

BROOKHAVEN NATIONAL LABORATORY

BIOFUELS FOR STEAM PRODUCTION

Brookhaven National Laboratory

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BROOKHAVEN
NATIONAL LABORATORY

a passion for discovery

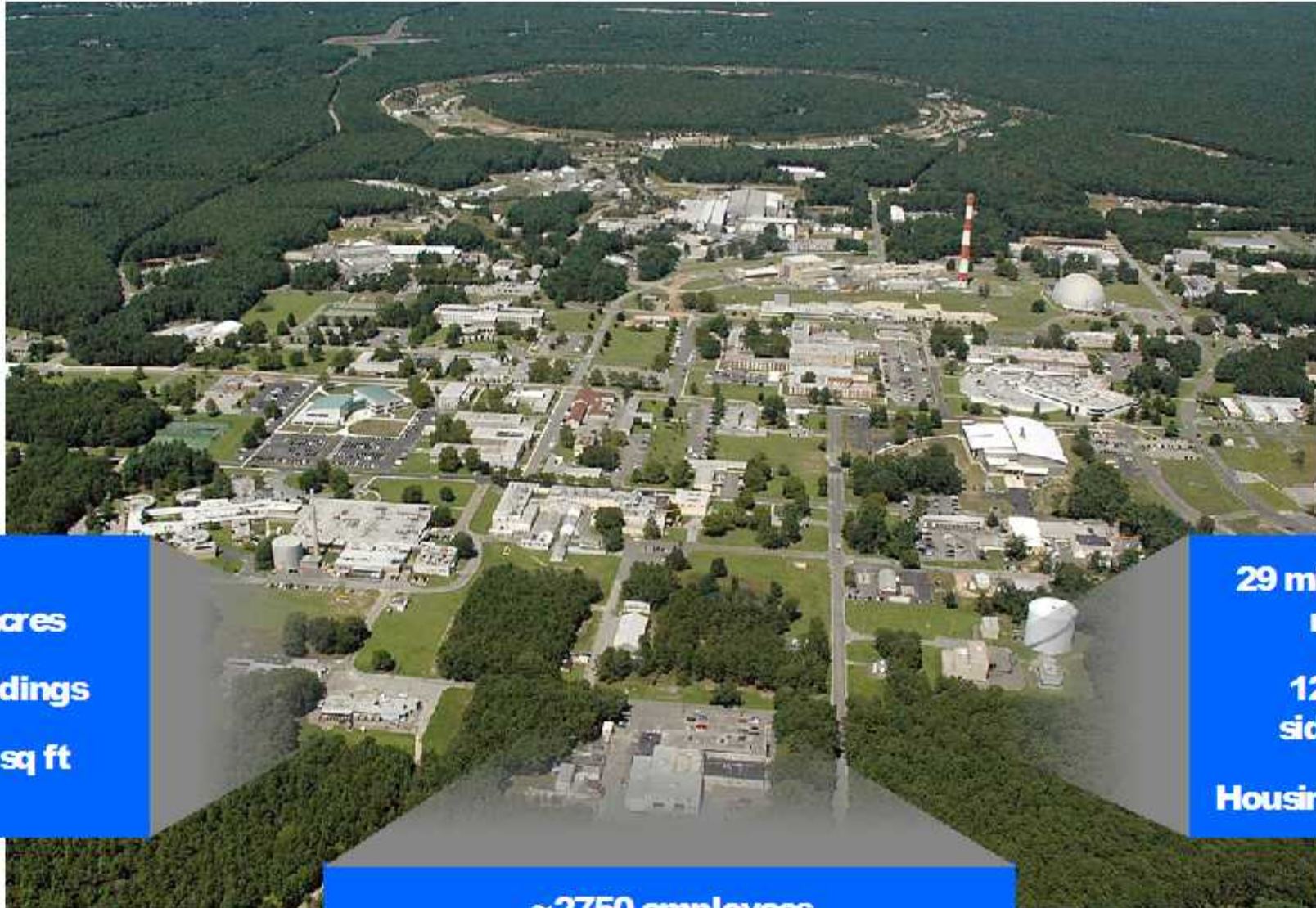


Today' s Discussion



- Brookhaven National Laboratory (BNL)
- Energy Conservation and Sustainability Efforts at BNL
- Biofuel for Steam/Electricity Production

Brookhaven National Laboratory *A passion for discovery*



5321 acres
350 buildings
~4.2M sq ft

29 miles paved roads

12 miles sidewalks

Housing for ~800

~2750 employees

>4000 guest users per year

FY08 Funding \$532M

Brookhaven Strategic/Business Plan

CFN/Nanoscience



NSLS II



New York Blue



**Core Programs
BES BER
EENS**

Materials for Catalysis: New nanocatalysts with enhanced loading/activity/tolerance

Solar Nano-materials: Create nano-structured *materials and assemblies* for higher efficiency, cost-effective photovoltaic devices/fuel generation.

Energy Storage Materials: Create and understand materials to increase density and stability of storage

Electric Grid Materials: Improve our understanding of strong electronic correlations for enhanced physical properties (e.g. T_c , J_c , ZT) of grid materials.

Biofuels: Lignocellulose breakdown, biomass enhancement, engineered plant production.

Collaborators/Joint Appointments



Discovery to Deployment

Energy and Environment

Conventional Energy Sources - Supplies Limited

Coal, Oil, Natural Gas, Nuclear, Hydro

Fossil Fuels – Stored Energy, but...

Burning Adds CO₂ to Atmosphere

Climate change

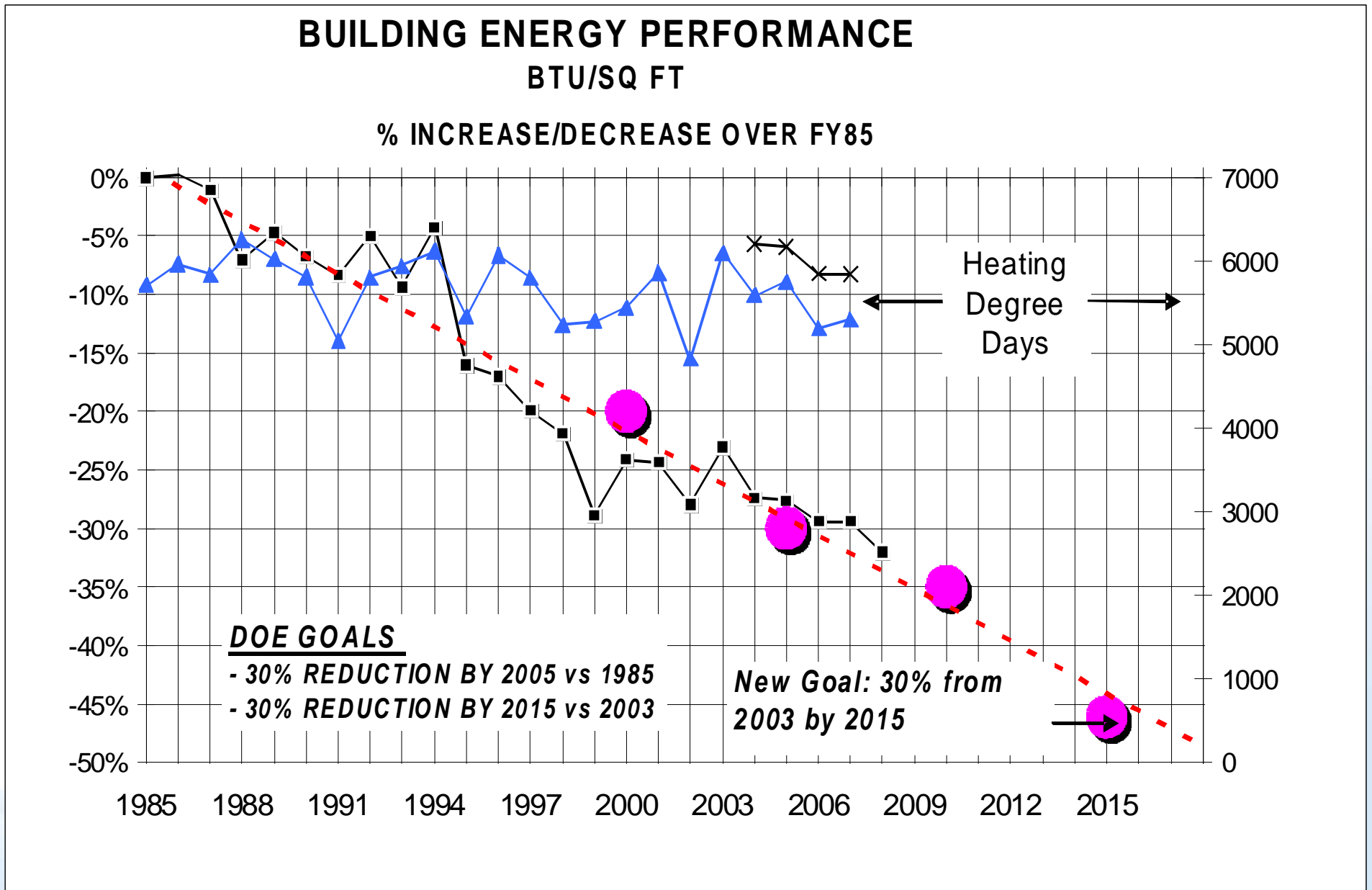
Potential to impact to all of us and future generations

Other negative impacts – pollution, health, etc.

We Must Find Alternatives and Be Efficient

Innovation will be key

BNL's Energy Efforts – Some History

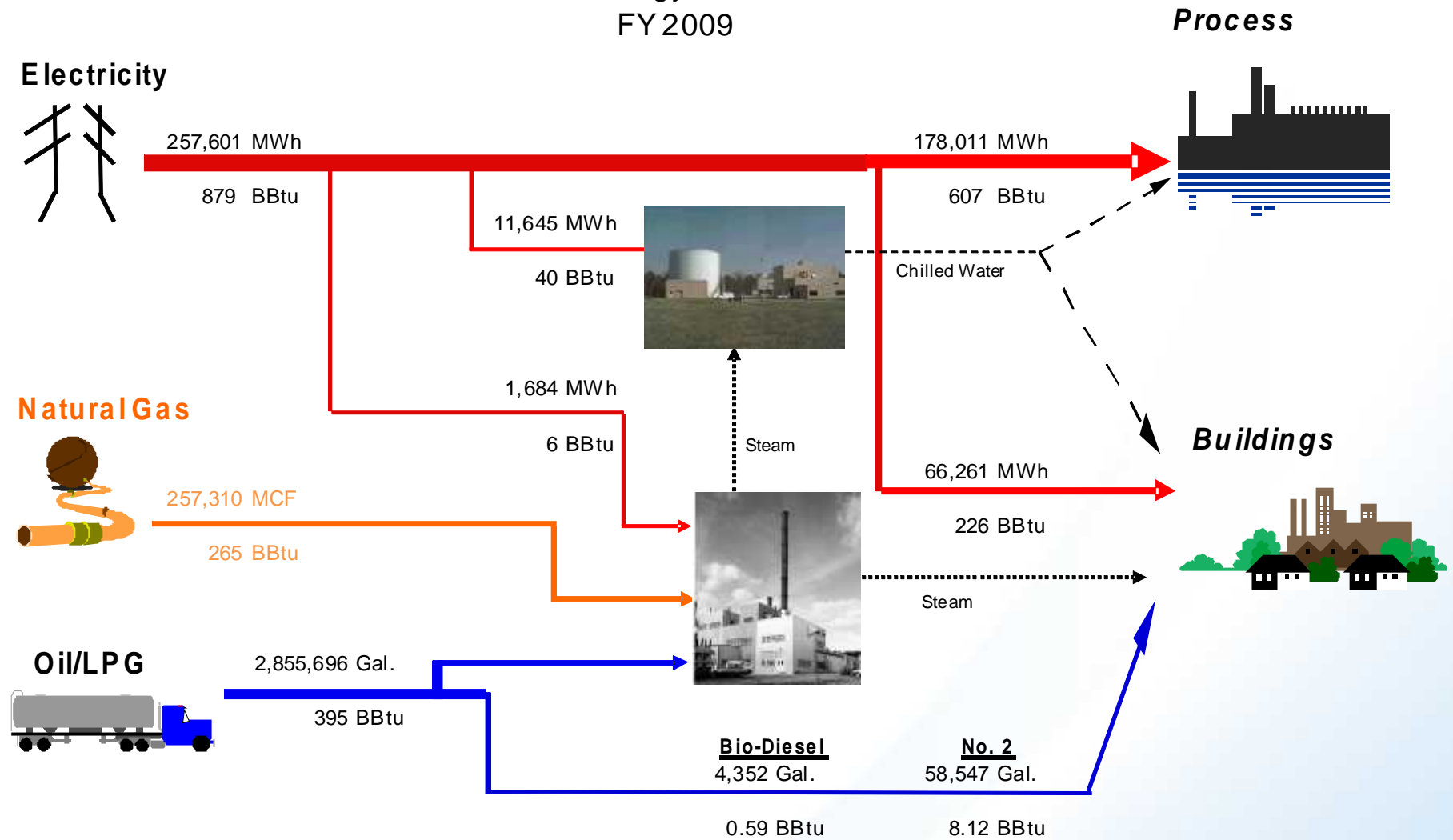


GOALS

- Continue to meet or exceed energy reduction goals.
- **Reduction of CO₂ emissions.**
- Move BNL to use of sustainable fuel/energy sources.
- **Apply best existing technologies.**
- Integrate innovations resulting from basic research into the full-scale implementation on a continuous basis.
- **Create innovative partnerships between BNL, government agencies, industry, universities, and public groups.**



Brookhaven National Laboratory Energy Use FY 2009

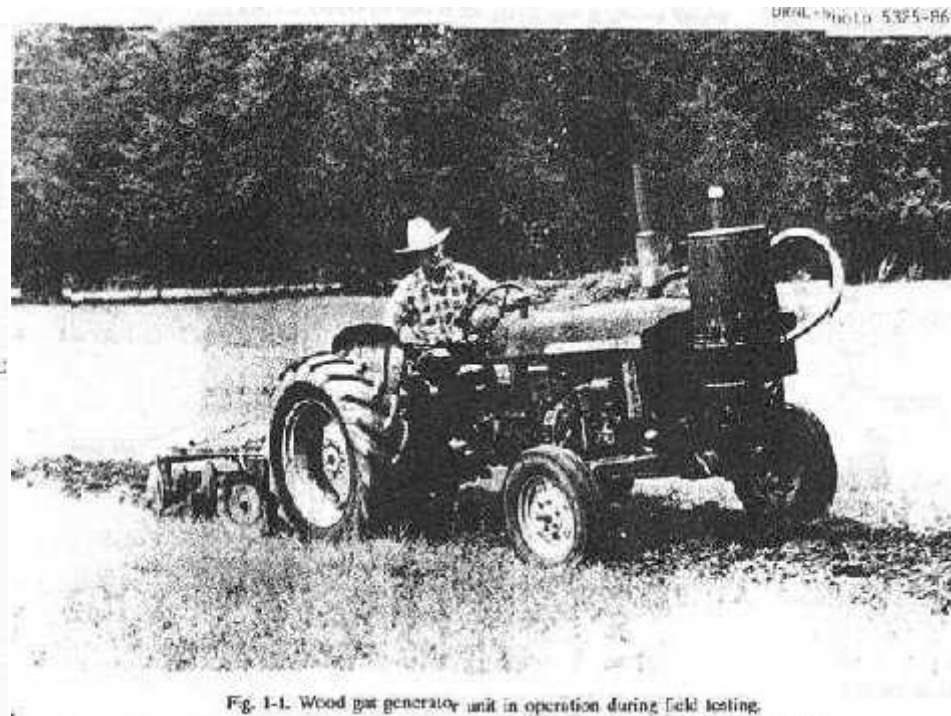
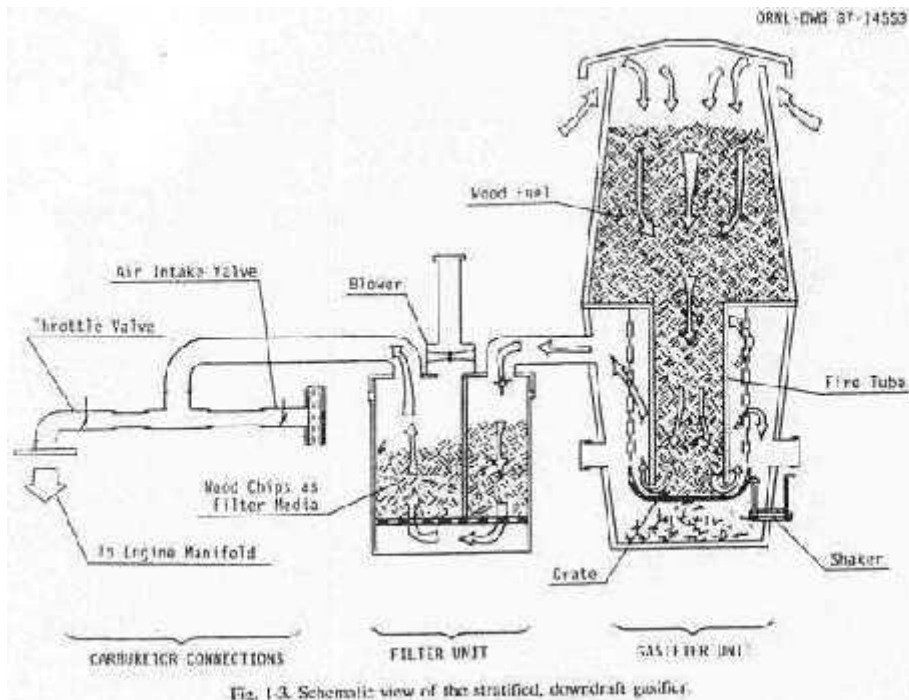


Sustainable fuel could produce $\sim 500 \times 10^9$ BTU/year

SUSTAINABLE ENERGY OPPORTUNITIES

- BNL/DOE commissioned a study in 2008 to evaluate possible sustainable energy opportunities at BNL.
- Looked at use of solar, geothermal, biofuels, wind, etc.
- Biofuels were determined to be suitable for use.
- Biodiesel and wood-derived gas for BNL steam and possible electric production potentially viable.
 - May be able to produce ~80% of steam needs (500k mmBtu)
- Biodiesel is commercially available and test burns can be arranged immediately.
- Further evaluation of a wood gasification facility at BNL is underway.

Gasification Diagram



The basics of wood gasification shown above are from a report on
“Construction of a Simplified Wood Gas Generator for Fueling Internal
Combustion Engines in a Petroleum Emergency

We will apply present technology to meet our present petroleum problems

Wood Supply

- ~54,000 tons/year needed to fuel the steam plant.
- **Wood from tree-trimming and other sources is now available from Long Island.**
- **Other sources of waste wood identified in the region.**
- **In the long term, wood from dedicated tree farms close to BNL may be an option.**
 - Enable a closed-loop system
 - Wood char from gasification can be returned to the farm for soil enrichment
- **Key for success is a long-term, favorable supply contract**

PILOT SCALE TREE FARM

- Pilot scale would be 10 acres in size
- Test five species of plants that have already been shown to be excellent short-rotation woody crop species
 - Poplar, sweet gum, sycamore, willow and pine, others
- Plants would be grown under different treatment/agricultural conditions currently under study at BNL to test for optimum growth



FULL SCALE TREE FARM

- **Require approximately 2500 acres**
 - 500 acres harvested annually
- **Find non-agricultural land for tree farm**
- **First crop of hybrid poplar to be planted as soon as possible**
 - **Other plantings done as results from pilot scale plot are obtained**



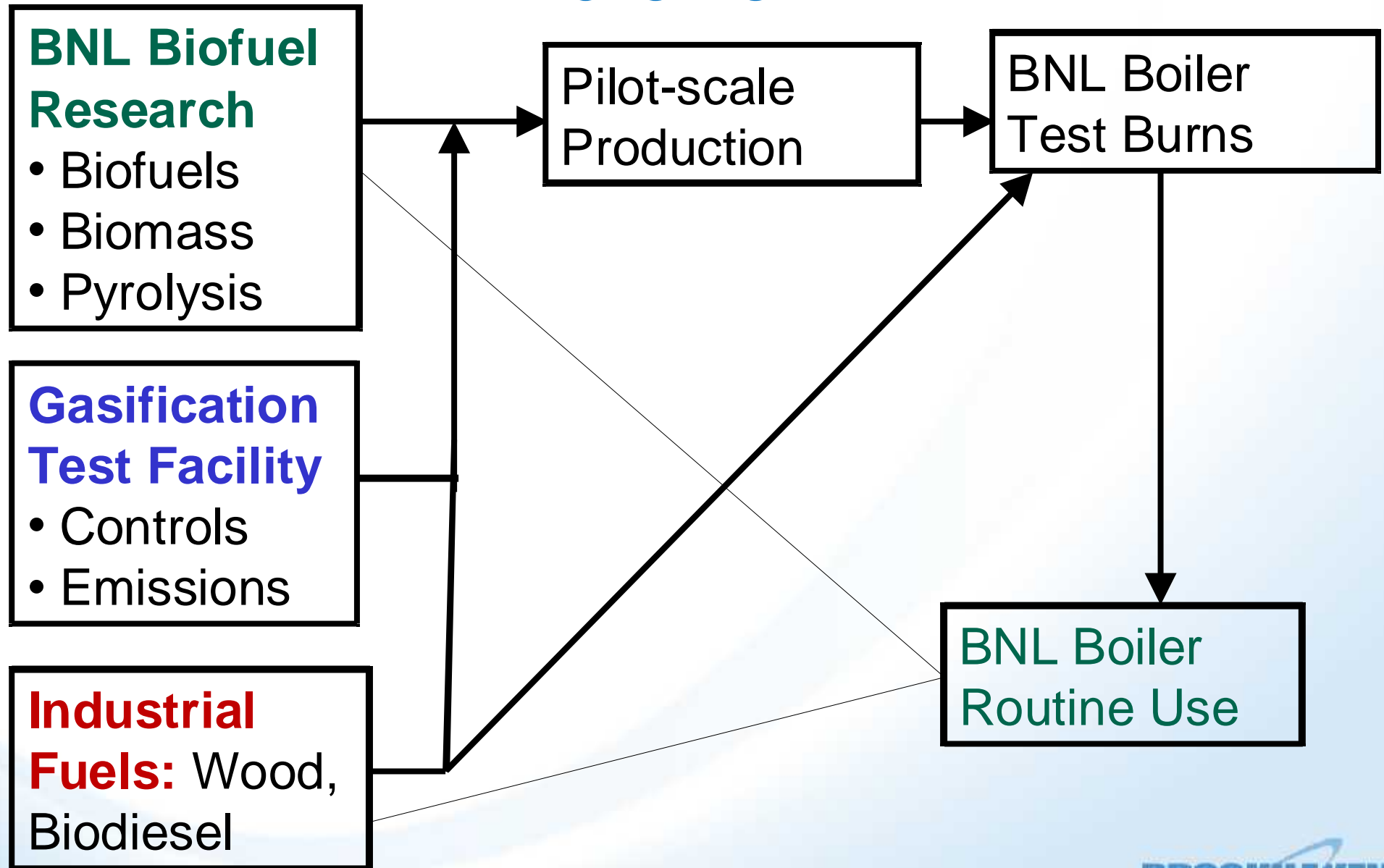
6-year old hybrid
Poplar tree

Pilot Scale Test Facilities

- **Pilot-scale testing of fuel performance will be carried out at a test facility that runs at an input rate of 1-1.5 million BTU/hour (top picture). Emissions of gases and particulate matter are measured to ensure the emissions do not exceed EPA standards (bottom picture).**
- **We will use these units to optimize steam production and minimize emissions with existing fuels and for fuels developed as a result of basic research activities.**
- **Integration of wood gasification units with the combustion process will be done prior to full-scale use.**



BNL-INDUSTRY COLLABORATION ON INTEGRATION RESEARCH, DEVELOPMENT, and APPLICATIONS OF BIOFUELS



ECONOMICS

Prediction is difficult, especially about the future. – Niels Bohr

- **WOOD:** Long-term supply with competitive pricing crucial
 - \$4 to \$5/mmBtu to be financeable in current fuel market
- **BioDiesel:** Premium compared to conventional fuel
- **Carbon tax:** Unknown impact, but will favor many biofuels
- **Future speculations?** (see comment above)



Summary

- **Biofuels can be used to reduce/eliminate fossil fuel use at the BNL steam plant**
- **They can be economically and environmentally acceptable**
- **Use of wood as one fuel could result in a close to carbon neutral operation**
- **Introduction of technology developments by integrating research, development and operational groups**
- **Full-scale operations could be achieved by 2020**

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