

DOE ARPA-E FLECCS & Industrial Heat Initiatives

Presentation to Industrial Technology Innovation Advisory Committee (ITIAC)

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History of ARPA-E

In 2007, The National Academies recommended Congress establish an Advanced Research Projects Agency within the U.S. Department of Energy to fund advanced energy R&D.





ARPA-E Mission





ARPA-E Program Cycle



ARPA-E "Mountains of Opportunity"





ARPA-E Impact Indicators 2023





ARPA-E Technology Initiatives

Providing technology leadership and funding across the energy spectrum:





DOE ARPA-E FLECCS Program

- NGCC's are 39% (2022) of US electricity generation today and the single largest source
- However;
 - Need to decarbonize ... pre-combustion, post-combustion, or a combination
 - Intermittent (vs base-load) service is increasing with renewable generation

Phase 2 Objectives:

- Develop carbon capture and storage (CCS) technologies that enable NGCC's to retain responsiveness to grid conditions in a high variable renewable energy (VRE) penetration environment.
- Explore retrofits to existing power generators as well as greenfield systems with a carbon-containing fuel input and electricity as an output.
- Model and evaluate value of NGCC/CCS technologies based upon the system cost of electricity of a net-zero carbon electricity grid.
- Integrate NGCC w/ CCS and long-term CO2 disposition

US electricity generation, by fuel type



<u>A record share of US electricity comes from clean energy</u> <u>World Economic Forum (weforum.org)</u>



FLECCS Phase 2 technology teams

NGCC CCS integrated with DAC using novel contactor



Georgia

Tech

Low-water solvent and rotating packed bed contactor



Active transport ceramic membrane integrated into HRSG



Novel sorbent with integrated storage/regeneration

TEA Modeling by Dr. Jesse Jenkins (Princeton Zero Lab)

8 RIVERS 8 Rivers Capital, LLC Novel solvent with proprietary adsorber



Research to improve decision-making and accelerate rapid, affordable, and effective transitions to net-zero carbon energy systems



H/J Class NGCC operational flexibility

OEM	Model	SC Output (MW)	1x1 CC Output (MW)	Ramp Rate (MW/min)	Ramp Rate (% of GT Base Load)	Start Time (Hot)	Turndown (%)	Reference
Mitsubishi Power	M501J AC	453	664	42	9.3	30	50%	<u>Mitsubishi Power </u> <u>M501J Series (mhi.com)</u>
Siemens Energy	SGT6- 9000HL	440	655	85	19.3	30	<30	<u>SGT6-9000HL Heavy</u> <u>Duty Gas Turbine</u> <u>(siemens-energy.com)</u>
GE Vernova	7HA.03	430	640	75	17.4	30	<30 + Standby Mode	<u>7HA Gas Turbine GE</u> <u>Gas Power</u>

<u>Result of significant investment from ~ 2000 - 2010</u>

- Recognition of change operation from primarily base load to intermediate (load following) service
- Gas and steam turbines benefited from jet engine technology
- HRSG's required upgrades including once-through (HP), attemperation & bypass legs



FLECCS Phase 2

- Recommend DOE & industry <u>continue</u> to address these integration and system level challenges
 - Steady state operation of components is not sufficient, integrated dynamic system-level modeling and analysis required
 - Need collaboration among NGCC OEM's & ISP's, plant owners & operators, CCS process developers, pipeline/sequestration stakeholders



ARPA-E: Industrial Heat Programs & Initiatives

- HITEMMP: High temperature, high pressure, efficient, and highly compact heat exchangers
- ROSIE: New technology pathways to enable zero direct process emissions in ironmaking (i.e., zero-process-emission ironmaking) and ultra-low life cycle emissions for steelmaking at scale
- Nuclear Heat (pre-FOA): Nuclear fission for zero-carbon, sustainable industrial heat



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ROSIE Revolutionizing Ore-to-Steel to Impact Emissions

Program Objectives:

- Encourage the development and scaling of innovative technologies while addressing challenges facing the iron and steel industry (e.g., regulations, reductant availability, electricity price uncertainty, feedstock availability)
- Exploit recent advances in electrolysis, plasma technology, and separations chemistry; as well as changes in the availability of waste tailings for processing, domestic sourcing incentives, and the development of new mining technologies
- Fund the development and demonstration of novel technologies that produce ironbased products from iron-containing feedstocks without process emissions in the ironmaking step

Program Goal:

 Demonstrate a zero-GHG path to cost parity with traditional incumbent carbothermic blast furnace technology







ARPA-E Summit 2024

Bolder Today, Brighter Tomorrow

CLIMMAT DUOTO CALLEDY

arpa.e energy innovation summit

May 22-24, 2024 | Dallas, Texas





Home (arpae-summit.com)





lf it works...

will it matter?





https://arpa-e.energy.gov



- Joined ARPA-E in December 2021 as a Technology-to-Market Advisor. Supporting programs in power generation (FLECCS), high temperature materials & coatings (ULTIMATE), nuclear fission (GEMINA, OPEN), and power distribution (GOPHURRS)
- Previously served with General Electric for 29 years with roles at GE Power and GE Global Research Center (GRC).
- Product Manager for the 9HA.02 Gas Turbine and Combined Cycle Power Plant.
- PhD in Mechanical Engineering from Rensselaer Polytechnic Institute. MS in Nuclear Engineering and BS in Nuclear Engineering & Mathematics at the University of Wisconsin-Madison.
- Awarded 38 patents

