to significantly accelerate the deployment of clean energy (e.g., energy efficiency and renewable energy) technologies and practices through place-based strategies involving a wide range of government, community, and business stakeholders and through capacity building.

Subprogram (in thousands)	FY 2021 Enacted	FY 2022 Request	FY 2022 vs. FY 2021	% Change
Weatherization Assistance	315,000	400,000	+85,000	+27%
<i>Training and Technical Assistance</i>	5,000	10,000	+5,000	+100%
Weatherization Readiness Fund	0	21,000	+21,000	-
State Energy Program	62,500	362,500	+300,000	+480%
Local Government Clean Energy Workforce Program	0	25,000	25,000	-
<b>Total</b>	<b>377,500</b>	<b>808,500</b>	<b>431,000</b>	<b>+114%</b>

## FY 2022 Emphasis Areas

- Build and expand capacity through technical assistance and new programs to ensure efficient and effective execution of the proposed American Jobs Plan block grant funding.
- Support EERE’s goal to accelerate the research, development, demonstration, and deployment (RDD&D) of innovative technologies that will achieve net-zero greenhouse gas emissions, economy-wide, by no later than 2050 and ensure the clean energy economy benefits all Americans.

# Weatherization & Intergovernmental Programs\* – Alignment to EERE Priorities

EERE Program Priority	FY 2021 Enacted (\$K)	FY 2022 Request (\$K)	Description of Support
Reduce the carbon footprint of buildings	373,500	804,230	WAP retrofits, WAP Readiness & portion of competitive fund; SEP Build Back Better, formula funding for buildings, planning, industry & resiliency; Better Buildings public sector; TA
Decarbonizing the electricity sector	4,000	4,270	SEP Electric power & renewables formula funding

*\*WIP anticipates that Build Back Better Challenge Grants will contribute to the following EERE Priorities as well: Decarbonizing the electricity sector; Decarbonizing transportation across all modes; and Reducing the carbon footprint of buildings; however, the magnitude of contribution will depend on what grantees propose and information reported to WIP post award.*

# Weatherization & Intergovernmental Programs – FY 2022 Highlights and Major Changes

**Weatherization Assistance Program (\$421M):** helps eligible low-income households reduce the comparatively large percentage of available income that they spend on energy. Highlights include:

- \$400 million in formula grants and training to support completion of approximately 50,000 low-income residential energy retrofits, which is a down payment on the Administration's commitment in the American Jobs Plan to retrofit 2 million homes;
- Establishment of a \$21 million “Weatherization Readiness Fund” to address structural or health and safety repairs needed to low-income homes that are not provided for under current WAP funding allocations;
- Exploration and development of methodologies to estimate non-energy impact savings and evaluation of the feasibility of including them in determining inclusion of energy conservation measures in WAP retrofits;
- WAP Enhancement and Innovation funds of up to 6 percent (up to a maximum of \$25 million) to competitively select and manage projects on improvements in indoor air quality, advanced technologies, and workforce development;
- Sustainable Energy Resources for Consumers (SERC) awards of up to 2 percent of WAP funding (approximately \$8.0 million) for installation of renewable technologies in low-income dwellings;
- Continued improvements in workforce training, quality standards, and worker certification to improve the quality of the work performed;
- Equitable statewide distribution review of DOE WAP funds to understand the energy burden on a by county basis and development of best practices and tools to assist state-level staff in making allocation decisions; and
- Development of targeted resources to further quality installation of energy conservation measures, focus on workforce development, and coordination with other funding streams through existing interagency working group.

# Weatherization & Intergovernmental Programs – FY 2022 Highlights and Major Changes

**State Energy Program (\$362.5M):** Continue to support existing programs to advance innovation in state energy offices and dissemination of best practices and launch challenge grant program to incubate novel approaches.

- Continue to support traditional formula-based grants to U.S. states, Washington, D.C., and 5 U.S. Territories and advance innovation in state energy offices and dissemination of best practices; maintain a portfolio of diverse energy efficiency and renewable energy programs and policies through an active network of state energy offices with the capacity to develop, improve, and implement these initiatives through the provision of funding through formula grants;
- Provide targeted technical assistance to states to advance transformative solutions for reducing energy use in government facilities; accelerating investment in public sector use of energy service performance contracts; and supporting high-impact projects focused on development and implementation of state policies addressing barriers limiting investment in energy efficiency and renewable energy, including self-sustaining financing models; and
- Design and launch the **Build Back Better Challenge Grants (\$300M)** program to incubate novel approaches to clean energy technology deployment, prioritizing investments that meet energy needs at the local level, and are inclusive in elevating impoverished and disenfranchised communities, and/or communities that have been marginalized or overburdened.

**Local Government Clean Energy Workforce Program (\$25M):** EERE seeks to establish a new program to:

- Provide targeted competitive awards, on-site capacity, peer exchanges, and technical assistance to support the development and deployment of transformative clean energy programs of qualifying local governments that create good paying jobs, with a focus on disadvantaged and small-to-medium jurisdictions;
- Operate in partnership between EERE's Weatherization and Intergovernmental Programs Office (WIP) and Building Technologies Office (BTO), and in coordination across DOE and other Federal agencies as appropriate; and
- Empower American cities, counties, and communities with high impact, place-based low-carbon solutions tailored to their needs, and developing and using a local workforce, with a focus on local clean energy programs that target environmental justice and workforce development outcomes.

# Weatherization & Intergovernmental Programs – FY 2020 - FY 2021 Accomplishments

## Weatherization Assistance Program

- FY 2021 formula grant allocations released January 21, 2021
- FY 2021: 15,674 homes weatherized\*; \$112.6M expended; virtual monitoring schedules in process
- Subgrantee administrative online modules completions: 3,300 users, 20 administrative trainings, 5,385 COVID-19 workplace safety trainings

## State Energy Program

- Workforce Development webinars hosted in November and April with State Energy Offices; part of a series for a joint DOE-NASEO initiative
- FY 2021 formula allocations released January 19, 2021; included voluntary opportunity to join new Technology Action Group (TAG) model in 2 areas: (1) onsite energy systems at critical facilities; (2) Main Street revitalization.
- Release of joint BTO-WIP Proving Ground FOA selections on January 20, 2021, focusing on field technology validation in state and local use cases; six awards to be launched spring/summer 2021
- New TA: *Federal Resilience Resources for State Energy Offices* posted to State and Local Solution Center
- Better Buildings Challenge: over 75 public-sector partners have saved \$790 million, 83 trillion Btus, and 1.8 billion gallons of water as of 2019 data
- Sustainable Wastewater Infrastructure of the Future (SWIFt) Accelerator: Launched Phase 2 with a goal to engage 200 facilities in a voluntary partnership to achieve 5% short-term and 25% long-term facility-wide energy savings; also signed on over 30 facilities to implement at least one next-generation technology
- Sustainable Correctional Infrastructure Partnership (SCIP) Accelerator: Launched with 12 states and 1 county representing 270 prisons and 1 jail to work with DOE toward achieving 20% portfolio-wide energy savings

\*Number of homes weatherized lower than planned in FY 2021 because to COVID-19 impacts on program operations.

# Renewable Power (RP)



# Renewable Power

RDD&D efforts in solar, wind, water, and geothermal power to help **reduce the costs** and accelerate the use and **integration of renewables**, contributing to a **reliable, secure, and resilient grid**.

(dollars in thousands)	FY 2021 Enacted	FY 2022 Request	\$ Change	% Change
Solar Energy Technologies	280,000	386,575	+106,575	38%
Wind Energy Technologies	110,000	204,870	+94,870	86%
Water Power Technologies	150,000	196,560	+46,560	31%
Geothermal Technologies	106,000	163,760	+57,760	54%

**Key EERE Priorities Enabled:**

Grid  
Industry  
Agriculture  
Buildings

**Accelerate deployment of renewable energy technologies by addressing market and regulatory questions, minimizing environmental and social impacts, and ensuring projects benefit local communities**

- Provide integrated, cross-office support to utilities, regulators, and state-local government in planning and operating high-renewables power systems
- Establish a national platform for low-income solar access to spur rooftop solar adoption, particularly in low-income communities
- Support environmental research and community engagement to accelerate permitting and adoption of utility-scale wind on land and offshore.

**Support U.S. manufacturing and secure supply chains to deliver new clean energy careers and eliminate dependence on vulnerable or unsustainable materials**

- Increased support for prize competitions designed to spur U.S. business innovation in solar.
- Support for a new EERE-wide initiative designed to support a qualified U.S. clean energy manufacturing workforce.

**Drive cost reductions to ensure renewable energy is a least-cost generation option across the entire country by 2030**

- Increase support for demonstration and validation of innovative technologies such as stationary energy storage, essential for attracting investment in renewables
- Support to demonstrate new geothermal drilling technologies to accelerate the speed of drilling, reduce well costs, and engage the oil & gas sector in geothermal energy development.
- RD&D to develop larger, light-weight turbines that allow operation at greater heights, platforms, and turbine designs to enable ultra-large floating wind turbines to access deep water offshore wind.

**Integrate renewables into the grid to ensure a clean power system is reliable and resilient in the face of changing demand and external threats**

- Increased support for HydroWIREs (Water Innovation for a Resilient Electricity System) to increase the flexibility of hydropower and support new pumped storage.

# Solar Energy – FY 2022 Request



The Solar Energy Program accelerates the research, development, demonstration and deployment of solar technologies in support of an equitable transition to a decarbonized power sector and energy system.

Subprogram (dollars in thousands)	FY 2021 Enacted	FY 2022 Request	FY 2022 vs. FY 2021	% Change
Concentrating Solar Power Technologies	60,000	60,000	-	-
Photovoltaic Technologies (formerly Photovoltaic R&D)	72,000	79,575	+7,575	+11%
Systems Integration	53,000	71,750	+18,750	+35%
Balance of Systems Soft Cost Reduction	35,000	75,250	+40,250	+115%
Manufacturing and Competitiveness	60,000	100,000	+40,000	+67%
<b>Total</b>	<b>280,000</b>	<b>386,575</b>	<b>+106,575</b>	<b>+38%</b>

## FY 2022 Emphasis Areas

- Accelerating solar deployment and associated job growth by reducing burdensome soft costs (e.g., interconnection, permitting and siting), increasing access to solar for low-income households, and providing workforce training.
- Development and demonstration of solar technologies' capabilities to support grid reliability, including essential grid services and cyber-security, and to pair with energy storage and other distributed energy resources to enhance community resilience, especially in underserved communities.
- Innovation in the full domestic supply chain for PV technology to increase the lifetime and reliability of PV systems, develop next generation technologies, and increase domestic solar manufacturing.
- Increased focus on technologies to decarbonize the industrial sector, including use of concentrating solar thermal power to drive thermochemical processes for industrial products.

# Solar Energy Technologies – Alignment to EERE Priorities



EERE Program Priority	FY 2021 Enacted (\$K)	FY 2022 Request (\$K)	Description of Support
Decarbonizing the electricity sector	280,000	357,825	SETO will enable continued cost reduction of photovoltaic components and systems, cost reduction in Concentrated Solar Power , new value streams for Concentrated Solar Power enable processes, addressing grid integration issues related to grid modeling, monitoring, control systems, storage integration and general grid modernization, and work related to the reduction of solar soft costs in areas like permitting, environmental factors, workforce and low-income access to solar. All proposed work has elements related to the reduction of carbon emissions from the electricity sector.
Reduce the carbon footprint of buildings	-	10,000	SETO is developing a program to research, develop and demonstrate building-integrated photovoltaics. The goal is to demonstrate photovoltaic products in real world environments to show their value and illustrate a path to market which would reduce GHG from buildings if commercialized.
Decarbonizing energy-intensive industries	2,500	37,500	Concentrated Solar Power will be investigating ways to use solar generated heat as an input to processes which can decarbonize areas other than electricity such as cement making, chemical processing and more.
Decarbonizing the agriculture sector, specifically focused on the nexus between energy and water	7,000	13,500	SETO support includes to the dual use of land for both photovoltaic electricity generation and agriculture with an objective to research and develop products for the industry to ensure siting of PV systems can be done effectively and efficiently while bringing benefits to other industries like agriculture.

# Solar Energy – FY 2022 Highlights and Major Changes



- **Workforce (\$20M):** National career accelerator to train and diversify the solar and clean energy workforce and build pathways for career placement and advancement in both solar installation and manufacturing.
- **Low-Income Solar Access to Community Solar (\$20M):** Develop an online platform available to states, utilities, and other stakeholders to manage the voluntary enrollment of low-income customers in community solar and reduce their household energy burden. The platform will also reduce acquisition and management costs of enrolling these customers in community solar.
- **PV Supply Chain (\$40M):** Develop and demonstrate PV technologies across the full supply chain with strong potential to grow the U.S. solar manufacturing sector and increase the share of domestic content in PV systems.
- **Grid Services from PV Systems (\$10M):** First-of-a-kind demonstrations of the provision of grid services from solar and wind technologies for an extended period time (>6 months) and use of the results to inform the planning and operation of the electric grid with increasing contributions from wind and solar.
- **Industrial Decarbonization (\$15M):** Leverage CSP technologies to support decarbonization of the industrial sector through research and development of solar thermochemical processes and components to produce solar-derived industrial products, chemicals, and fuels.

# Solar Energy Technologies – FY 2020 - FY 2021 Accomplishments

## Advancing Photovoltaics

- Awarded **\$40M** to advance perovskite device and **manufacturing R&D** as well as establish an independent validation and bankability center.
- The **PV Fleets Initiative** and its industry partners now have a functioning methodology for cleaning large amounts of PV plant data and generating fleet performance reports that cover key information for system owners and identify potentially troubled assets. The PV Fleets Initiative has collected 2.5GW of data with an average system life of 5 years.

## Integrating Solar in the Grid

- **Approval of revised IEEE 1547.1 smart inverter testing standard-** NREL and SETO staff contributed to this standard which creates nationally applicable guidance for distributed energy resource manufacturers on how grid support functions in their products will be tested. This will allow the adoption of updated interconnection requirements and contribute to future grids being able to handle higher penetrations of renewable energy and storage devices.

- SETO (with the support of WETO) released a FOA topic to award and launch the **Grid-Forming Technologies Research Consortium** which will bring together researchers and stakeholders to advance research on grid-forming solar, wind, and storage inverters, and other grid-forming technologies, and ensure that these technologies enhance power systems operation.
- Initiated the development of **Power Electronic Testbed (PEGI)** as a major part of **Advanced Research on Integrated Energy Systems (ARIES)**, a next generation research platform for energy system modelling. PEGI will allow the function of power electronic devices to be tested in complex operational environments enabled by ARIES. The goal is to prove the safe and reliable function of the electric grid with very high levels of renewables generation integrated with power electronics.

## Expanding Programming to New Areas

- First dedicated **topics on the intersection of solar energy and agriculture**, looking at dual use of land and new technologies, and **artificial intelligence applications in solar energy** such as grid integration and operations, system performance modeling and irradiance forecasting.



# Solar Energy Technologies – FY 2020 - FY 2021 Accomplishments

## Assistance at the Local Level

- The National Community Solar Partnership (NCSP), launched in September 2019, provided **technical assistance to over 100 members of the partnership** to help them address specific local barriers to community solar development. In addition, NCSP **launched its first two collaborative working groups** addressing barriers in the multifamily affordable housing and municipal utility sectors. NCSP's goal is to make solar energy accessible and affordable for all US households by 2025.
- **Over 400 communities have been designated SolSmart** to date. SolSmart is a national designation program designed to recognize communities that have taken steps to address local barriers to solar energy. In May 2021 SETO launched a FOA to compete the future management of the program and to increase its scope to include things like energy storage.
- Solar Automated Permit Processing Software for Distributed PV (**SolarAPP**) **alpha version was launched for testing by authorities having jurisdiction (AHJs) and PV installers**. Permitting is a continuing challenge for the PV industry as AHJs have differing tools, rules and levels of experience with solar PV which can make the installation more complex and time consuming than need be. SolarAPP will provide AHJs the capability to streamline and bring uniformity to permitting processes and provide transparency to evaluation timelines ultimately driving down costs to the consumer.

## Assisting Innovation to Reach Market

- **Launched the first two rounds of the American-Made Solar Desalination Prize** which is designed to accelerate the development of low-cost desalination systems that use solar-thermal power to product clean water. Round 1 of the prize received more applicants than anticipated and awarded 19 quarterfinalists in October of 2020. Round 2 was launched in March 2021.
- **Awarded Round 3 and launched Round 4 of the American-Made Solar Prizes**. The American-Made Solar Prizes are a series of competitions meant to drive product development and commercialization with the goal of developing US manufacturable products and rapidly bring them to pilot testing and, subsequently, the market. Each round starts with 20 first content awardees and ends with two grand prize winners.

# Wind Energy Technologies Office – FY 2022 Request



The Wind Technologies Office (WETO) supports a portfolio of research and innovation designed to accelerate technological advancement and deployment of offshore, land-based, and distributed wind energy technologies and their integration with the electric grid.

Subprogram (dollars in thousands)	FY 2021 Enacted	FY 2022 Request	FY 2022 vs. FY 2021	% Change
Offshore Wind	63,200	100,260	+37,060	+59%
Land-Based Wind	31,800	40,000	+8,200	+26%
Distributed Wind	10,000	17,750	+7,750	+78%
Grid Integration & Analysis	5,000	46,860	+41,860	+837%
Systems Integration	0	0	0	-
STEM & Workforce Development	0	0	0	-
Data, Modeling, & Analysis	0	0	0	-
<b>Total</b>	<b>110,000</b>	<b>204,870</b>	<b>+94,870</b>	<b>+86%</b>

## FY 2022 Emphasis Areas

- Align with and realize the Administration’s goals of fully decarbonizing electricity by 2035, 30 GW of offshore wind by 2030, and a net-zero carbon economy by 2050.
- R&D strategies for scaling installed wind capacity from 122 GW today to over 500 GW by 2035, as proposed, call for acceleration in:
  - Cost reduction through scientific understanding and technology innovation, including advances in turbine technology, economies of scale (taller, lighter, and more powerful machines), wind plant optimization, novel platform concepts for floating wind in deep water, and enhancements for rural and distributed wind systems;
  - Discovering sustainable solutions to environmental and siting concerns for wildlife, radar interference, and social aspects of use-conflicts, and working with state and local partnerships to promote Environmental Justice and equitable benefits for all communities; and
  - Integrating all forms of wind energy with grid systems and facilitating a transformational shift in energy sourcing, transmission, power electronics and controls needed to ensure efficient, secure, reliable and resilient electric power in a new energy future.



# Wind Power Technologies – Alignment to EERE Priorities



EERE Program Priority	FY 2021 Enacted (\$K)	FY 2022 Request (\$K)	Description of Support
Decarbonize Electricity	82,500	179,555	WETO's priorities include a broad portfolio of research, development, demonstration, and deployment activities focused on addressing barriers and accelerating U.S. wind deployment, stimulating investment, creating jobs, and facilitating the growth of U.S. manufacturing and supply chain. With this portfolio of investments, DOE will accelerate innovation, cut the cost of wind energy by 50% across all wind types, reduce environmental and siting barriers to wind project development, and support wind energy's integration with the grid and transmission build-out.
Decarbonize Transportation across all modes	-	5,000	Integration and demonstration of a multi-megawatt water electrolyzer coupled with renewable wind power generation (focusing on offshore wind and potential for land-based wind) to produce low cost, emission free, green hydrogen to be used for clean fuels (joint effort with HFTO)
Decarbonize Agriculture	-	5,000	Accelerate deployment of distributed wind and wind hybrid DER systems by addressing today's market barriers, specifically permitting processes, through network-sourced best practices, and provide a framework for identifying more targeted place-based solutions opportunities, such as agricultural electrification/decarbonization.

# Wind Energy Technologies – FY 2022 Highlights and Major Changes



- **Environmental and Siting R&D (\$37.6M):** Research and development of solutions to reduce environmental and siting barriers to land-based and offshore wind, coordinated with DOE's Solar and Water Programs on related efforts and issues, including support of social science and socioeconomic research to understand impacts of wind energy and provide objective information on the benefits and costs of wind development;
- **Floating Offshore Wind (\$20M):** Technology development to enable ultra-large floating wind turbines to access the 58 percent of U.S. offshore wind resources that are in in deep water, including the entire West Coast; improve resource characterization and forecasting specific to wind plant power generation; technology innovations to optimize wind plant performance and reliability, and breakthroughs to facilitate the next generation of rotors for tall wind applications;
- **Enabling Technologies for Offshore Wind Grid Integration (\$12.6M):** Research to assess transmission infrastructure requirements to maintain system reliability and ensure cost-effective transmission access for offshore wind, while identifying innovative solutions to provide advanced grid services and reduce costs; and
- **Accelerate All Wind Deployment (\$15M):** Advanced materials and manufacturing R&D to develop innovative solutions to scaling, reliability, transportation constraints, materials, and supply chain challenges to accelerate wind deployment of all types and optimize opportunities for domestic manufacturing.

# Wind Energy Technologies – FY 2020 - 2021 Accomplishments

## Offshore Wind

### Offshore Wind Demonstrations

- Accelerated the advancement of U.S. offshore wind technology, including progress on an innovative demonstration project:
  - **University of Maine** floating, semi-submersible concrete foundation

### Buoys

- Deployed two offshore wind research buoys off the coast of California to gather metocean measurements off the West Coast.

### R&D Consortium

- Funded 40 awards totaling \$28.3M through the National Offshore Wind R&D Consortium to lower the costs of U.S. offshore wind and support supply chain development.

## Land-based Wind

### Bat and Bird Deterrents

- Funded a bat deterrent system that was successfully commercialized and installed. Supported the development of PNNL's
- Supported development of a stereo-vision solution for evaluating flight tracks and other data on birds and bats around offshore wind turbines.

### Eagle Impact Mitigation

- Concluded research exploring eagle physiology to improve the effectiveness of deterrents at wind energy facilities.
- Improved a turbine-mounted eagle detection, deterrence, and blade strike monitoring system that automatically triggers a deterrent or shuts down the turbine if an eagle is within range of the system.

## Distributed Wind

### Small Business Enablers

- Advanced technology development and systems improvements through the Competitiveness Improvement Project (CIP).

### Wind for Defense and Disaster Applications

- Created the Defense Deployable Disaster Wind Turbine project to develop rapidly deployable wind energy systems for defense and disaster response.

### Rural Wind Power

- Addressed barriers to deployment through the Rural Area Distributed Wind Integration Network Development (RADWIND)

### Wind-Powered Microgrids

- Validated technology to support Microgrids, Infrastructure Resilience, and Advanced Controls Launchpad (MIRACL).

## Grid Integration

### Grid Services

- Demonstrations to prove wind could provide a full array of essential grid services

### Easing Grid Congestion

- Developed dynamic line rating tools to optimize use of existing transmission lines and reduce congestion.

### Cybersecurity

- Published the Roadmap for Wind Cybersecurity outlining best practices to defend, detect, and mitigate challenges of cyber threats to wind turbines and their control systems operating in the U.S.

### Grid Modernization:

- Supported the crosscutting Grid Modernization Initiative to develop tools and technologies to measure, analyze, protect, and enable the grid of the future.

# Water Power Technologies FY 2022 Request



The Water Power Technologies Office (WPTO) administers a broad portfolio of research, development, and demonstration activities to strengthen the body of scientific and engineering knowledge and support industry efforts to develop and deploy hydropower and marine energy technologies at all scales.

Subprogram (dollars in thousands)	FY 2021 Enacted	FY 2022 Request	FY 2022 vs. FY 2021	% Change
Hydropower Technologies	41,000	84,560	+43,560	+106%
Marine Energy Technologies	109,000	112,000	+3,000	+3%
Total	150,000	196,560	+46,560	+31%

## FY 2022 Emphasis Areas

- Strengthen hydro's role as a flexible, firm asset on the grid by expanding analytical tools, technology development, and administration of tech assistance to bolster efforts for hydro fleet operators and pumped storage hydro to enable more solar and wind on the grid. This also includes expanding research to understand the future of hydro in the face of climate change, including hydrologic impact assessment, and strengthening the environmental portfolio.
- Develop the R&D, technologies, and demonstration programs to expand hydro's role in powering nonpowered dams, including to serve new markets like irrigation modernization, and demonstration of additional values of hydropower.
- Build on work to provide technical assistance to climate-impacted communities through the Energy Transition Initiative Partnership Project (ETIPP) and ensure programs across the portfolio increase equity and address diversity.
- Continue work to drive down costs of marine energy by investing in advanced materials and controls, foundational R&D at universities, supporting entrepreneurship, and demonstrating systems to meet near-term blue economy markets.
- Across the portfolio, invest in STEM, workforce development, and partnerships with communities and end-users.

# Water Power Technologies – Alignment to EERE Priorities



EERE Program Priority	FY 2021 Enacted (\$K)	FY 2022 Request (\$K)	Description of Support
Decarbonizing the electricity sector	126,000	174,800	Provide funding across both the hydropower and marine energy portfolio with the purpose of decarbonizing the electricity sector. For hydropower, this includes investing in technologies and analyses needed to enhance hydropower's ability to provide critical grid services and carbon-free power to the grid, and the investments in technologies to enable new hydropower development. In marine energy, this includes supporting the research, testing, and demonstration of technologies to drive down costs for marine energy systems to provide electricity to distributed grids in the short-term, and the national grid in the long-term.
Decarbonizing energy-intensive industries	86,000	102,000	In the hydropower portfolio, decarbonization of industry can include coproduction of fuels like hydrogen. In marine energy, investments into systems of the future could ultimately results in power to provide fuels, water, and other services for decarbonization of off-grid, at-sea industries, including maritime fuels and aquaculture energy provisions.
Decarbonize transportation across all modes	250	250	WPTO has supported a working group of experts around equities in the marine transportation sector, working to share information to revitalize the maritime transportation sector with focus on reducing fossil fuel consumption and GHG emissions.
Decarbonizing the agriculture sector, specifically focused on the nexus between energy and water	5,700	20,800	In hydropower, building off case studies and a visualization tool, launch a demonstration program to accelerate deployment of a new irrigation modernization paradigm. Building on the Powering the Blue Economy initiative and the Waves to Water, WPTO will fund longer-term wave powered desalination systems, which could include tech to support aquaculture or ag purposes. WPTO will also fund aquaculture activities, including characterization of marine energy resources in aquaculture-relevant locations, and energy requirements and energy storage options for aquaculture installations, including implications for ocean CDR.

# Water Power –FY 2022 Hydro Highlights and Major Changes



- **Increase Funding for Hydro Flexibility & Storage Expansion (\$26M):** Invest in a fleet-wide, but regionally informed, approaches to increasing hydropower flexibility, storage, and community/utility focused assistance. This includes work to support hybrids, pumped storage valuation, among others.
- **Enhancing Understanding of Hydrologic and Climate for Hydropower (\$18M):** Develop a suite of climate and hydrologic models and decision-makings tools to provide accurate state-of-the-art climate information and diagnostic capabilities.
- **Investing to Modernize the Existing Hydro Fleet (\$8M):** Build upon foundational work to establish the foundation for digital twin applications of hydropower, and cybersecurity planning, and environmental technology development like fish passage for relicensing and new builds
- **Expanding Hydro by Powering Nonpowered Dams and Infrastructure (\$26M):** Increase in funding would support advanced manufacturing, advance technology demonstrations of powering nonpowered dams, expanded efforts into demonstration hydro's potential in partnership with USDA for irrigation modernization, as well as investment in novel water infrastructure sensing capabilities in coordination with AMO.
- **STEM/Workforce (\$1.1M):** Expand efforts to attract, retain, and retrain talent for the hydropower sector.



# Water Power –FY 2022 Marine Highlights and Major Changes



- **Energy Transitions Initiative Partnership Project Expansion (Crosscutting Hydro/Marine) (\$10M):** Expand ETIPP to support more communities, expand community-based organizations support, and fund to support demonstrations based on the plans developed through ETIPP.
- **Demonstration and In-Water Deployment of Marine Energy Systems (\$45M):** Expand on the Powering the Blue Economy (PBE) initiative, to demonstrate PBE applications like desalination systems for remote communities and disaster relief and recovery, marine energy powered ocean observing systems, and design and systems based on outcomes of first cohort of ETIPP. And support the fabrication and demonstration of potential grid-connected devices at the PacWave facility.
- **Foundational R&D, Resource Assessment, Alternative Markets, and Prototyping for Marine (\$29M):** Invest in controls, advanced materials, university early-stage R&D, expanded assessments of ocean energy, and increased SBIR investments. Expand foundational work assessing feasibility of other PBE markets like aquaculture or thermal gradients to support R&D and demo growth.
- **Testing and Infrastructure for Marine (\$18M):** Maintain funding for the TEAMER program, which provides access to free testing for developers and researchers, investments in infrastructure upgrades, and funding for the PacWave facility. Invest in infrastructure at labs and universities.
- **STEM/Workforce (\$2.1M):** Build on successful Marine Energy Collegiate Competition, and support fellowships and other STEM-focused activities to build a robust marine energy workforce.



# Hydropower and PSH Technologies – FY2020 - 2021 Accomplishments



- **California Hydroelectric Project Is Now Operational:** The Sacramento Municipal Utility District's new 2.7-MW hydroelectric powerhouse, which received \$1.5 million in DOE funding, is now operational. As the new powerhouse is considered a “small hydro” project (less than 30 MW), the electricity it produces will count toward California's Renewable Portfolio Standard.
- **National Labs Commercialize Environmental Evaluation Tools:** Under the HydroPASSAGE project, PNNL and ORNL commercialized proven environmental evaluation tools for industry use to increase fish survival and lower operational costs.
- **Acoustic Transmitter Improves Juvenile Fish Tracking and Analysis:** PNNL developed new, highly miniaturized fish-tags, able to be quickly injected, even into tiny juvenile eel and lamprey.
- **Low-Cost, Modular Pumped Storage That Can Be Installed Anywhere:** The Ground-Level Integrated Diverse Energy Storage (GLIDES) project, led by ORNL, concluded initial phases of R&D on a new form of PSH targeting the gap between small-scale batteries and large grid-scale PSH options. GLIDES is a modular, scalable energy storage technology with promising estimated returns on investment for future commercial projects.
- **National Lab, Municipal Power Utility Test Energy Storage for Small Hydropower Generation:** INL and Idaho Falls Power demonstrated a run-of-river hydropower system paired with energy storage to enable small hydro plants to serve critical loads and increase energy resilience.

# Marine Energy Technologies – FY2020 - FY2021 Accomplishments



- [RivGen® Power System Now Longest-Operating Current Energy Converter in the U.S.:](#) Ocean Renewable Power Co. concluded summer inspection and maintenance of its RivGen® submerged river current turbine system, redeployed it, and resumed operations, sending power to the Igiugig, Alaska, community grid.
- [First U.S.-Accredited, Grid-Connected Wave Energy Test Receives 25-Year Permit:](#) PacWave South is the first commercial-scale, utility grid-connected test site in the U.S. to obtain a FERC license and will be the first marine renewable energy research facility in federal waters off the Pacific Coast.
- [Verdant Power Successfully Deploys Tidal Power System in NYC:](#) In October 2020, Verdant Power successfully installed three, fifth-generation tidal power turbines on a TriFrame™ mounting system at its Roosevelt Island Tidal Energy Project site in New York City's East River. During the 6 month deployment, the array has continuously operated and generated 200MWh—a U.S. record for marine energy production.
- [WPTO Creates New STEM Hub to Inspire the Future Workforce, Reaches Visitors to the Northeast's Largest Aquarium:](#) Some of the resources featured are already being used, including as part of a public energy exhibit at Mystic Aquarium in Connecticut.



# Geothermal Technologies – FY 2022 Request



Geothermal Technologies researches, develops, and validates innovative and cost-competitive technologies and tools to locate, access, and develop geothermal resources in the United States, enabling the deployment of carbon-free, flexible geothermal energy in both the electric and non-electric sectors.

Subprogram (dollars in thousands)	FY 2021 Enacted	FY 2022 Request	FY 2022 vs. FY 2021	% Change
Enhanced Geothermal Systems	65,000	70,380	+5,380	+8%
Hydrothermal Resources (formerly Hydrothermal)	20,000	39,100	+19,100	+96%
Low Temperature and Coproduced Resources	15,000	34,700	+19,700	+131%
Data, Modeling, and Analysis (formerly Systems Analysis)	6,000	19,580	+13,580	+226%
Total	106,000	163,760	+57,760	+54%

## FY 2022 Emphasis Areas

- The Geothermal Technologies Office (GTO) will support R&D for technologies to help the U.S. achieve a **carbon pollution-free electricity sector no later than 2035** through investments in the Frontier Observatory for Research in Geothermal Energy (FORGE), a drilling technology demonstration campaign, EGS near-field demonstrations, a new initiative aimed at transitioning oil and gas technologies and talent to geothermal energy, and grid policy and regulatory support.
- GTO will also emphasize the Administration’s goal to **reduce the carbon footprint of the U.S. building stock by 80% by 2035** through programs designed to deploy geothermal heating/cooling at Federal Installations (in partnership with FEMP), provide technical assistance for communities installing geothermal heating and cooling, and collaborate with BTO to demonstrate the market viability of geothermal in highly energy-efficient, demand-flexible, low-carbon buildings.
- GTO’s programs focus on **accruing benefits to disadvantaged communities** – Geothermal’s high-capacity factor, small physical footprint, and wide-ranging applications ensure that it can be utilized in urban centers, rural areas, and remote communities where geothermal has high technical and economic potential.

# Geothermal Technologies – Alignment to EERE Priorities



EERE Program Priority	FY 2021 Enacted (\$K)	FY 2022 Request (\$K)	Description of Support
Decarbonizing the electricity sector	106,010	163,760	GTO's priorities include a broad portfolio of RDD&D activities focused on driving down the costs and risks of geothermal power development, moving the built environment to geothermal heating and cooling, and easing the stress on the energy grid through research in thermal energy storage.
Decarbonizing transportation across all modes	4,300	2,150	GTO will continue its important work in R&D to extract lithium from geothermal brines. Geothermal brines, especially in the Salton Sea in California, could provide 40% of the global need for Lithium, including all EV needs.
Reduce the carbon footprint of buildings	15,000	34,700	GTO's Low-temperature portfolio supports RD&D for the built environment. In FY22, GTO will make large investments in this area, including technical assistance for geothermal heating and cooling.; collaborating with FEMP to demonstrate geothermal heating and cooling on Federal installations; and working with BTO on Next Generation Connected Cities.

# Geothermal Technologies – FY 2022 Highlights and Major Changes



**Frontier Observatory in Research in Geothermal Energy (FORGE) (\$20M):** Utah FORGE drilled the first-ever highly deviated geothermal well at a rate twice the industry standard. In FY 2022, GTO will support the next R&D solicitation, contributing to meeting Administration goals for a carbon-free electric grid.

**Drilling Technology Demonstration Campaign (\$20M):** This campaign will enable field demonstration to prove utility and efficacy to industry and attract future private investment and use to further the Nation's goal to a 100 percent clean energy economy.

**Community Geothermal Heating & Cooling Technical Assistance & Deployment (\$15M):** This initiative funds technical assistance to demonstrate, deploy, and implement community-scale direct use geothermal district energy systems through installation of geothermal heat pumps (GHP) and/or direct use of geothermal fluids.

**Geothermal Energy from Oil and gas Demonstrated Engineering (GEODE) (\$10M):** This is a new consortium designed to leverage the oil & gas subsurface industry to help solve geothermal energy's toughest challenges.

**Federal Partnerships for Geothermal Installations (\$5.4M):** GTO and FEMP will make it possible for Federal agencies (DOD, GSA, State, NASA, DOE Labs, Park Service) to consider geothermal energy to heat/cool (and in some limited cases, potentially power) their installations.

**Next Generation Connected Communities (\$5M):** GTO will collaborate with the Building Technologies Office to demonstrate the market viability of highly energy-efficient, demand-flexible, low-carbon buildings integrated with distributed energy resources (DERs) and related infrastructure to reliably and cost-effectively contribute to America's transition to a zero-carbon grid.

# Geothermal Technologies – FY 2020 – FY 2021 Accomplishments

- The Play Fairway Analysis (PFA) projects confirmed geothermal resource availability in NV and ID. The next step, awarded in FY20, is to leverage the Great Basin PFA to generate a playbook for discovering hidden systems through new data, modeling, machine learning, and quantification of the Great Basin resource.
- Geoscience Data Acquisition for Western Nevada (GeoDAWN) is an FY20 interagency agreement with USGS that provides solutions to U.S. needs for both energy and critical minerals. Researchers are gathering new subsurface data in the Walker Lane geologic zone in western NV that will be leveraged to use machine learning techniques to locate undiscovered geothermal resources and identify critical mineral deposits for domestic use.
- Energy Storage Grand Challenge studies support GTO goals for increasing geothermal district heating and geothermal heat pump deployment. The deep direct use feasibility studies funded over the last few years progressed the science of low temperature geothermal applications. The focus in FY20 is on engineering, design and demonstration of deep direct use via a new project selections located at Cornell University and West Virginia University.
- The Geothermal Lithium Extraction Prize is a 3-phase prize that launched in March 2021 that will advance technological barriers inhibiting our ability to produce cost-effective, domestic lithium from geothermal brines in the Salton Sea. The prize is open to academic teams and leverages industry for mentorship and guidance.
- Experiments conducted at Sanford Underground Research Facility at a 4850-foot depth, including the validation of numerical modeling, continuous monitoring of boreholes, and robust data collection and imaging, have successfully demonstrated the creation and subsequent activation of new fractures for EGS development. A new experimental test bed is under development (Experiment 2) at the 4100-foot depth focused on EGS development through shear activation of existing fractures.
- Since the first well was drilled at the FORGE site in 2018, the initiative has demonstrated ~3X improvement in drilling, completed a first-of-its-kind highly deviated geothermal well, and selected \$46M of innovative projects to address critical technology needs for EGS development and deployment.
- GTO-funded partners, Hotrock Energy Research Organization (HERO) in collaboration with SwellX LTD and Fervo, have both successfully tested their zonal isolation designs at 6000 psi. HERO will move towards testing materials at temperatures over 175°C while Fervo has already successfully tested at 225°C and will move to field test in Spring 2021. These experiments showing successful demonstration under real-world conditions are crucial in moving these innovative technologies towards deployment and application.
- The Geothermal Manufacturing Prize, led by GTO and AMO, has advanced to the semi-finalist stage (Make!) where 10 teams are additively manufacturing innovative prototypes of geothermal drilling, logging and production, and zonal isolation tools through Fall 2021.

# Corporate Support



# Corporate Support Programs – FY 2022 Request

Corporate Support Programs support a range of activities to make EERE more efficient and effective. This effort includes support to strengthen EERE’s overall performance, organization, budget, laboratory management, operations, human capital, and project management while achieving significant cost savings. This work includes support for program direction and facilities and infrastructure as part of EERE’s stewardship of the National Renewable Energy Laboratory (NREL) in Golden, Colorado.

Subprogram	FY 2021 Enacted (\$K)	FY 2022 Request (\$K)	FY 2022 vs FY 2021 (\$K)
Program Direction	165,000	250,000	+85,000
Strategic Programs	14,500	43,585	+29,085
Facilities and Infrastructure	130,000	175,000	+45,000
<b>Total</b>	<b>309,500</b>	<b>468,565</b>	<b>+159,085</b>

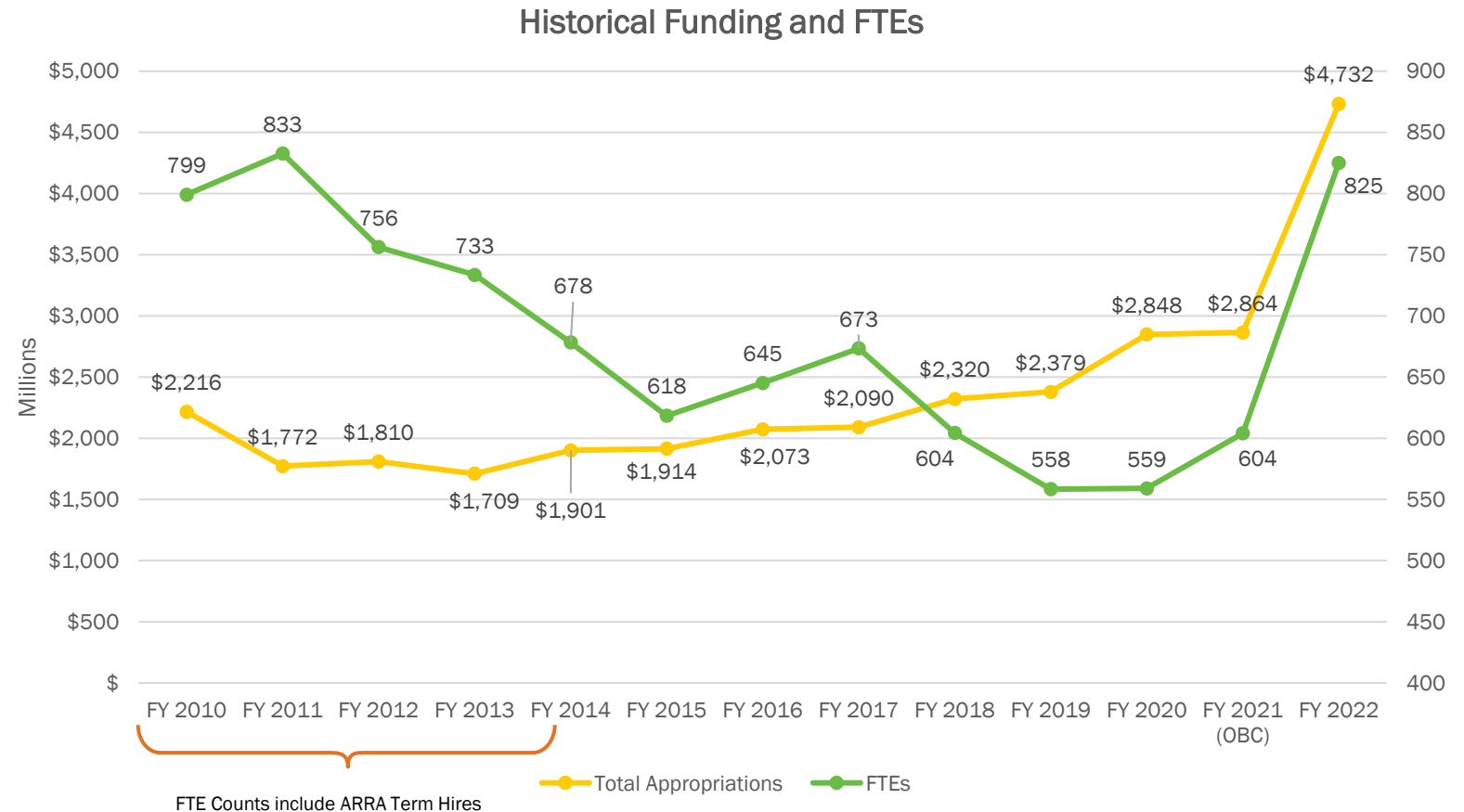
# EERE Staffing & FY 2022 Program Direction Request

## FY 2022 Request:

- **65% overall increase in EERE funding**
- **52% increase for EERE Program Direction (\$250M)**
  - Support for up to 825 FTE, including additional staff to implement Administration priorities
  - Support to equip a mobile workforce and increase other support needed at increased EERE funding level
  - Build capacity to ensure American Jobs Plan programs are implemented efficiently and effectively

From FY 2011-21 EERE has seen a **\$1B increase** in appropriations:

**~27% reduction in staff**



# Corporate Support Programs – FY 2022 Highlights

## Program Direction (\$250M)

- Support 825 FTEs at Headquarters, the Golden Field Office, and the National Energy Technology Laboratory.
- Support strengthening EERE's overall performance, organization, budget, laboratory management, operations, human capital, and project management while achieving significant cost savings; and
- Support project management and procurement across EERE's full portfolio of projects, including closing out completed financial assistance awards.
- Build capacity to ensure Administration priorities, including the American Jobs Plan programs are implemented efficiently and effectively.

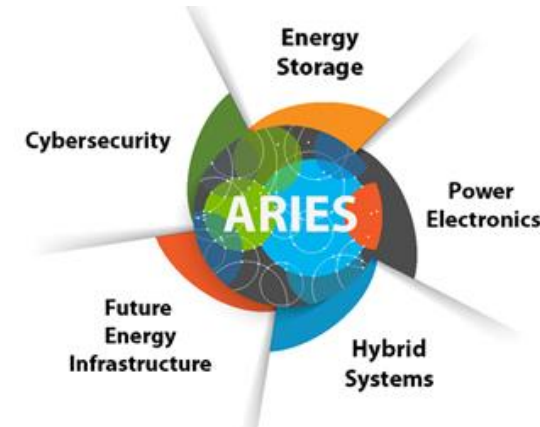
## Strategic Programs (\$45.6M)

- Continue support for deployment efforts under the Energy Transitions Initiative (ETI) to address high energy costs, reliability, and inadequate infrastructure challenges faced by islands and remote communities.
- Engage state and local policymakers, business leaders, community advocates, academics, utilities, transit agencies, and other partners to leverage their regions' unique strengths to tackle the climate emergency and to create healthy, safe, and thriving communities, including energy communities, with clean energy jobs that cater to different education and experience levels.
- Significantly expand analysis and impact evaluation efforts and stand up new technical assistance functions in support of key EERE programmatic priorities and key emphasis areas including equity and environmental justice.
- Initiates support for a new subprogram to allow EERE to support cross-technology initiatives including those included in the American Jobs Plan.

# Corporate Support Programs: Facilities and Infrastructure – FY 2022 Highlights

## Facilities and Infrastructure (\$175M)

- **Advanced Research in Integrated Energy Systems (ARIES) - \$44.25M**
  - ARIES research focus areas include energy storage, power electronics, hybrid systems, future energy infrastructure, and cybersecurity. Investments address the challenges of designing and constructing future energy systems using the basic principles of operating large-scale hybrid energy systems that interconnect multiple generation and storage technologies and solving the complex problem of controlling the interactions between millions of distributed assets.
- **Kestrel High Performance Computer (HPC)/HPC operations at the ESIF - \$ 27.45M**
  - Funds the first year of a four-year Kestrel HPC refresh/upgrade
  - Continues Eagle HPC operations (FY 2023 planned decommissioning).
- **Waste Handling Facility on the NREL South Table Mountain Campus - \$9.5M**
- **Energy Materials and Processing at Scale (EMAPS) - \$8M**
  - Provides preliminary design funding for the line-item construction project.
- **Cybersecurity and Sitewide Facility Support increases by \$5.8M**



# EMAPS - Energy Materials and Processing at Scale

TEC range is \$90M to \$160M, Estimated CD-4, 2Q FY 2025

New capability designed to develop hybrid, multidisciplinary science and technology approaches, from bench to fully integrated and industrially relevant pilot scale, to address emerging circular economy, sustainability challenges, and manufacturing for energy materials.

## Mission Need

- A multi-disciplinary research capability in process integration that draws on bench scale innovations from multiple institutions and transforms them into integrated and scalable “hybrid technology processes” needed to develop a circular economy and to ready DOE energy innovations for commercial development.

## Process Integration

- Control and capitalize on the interactions between different phases of R&D in order to employ resources more effectively, minimize costs, and greatly reduce time from innovation to marketable technology.

## Impact

- Global economic competitiveness requires circularity in our materials, products and energy economy
- Accelerate the transition to a circular economy for energy-relevant and energy-intensive materials and processes
- New materials, concepts and advanced manufacturing processes

**Note: This project is pre-CD-1; therefore, schedule and funding estimates are preliminary**

