

BNL Energy Strategy

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BROOKHAVEN
NATIONAL LABORATORY

a passion for discovery



Many DOE National Labs are strongly connected to their regions

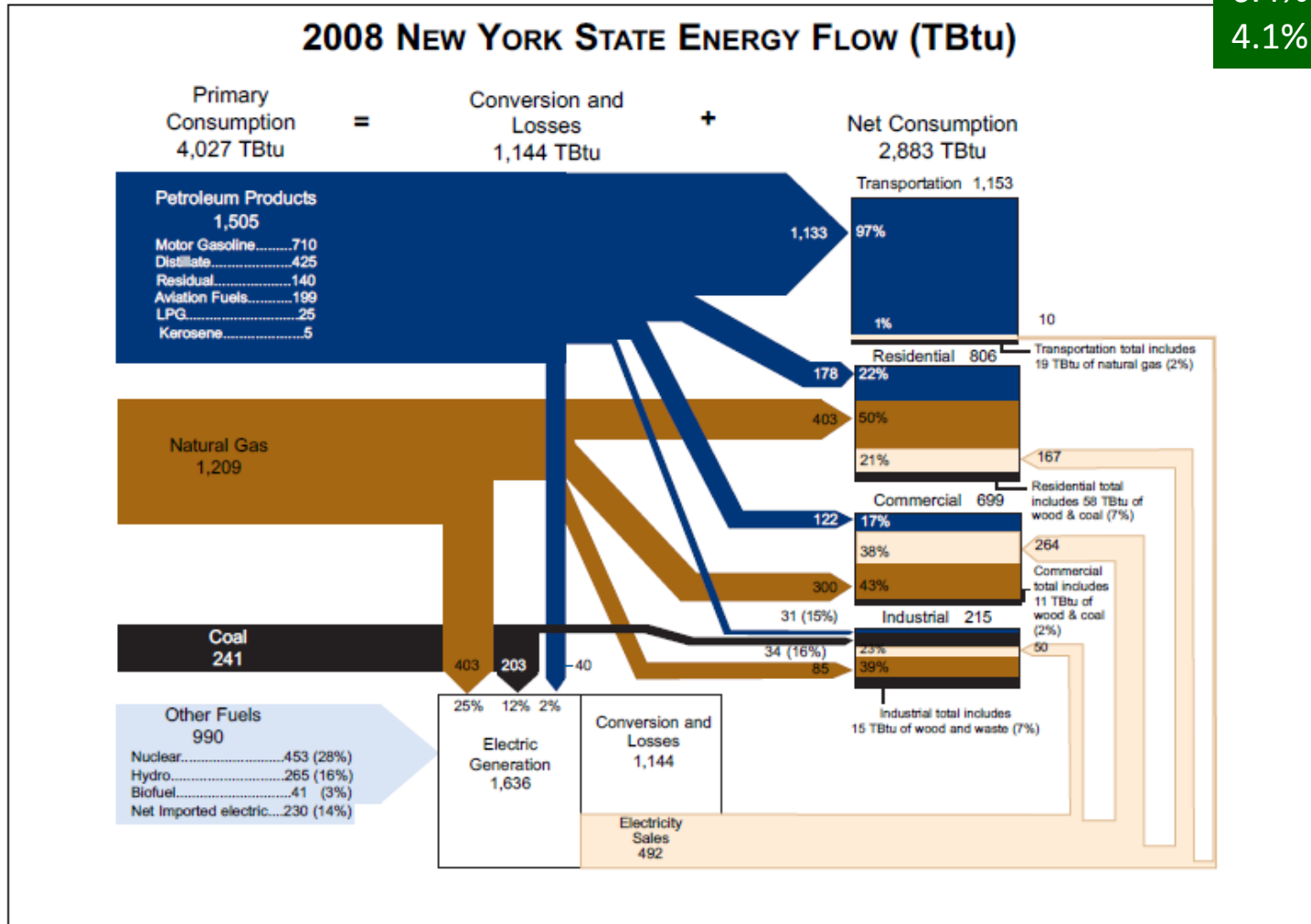
- Pacific Northwest National Lab has strong connection to the BPA and the transmission issues of the West.
- Oak Ridge National Lab has worked for many years with TVA and the utilities of the Southeast.
- More recently Brookhaven has been developing a similar set of relationships with New York and Northeastern grid issues.

The BNL strategy is a market back approach – starting with the State of New York

- BNL is not a large part of the DOE applied research portfolio.
- New York and the Northeast have some of the most pressing grid problems in the country –
 - Congestion (particularly NY)
 - Aging infrastructure
- Our goal has been to focus on solutions for the State of New York to both focus our portfolio and strategy.

New York and NY's problems don't look like the rest of the country...

6.4% of US population
4.1% of primary energy



New York Energy Flows (NYSERDA)

“Patterns and Trends: New York State Energy Profiles 1994-2008”,
New York State Energy Research and Development Authority.
<http://www.nyserdera.org/publications/default.asp>

Our selection of energy goals and focus areas are aligned with Executive Order 24: 80% Carbon Reduction by 2050

All scenarios to meet this goal suggest:

- Increased electrification, particularly in light vehicle transportation
- Displacement of fossil fuels with sustainable fuels

NYS Challenges

ELECTRIC SYSTEMS

- Must increase our efficiency (NY delivered electric eff. = 30%)
- Increased use of renewable generation (wind/solar)
 - Intermittency issues
 - Transmission
 - Reliability
- Ability to deliver/manage electricity
 - Grid congestion

SUSTAINABLE FUELS

- Displace fossil fuels with sustainable fuel sources

Brookhaven Basic Research

ELECTRIC SYSTEMS

- High efficiency organic photovoltaics
- Superconducting transmission
- Materials for batteries

SUSTAINABLE FUELS

- Engineered biosystems
- Catalysis for fuel cells
- Fuels from carbon dioxide

The BNL Strategy has 7 thrusts in two focus areas

- 1.0 Science technology for electric infrastructure
 - 1.1 De-carbonized generation
 - 1.2 Renewables integration
 - 1.3 Grid scale storage
 - 1.4 A robust & effective T&D system
- 2.0 Sustainable chemical conversions
 - 2.1 Solar-to-fuel conversion through oxidation-reduction reactions
 - 2.2 Improved catalysts for synthesis of fuels by sustainable pathways
 - 2.3 Electro-catalysis chemical-electrical conversion in fuel cells
- The outcomes implicit in the 7 thrust areas are also of national and global interest

Brookhaven Energy R&D: A Collaborative Approach

Basic Research, Applied Research, and Industry Working Together

BNL Resources



BNL
Research



NY State Consortia/Resources

ENERGY CHALLENGES: New York and Beyond

Electric Systems

Sustainable Fuels

DOE ALIGNMENT/LEVERAGE

DOE Priority Research Directions

4 Energy Frontier Research Centers

Collaborators/Joint Appointments



Rensselaer



R·I·T



SYRACUSE

IBM



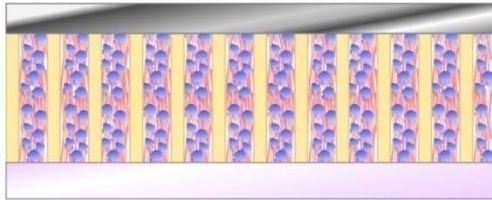
BROOKHAVEN
NATIONAL LABORATORY

Brookhaven Electric Grid R&D

Generation

Organic photovoltaics

- Inexpensive for large scale deployment
- Issue of efficiency



- **BNL Contribution**
- Nano-structured PV with double the efficiency per active unit area

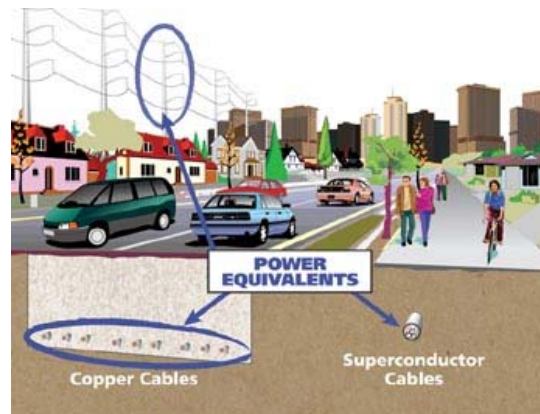


Brookhaven Science Associates

Transmission

Superconducting Lines

- Power density driver



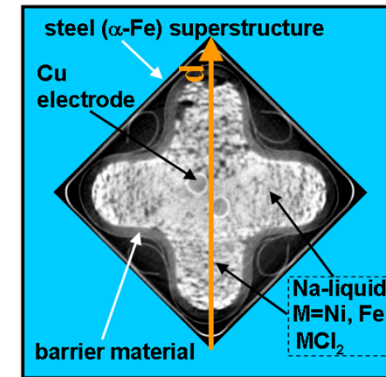
- **BNL Contribution**
- Reel-to-reel growth of superconducting materials



Storage

Batteries

- X-ray probes, materials



- **BNL Contribution**
- X-ray tools probing real batteries in operation
- **SMES**
- Grid scale storage

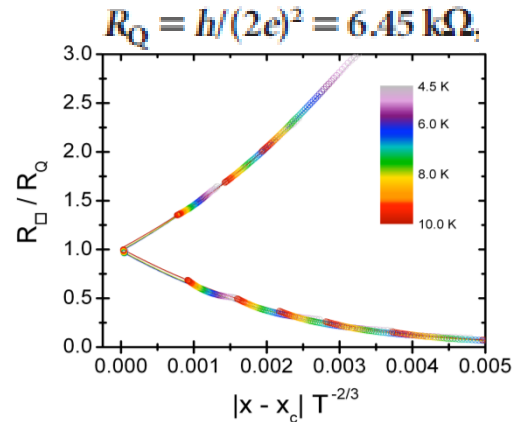


Electric Infrastructure: Advanced Materials for Renewables Integration

DOE – BES

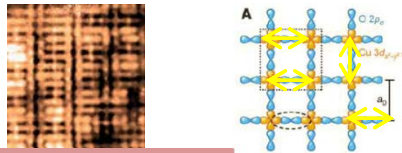
Unraveling the nature of HTS

Critical point at the pair quantum resistance

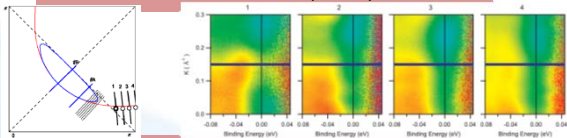


Nature 472, 458 (2011)

Evidence for Localized Pairing in the Normal State



STM - Nature 466, 374 (2010)

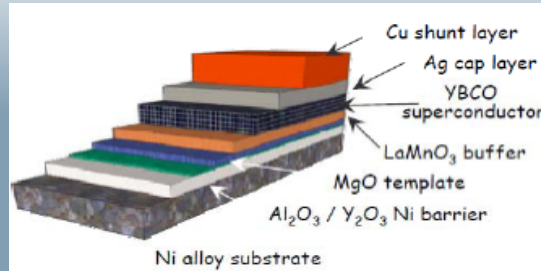


ARPES - Nature 456, 77 (2008)

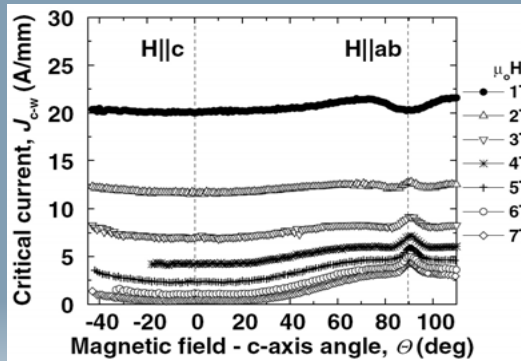
DOE (BES & EERE)

Improved Critical Properties

2G YBCO Coated Conductors



Sub-atmospheric growth process enables reel-to-reel production of long length HTS tapes (BNL Patent)

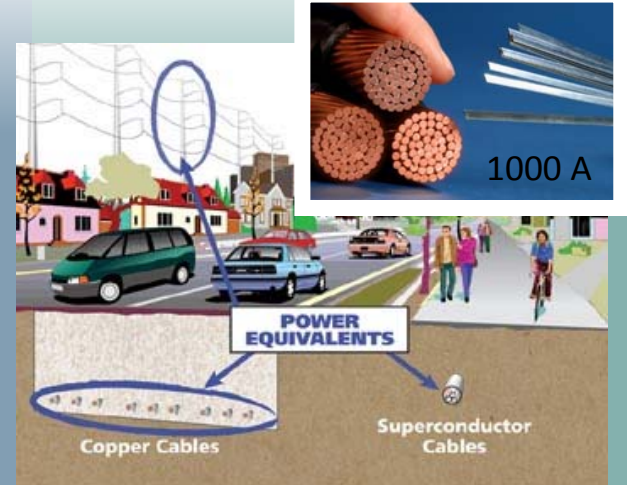


Engineering strong/isotropic pins to achieve record high $J_c(H)$ and T_c in $\text{YBa}_2\text{Cu}_3\text{O}_7$ for HTS cables

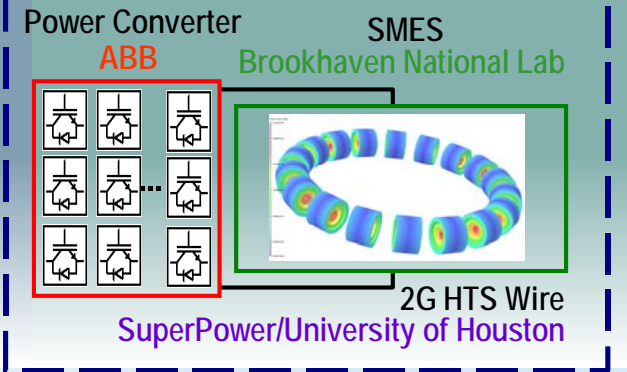
BNL-Industry CRADA / ARPA-E

HTS Cables, SMES

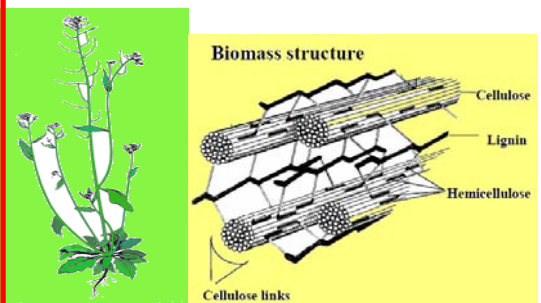
High Capacity, Fault-limiting



GRIDS SMES SYSTEM



Thermochemical Conversion of Biomass to Renewable Fuels – reaching back into basic research




Biomass structure

Cellulose
Lignin
Hemicellulose
Cellulose links

Arabidopsis **Biomass Structure**

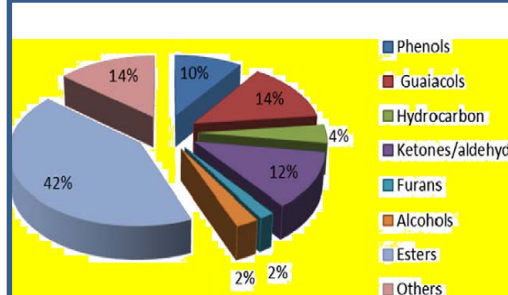
ELS: BIOLOGY

High-pressure pyroprobe

GC-MS

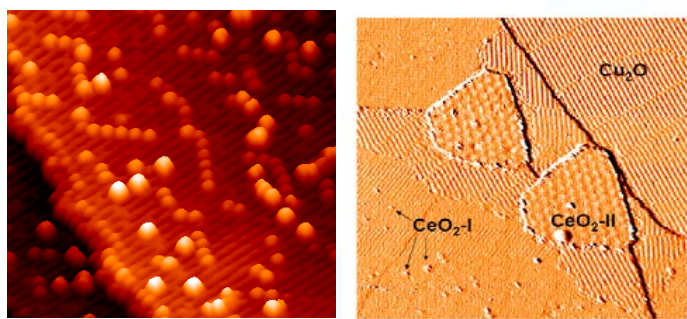
GARS: SET



Product Category	Percentage
Phenols	42%
Guaiacols	14%
Hydrocarbon	10%
Ketones/aldehydes	14%
Furans	4%
Alcohols	12%
Esters	2%
Others	2%

Characterization of thermochemical conversion products for conditioning and conversion

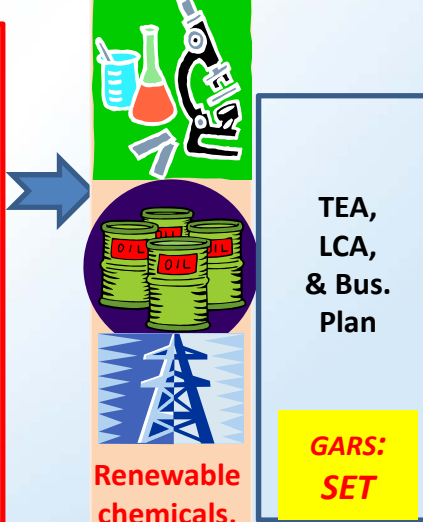
GARS: SET

BNL's proprietary low-cost and low-temperature nano-catalysts with tailored crystalline structure for product conditioning and synthesis

150nm x 150nm

BES: CFN-CHEMISTRY

TEA, LCA, & Bus. Plan

Renewable chemicals, Fuels, and power

GARS: SET

BNL's Vision for a Smarter Grid Test Bed & Simulation Lab

