Enabling a Net-Zero Energy Future

Driving Innovation. Delivering Solutions.

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Resource Sustainability Annual Proj. Rev. Meeting
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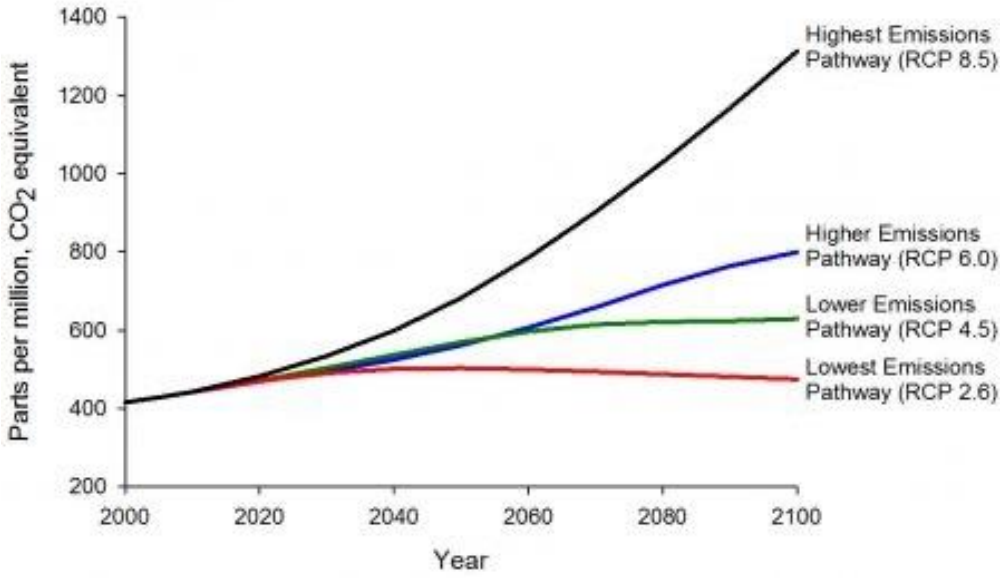
U.S. DEPARTMENT OF ENERGY | NATIONAL ENERGY TECHNOLOGY LABORATORY

We do not inherit the earth from our ancestors, we borrow it from our children

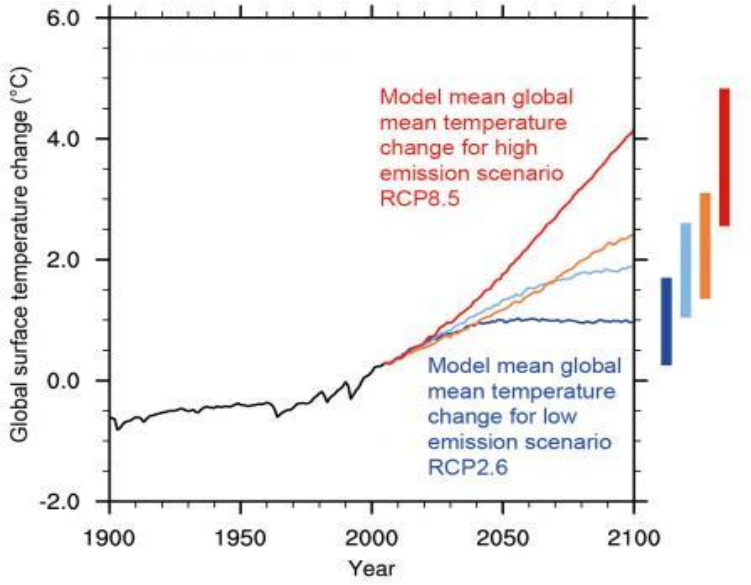
- Unknown

Climate Change – Urgency

Projected Atmospheric [CO_2]



Projected Global Temp. Increase



Transition to a Carbon-free Economy

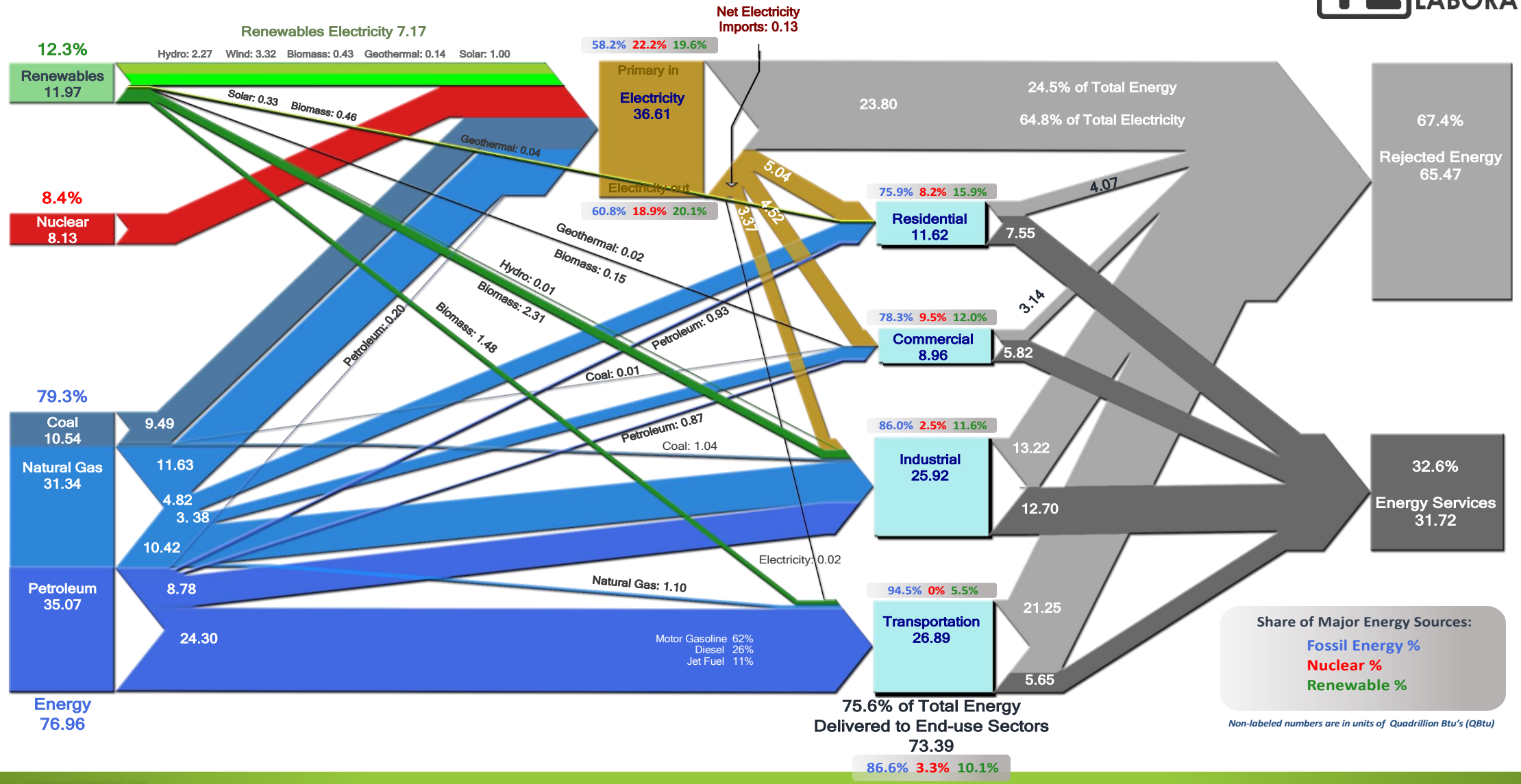
- President Biden's goals:
  - 50% emissions reduction by 2030
  - CO_2 emissions-free power sector by 2035
  - Net-zero emissions economy by 2050
- Industrial Perspective:
  - Sustainability, carbon management, decarbonization

Tackling the Climate Crisis

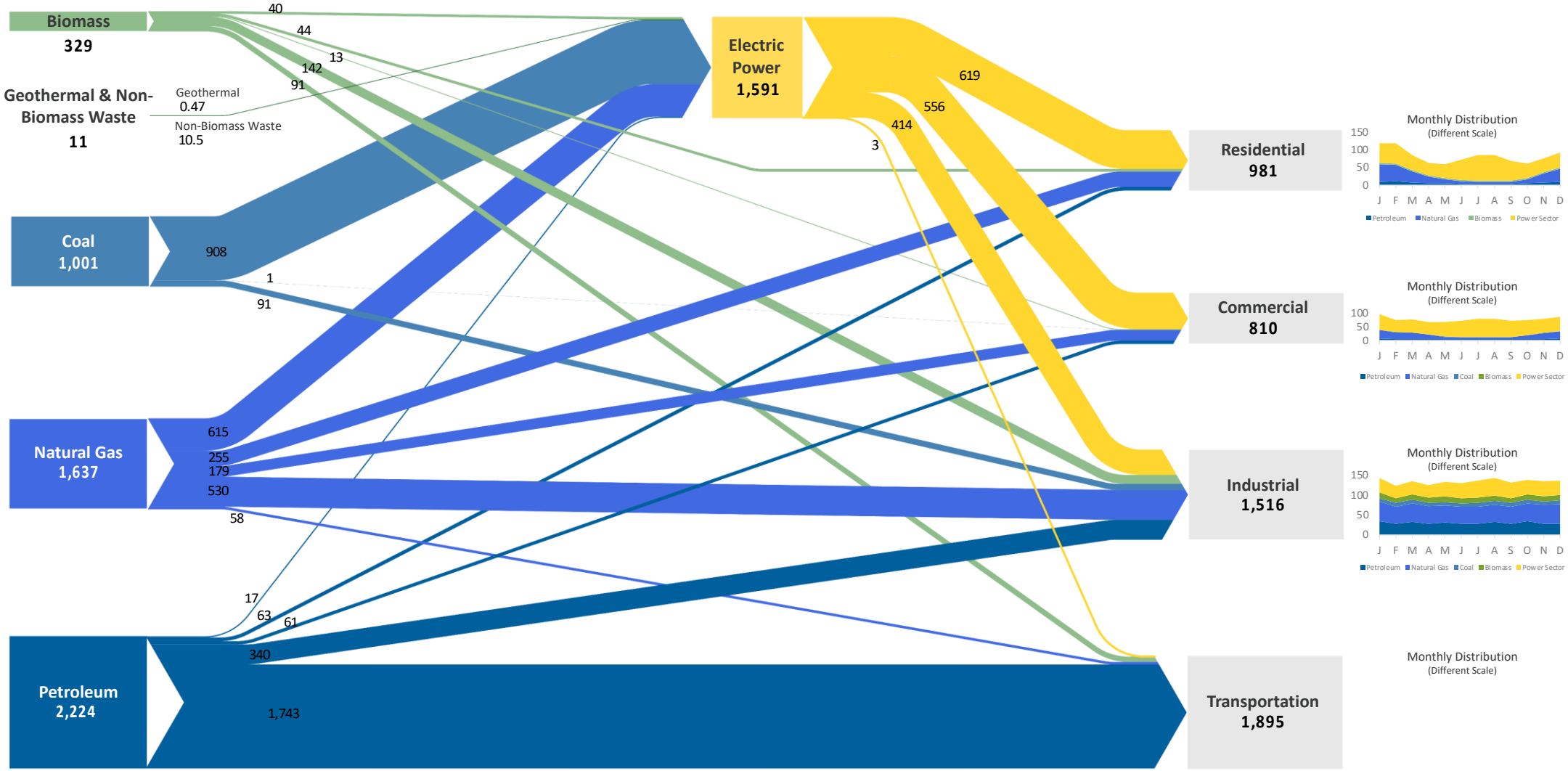
Advancing Environmental Justice

Domestic Clean Energy Manufacturing

2021 Est. U.S. Energy Consumption : 97 Quads



2021 Est. U.S. Energy-Related CO_2 Emissions: 5,202 MT



Taking Action!

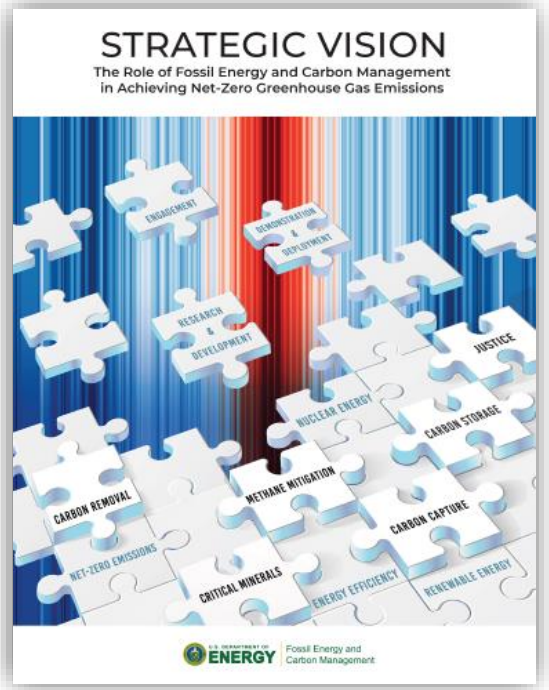
- **Largest fundings ever received by DOE**

BIL

IRA

- **Realignment of DOE**

- **A new FECM Vision**

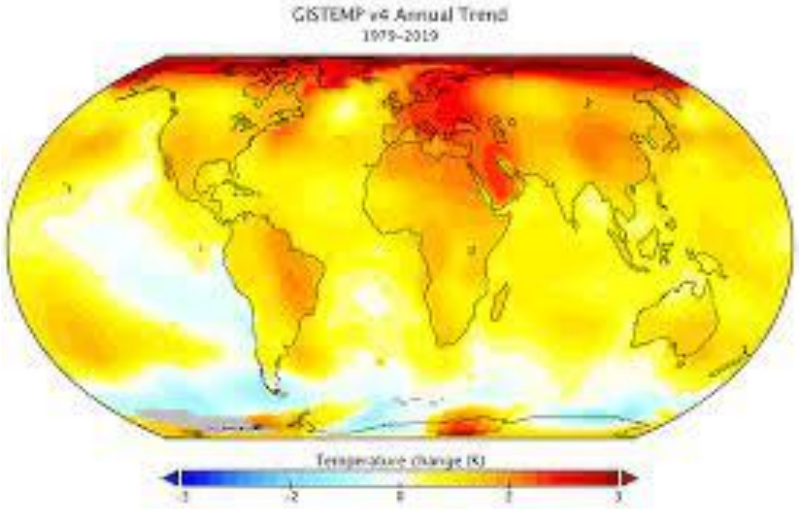


The National Laboratory System

>60,000 Staff, >$50B Infrastructure

Rapid solutions to National Emergencies

Provide solutions to difficult problems



Conduct enduring research for long-term national benefit

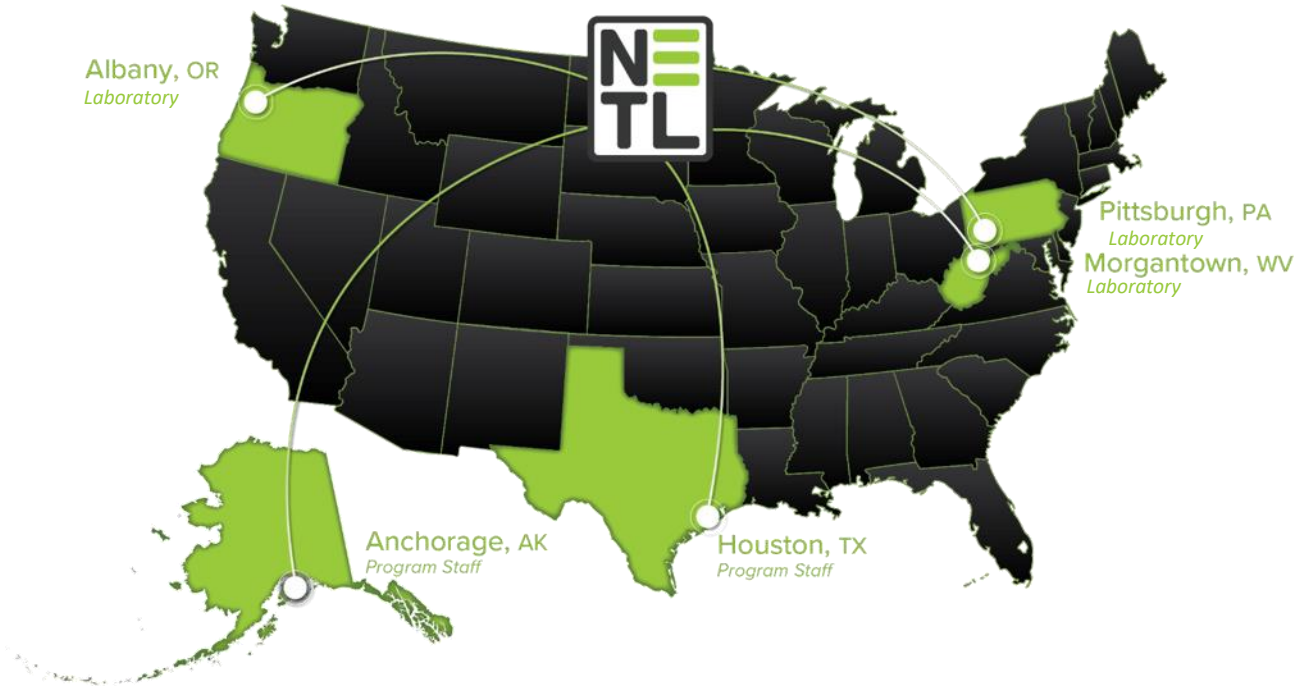
Leverage multi-disciplinary teams

Provide cutting edge technical facilities

https://en.wikipedia.org/wiki/Deepwater_Horizon_explosion
https://climate.nasa.gov/blog/3017/making-sense-of-climate-sensitivity/

Driving Innovation, Delivering Solutions

National Energy Technology Laboratory (NETL) is **one of 17** U.S. Department of Energy (DOE) national laboratories; producing technological solutions to America's energy challenges.



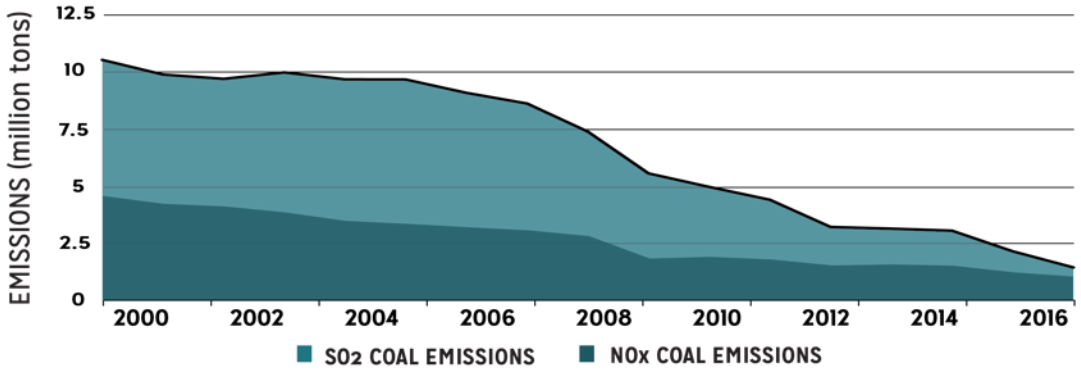
- NETL has **3-R&D Campuses**
- Only National Lab **dedicated carbon research**
- Only GOGO DOE Lab
- **One of three applied** national labs
- **Over a century** of innovation and solutions

MISSION **Discover**, **integrate**, and **mature** technology solutions to **enhance** the nation's energy foundation and **protect** the environment for future generations.

A History Delivering Solutions

Reduced the Impact of SOx & NOx

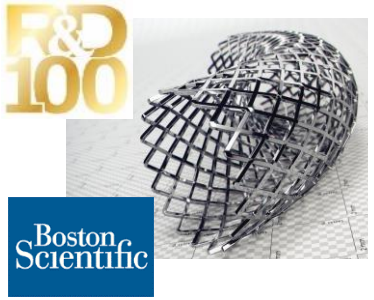
- NETL significantly contributed to cost reductions of SO_x & NOx controls for power plants resulting In greater than 82% and 88%



Lighter, Safer, & Cost-Effective Armor for the Warfighter

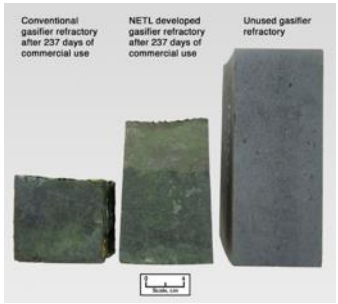
- Work with TACOM & ARL
- Used in military activities since 1990's
- Since 2008, when used, armor decreased casualties by over 50%

Thinner, More Flexible Stents



- 3rd gen. of stent has coronary & non-coronary applications
- One of the leading stent platforms in the world with total sales exceeding $18 billion.
- BSCI maintains a 45% share of the U.S. market & a 35% global share of the overall stent market using the platinum/chromium

Durable Refractory Brick Improves Service Life & Costs

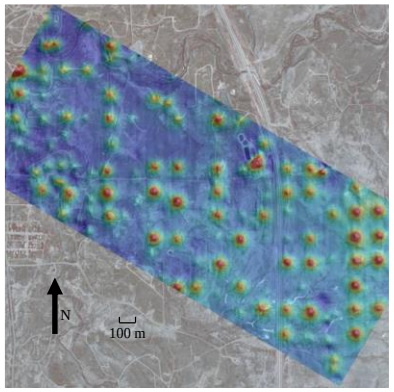


- Licensed to Harbison-Walker, commercially produced as Aurex 95
- Used in nearly every slagging gasifier world-wide, NETL technology doubled refractory service life
- Represents the most significant improvement in these technologies in more than 30 years

NETL Technical Capabilities

Computational Science & Engineering

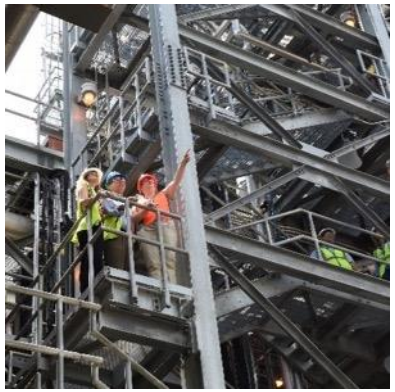
Materials Engineering & Manufacturing



Geological & Environmental Systems

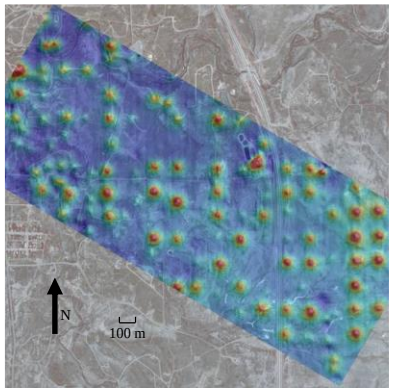
Energy Conversion Engineering

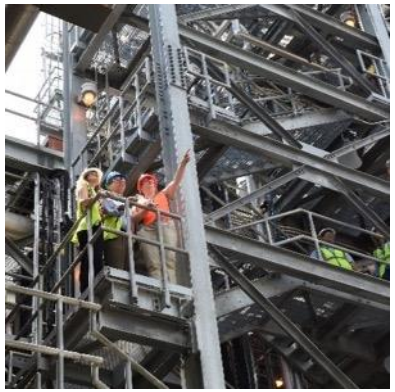
Strategic Systems Analysis & Engineering



Program Execution & Integration

NETL Themes Enabling Solutions





Computational Science & Engineering	Materials Engineering & Manufacturing	Geological & Environmental Systems	Energy Conversion Engineering	Strategic Systems Analysis & Engineering	Program Execution & Integration

Broad systems analysis guiding research, development, demonstration and deployment

Experiments at real conditions with real samples at right scales

Accelerating deployment via advanced modeling

Multi-disciplinary, solution driven teams

FECM Exciting Research & Development

Develop and deploy technologies and approaches to reduce the environmental impact of historic, current and future use of natural resources

- Critical Materials
- Carbon Ore Processing
- Methane Mitigation
- Water Management

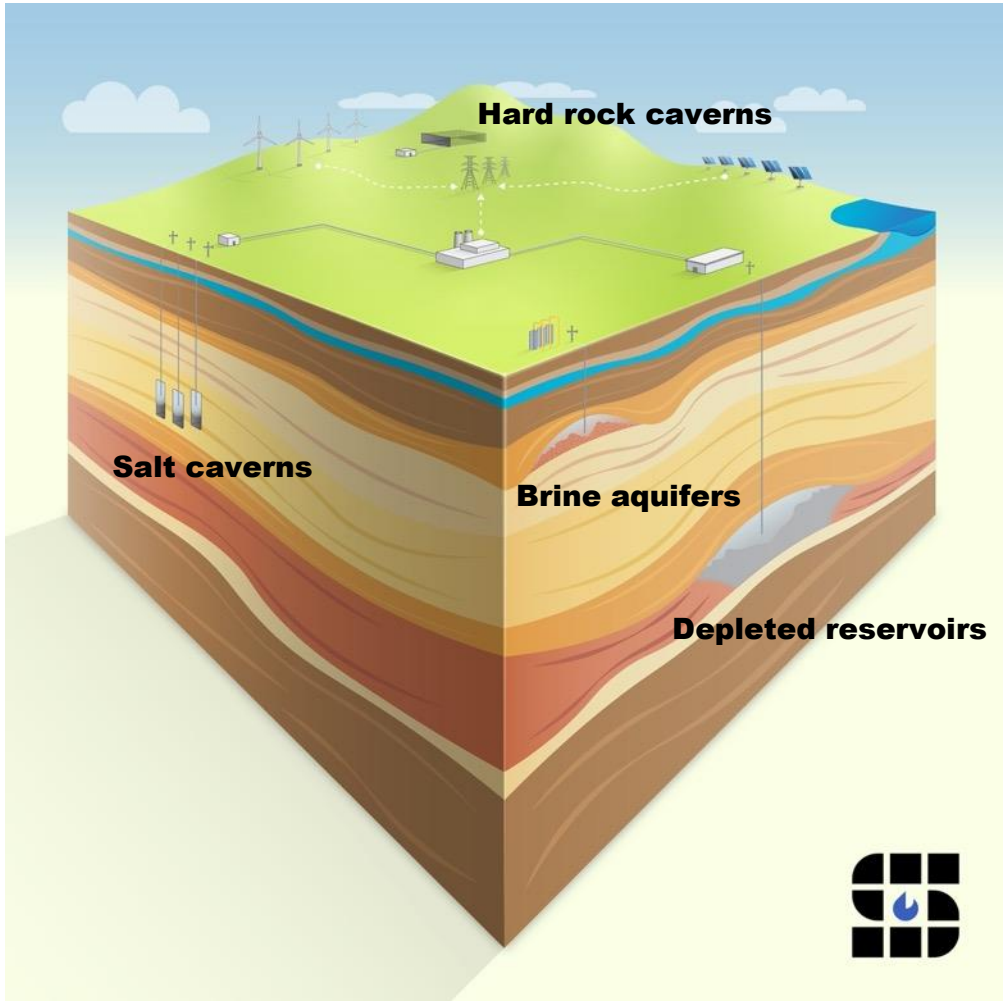
Tools to enable solutions

FECM's Subsurface H_2 Assessment, Storage, & Technology Acceleration

Goodman et al. – Tuesday Afternoon

SHASTA
Subsurface Hydrogen Assessment, Storage, and Technology Acceleration

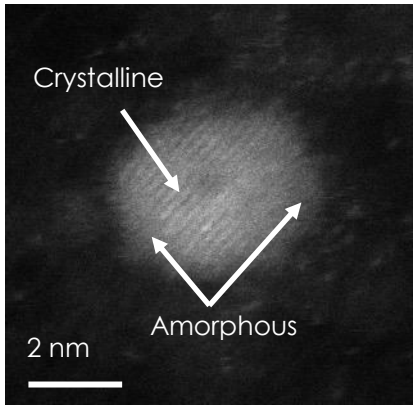
Identify and **address key technological hurdles** and **develop tools and technologies** to enable broad public acceptance for **subsurface storage** of pure hydrogen and hydrogen/natural gas mixtures

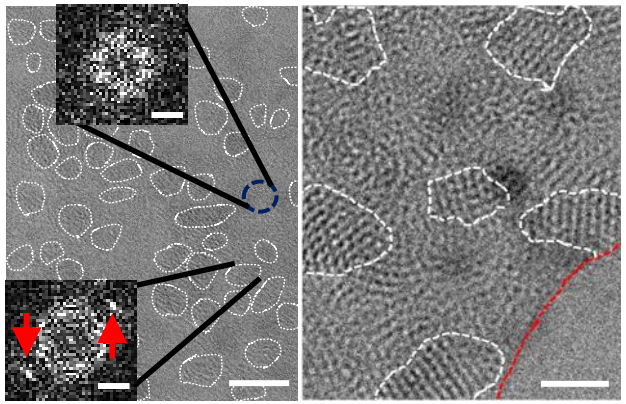


Carbon Electronics from Charred Carbon Wastes

Matranga et al. – Wednesday Morning

Memristor Computer Memory Devices





Memristor Memory Devices:

- Atomically thin **carbon** dielectric film invented that improves performance & facilitates miniaturization.
- Solution-based scalable manufacturing produces 3" prototypes & facilitates tech transfer to industry.
- Improves Memristor Performance:
  - Ultralow operating voltage (<0.4 V)
  - Fast switching time (<20 ns)
  - Low energy consumption (<20 fJ per operation)
  - Minimal device spatiotemporal variability
  - Outperforms metal oxides used in commercial devices
- Carbon film also demonstrated as gate dielectric in Field Effect Transistors (FETs)

FECM-NETL's Direct Air Capture (DAC) Center

NATIONAL ENERGY TECHNOLOGY LABORATORY

Supporting rapid technology development for atmospheric CO_2 capture

- ✓ Leverages national laboratory competencies to support private sector technology maturation
- ✓ Targets technologies beyond the conceptional stage but before full pilot scale – TRL 3 to 6
- ✓ Integrates experimental and modeling techniques to efficiently resolve scale-up issues
- ✓ Tests capture materials and processes under conditions representative of a variety of climates

CAPABILITIES

Lab-scale systems for novel solvent and sorbent material development	Bench-scale test beds with flexible reactor designs	Small pilot-scale bays for evaluating developer-built DAC skids	Advanced instrumentation with remote and autonomous operation	Air feed with a wide variety of environmental conditions	Compression and storage equipment for reuse of captured CO_2 at NETL

Develop, Demonstrate & Deploy

- **Challenge: We must act with a sense of urgency to combat climate change; it is a big, complex problem**
- **Alignment: Unprecedented government support; industrial priority**
- **Action: Partnership will be critical in developing a multitude of solutions**

The only limit to our realization of tomorrow will be our doubts of today.

- Franklin D. Roosevelt

Thank You!

CONTACT

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