



Coal Quality Requirements for Next Generation Power Production

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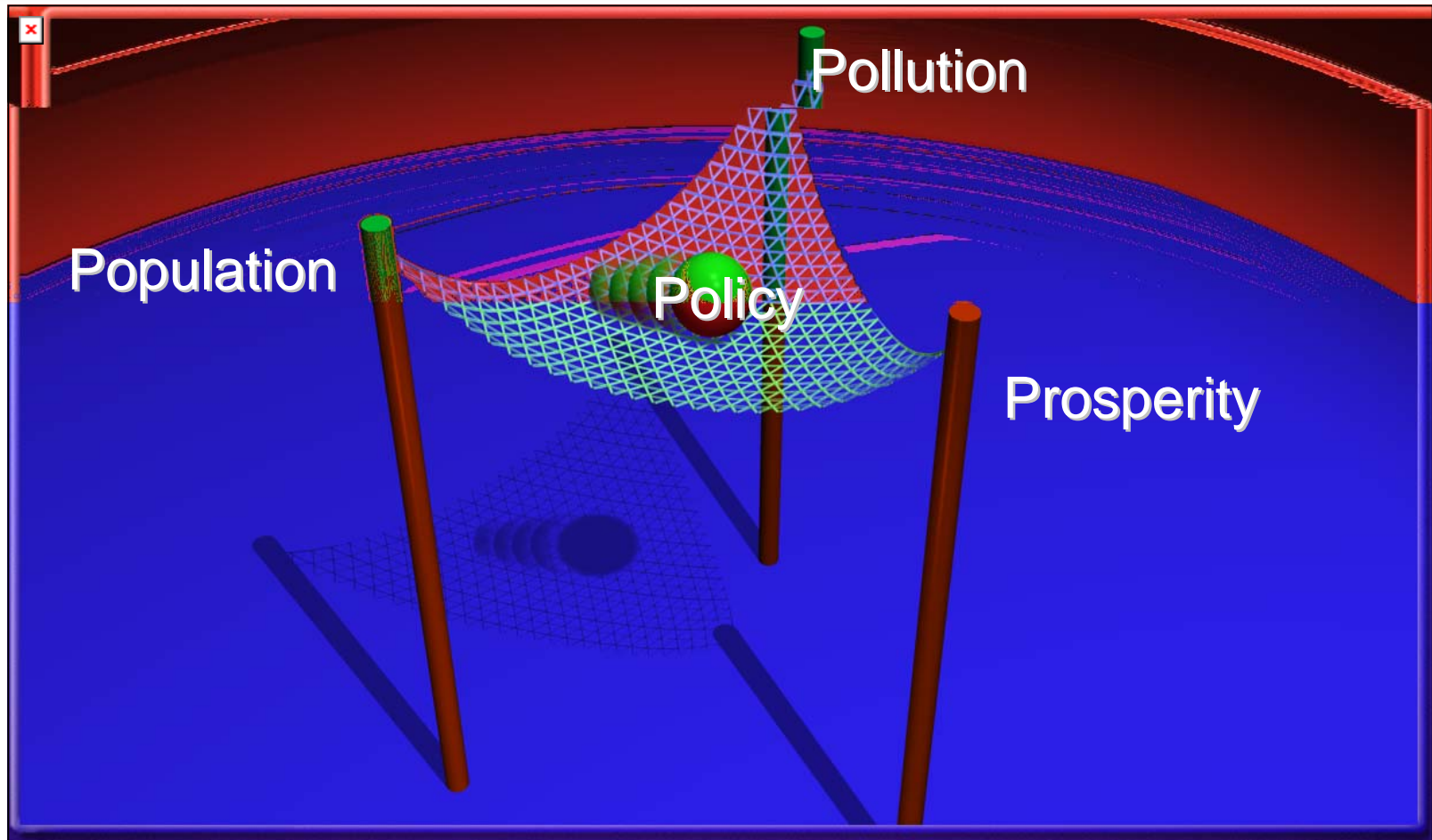
Manager, Combustion

Generation Product Sector

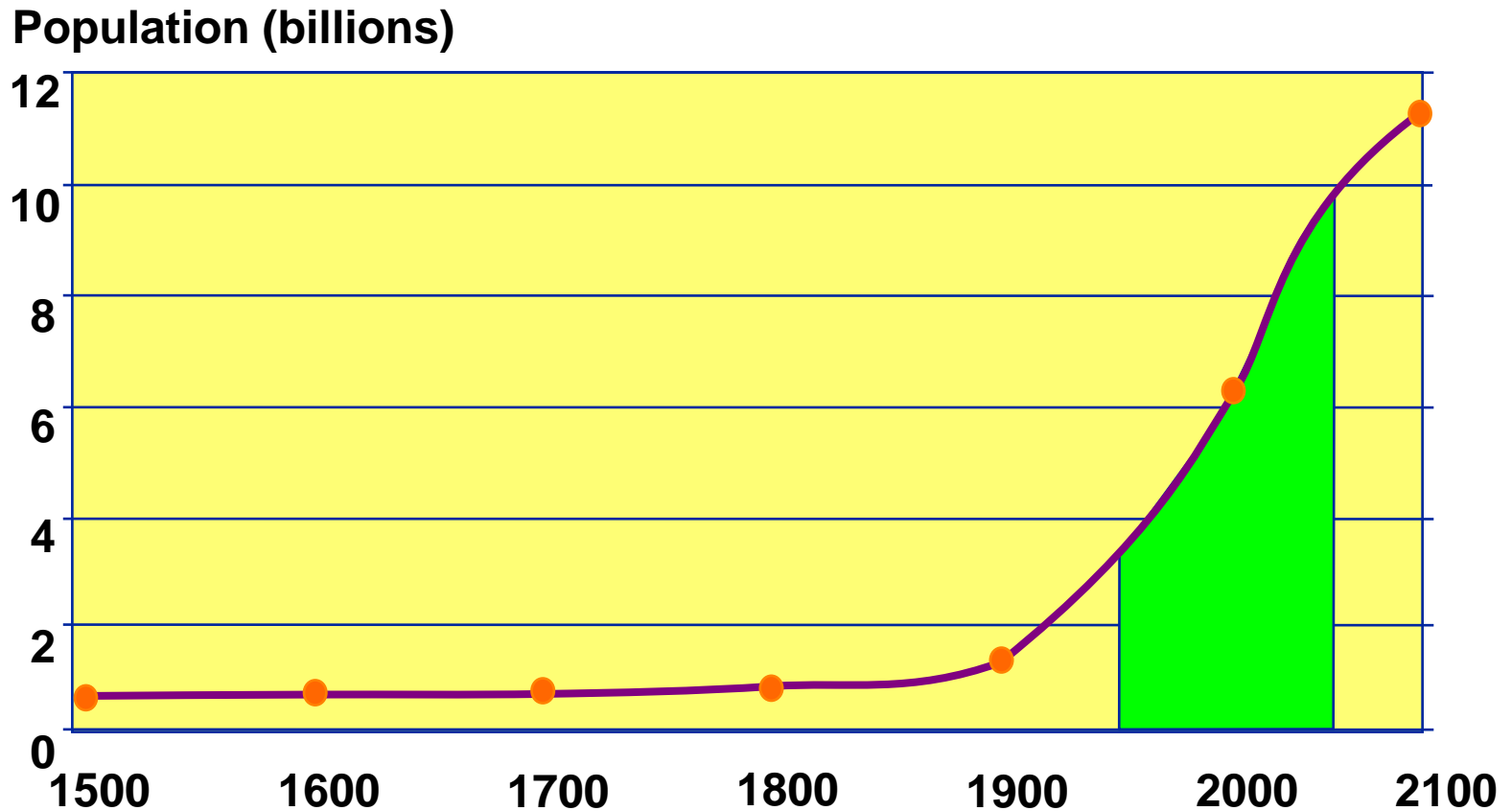
Outline

- Importance of Electrification
- EPRI's Roadmap to Sustainable Electric Future
- Coal-based generation
- Coal quality requirements and concerns
- Recommendations, suggestions

Policy Trilemma



Global Population Explosion



Megacities Will Challenge Infrastructure Capabilities

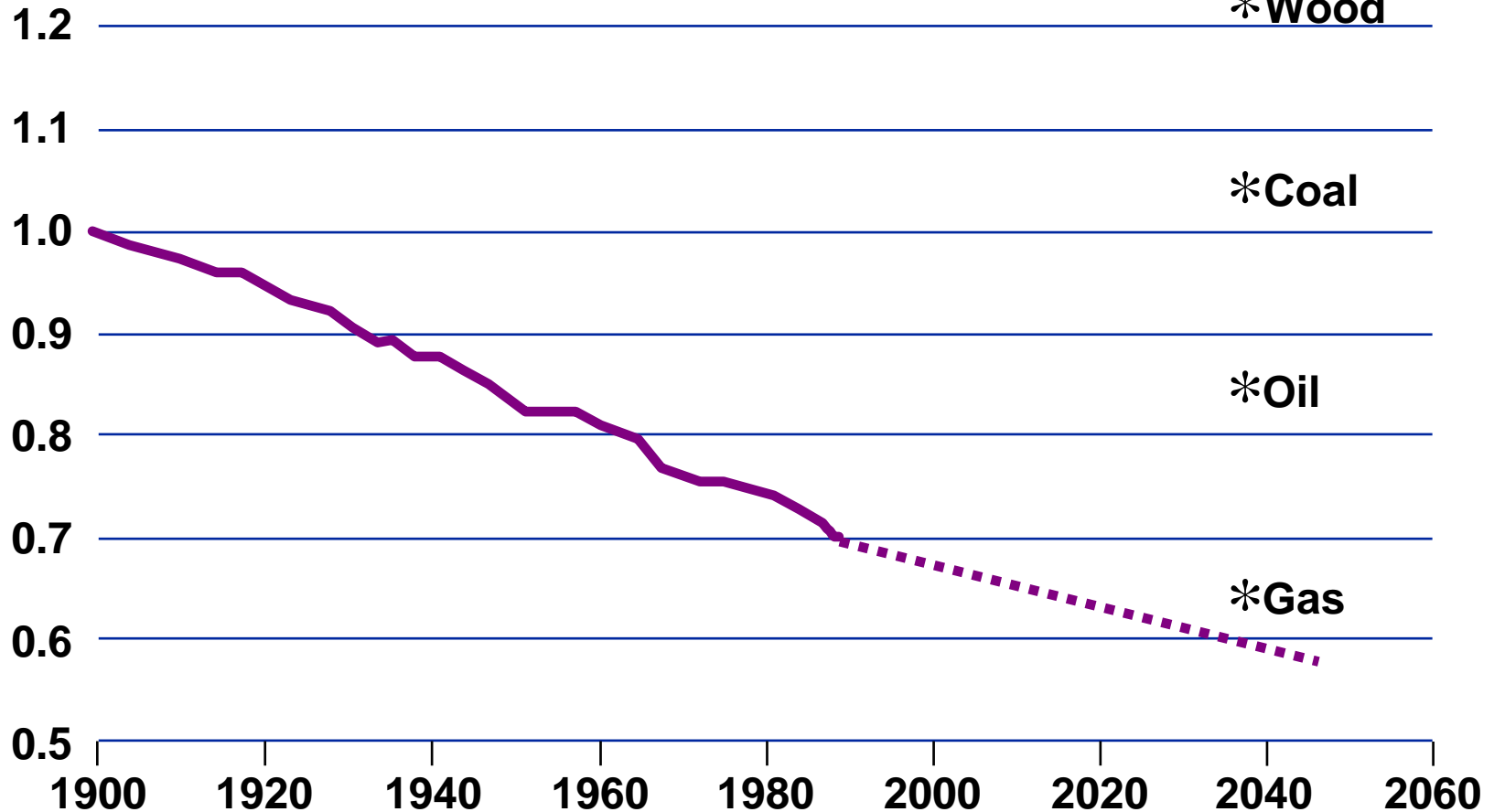


Prosperity: Electrification is the Key

- Electrification, prosperity tightly correlated
- Electricity provides improvements to global energy efficiency
 - Fax seven times as efficient as courier, email about magnitude more efficient than fax
 - Electric transportation twice as efficient as gas
- Developing countries will be able to “leapfrog” historically high patterns of energy intensity by adopting more efficient technologies

The Carbon Challenge

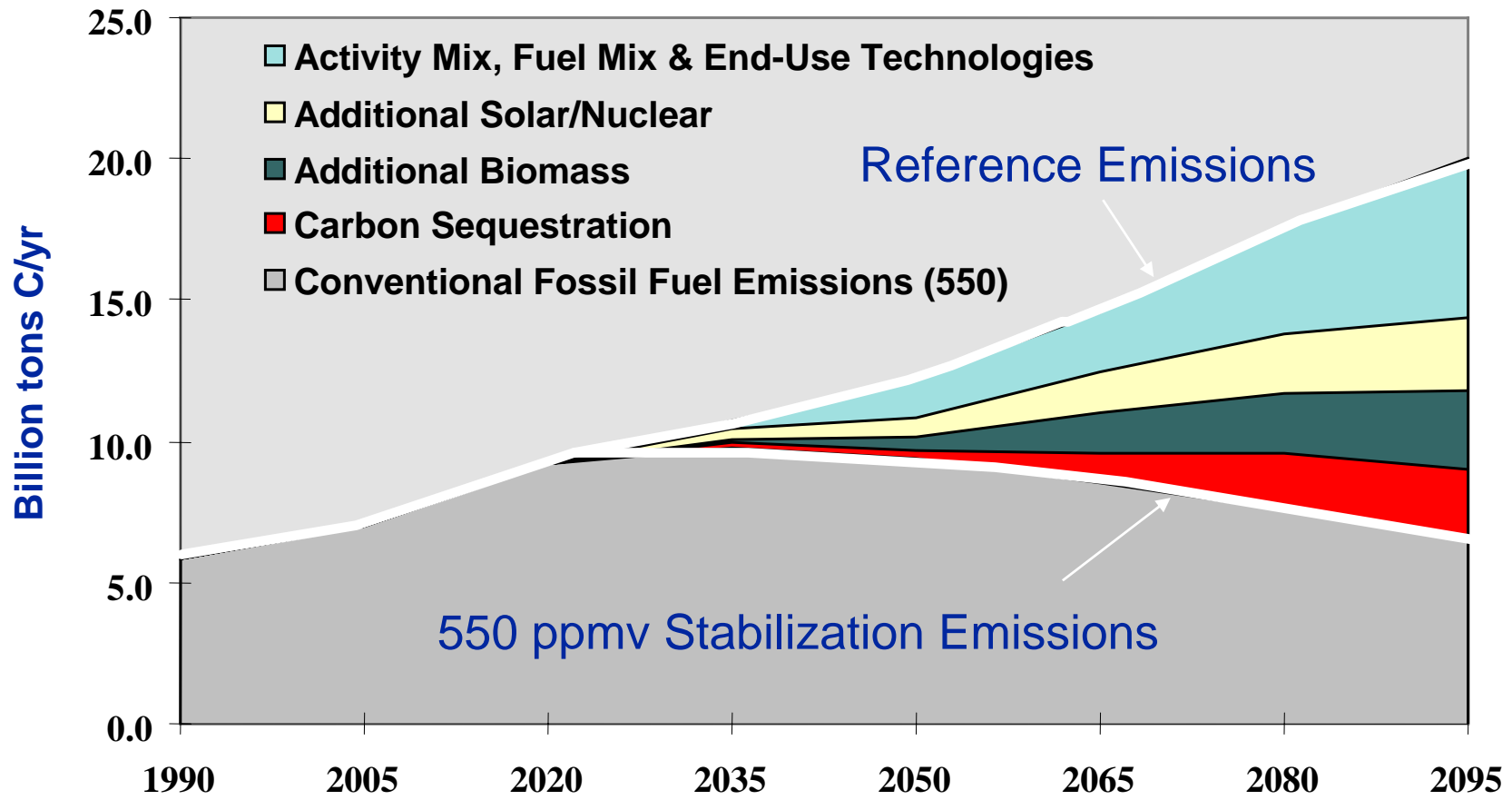
Carbon Intensity (tC/toe*)



Source: National Academy of Engineering, 1997

*Tonnes of carbon per tonne of oil equivalent

Filling the Global CO₂ Emissions Gap



Source: Battelle/EPRI

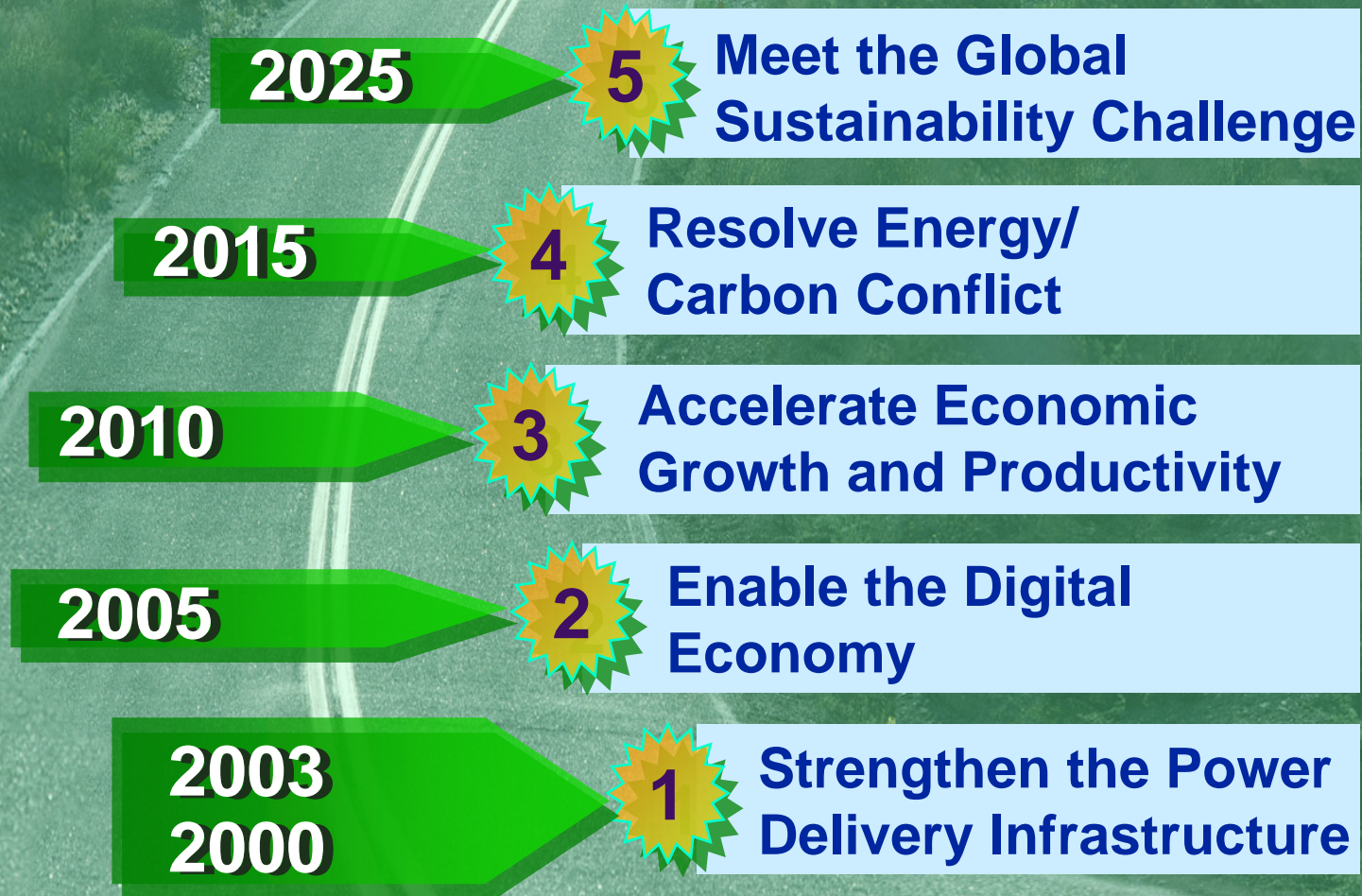
Creating a Roadmap to the Future

**Sustainable
Energy Future**

Technology Roadmap

**Energy Industry
Needs Today**

Building the Electricity Technology Road



What 10,000 GW of Global Generating Capacity Means

- Tripling current world power plant capacity
- Adding 200,000 MW/yr
- Investing \$100 - 150 billion/yr

It's equivalent to:

- < 5 years of current world automobile engine production
- Less than 0.3% of world GDP
- Less than the world spends on cigarettes, etc.

It can and must be done!

Broad Portfolio of Generation Options



Limit-Breaking Technologies

Clean coal technologies

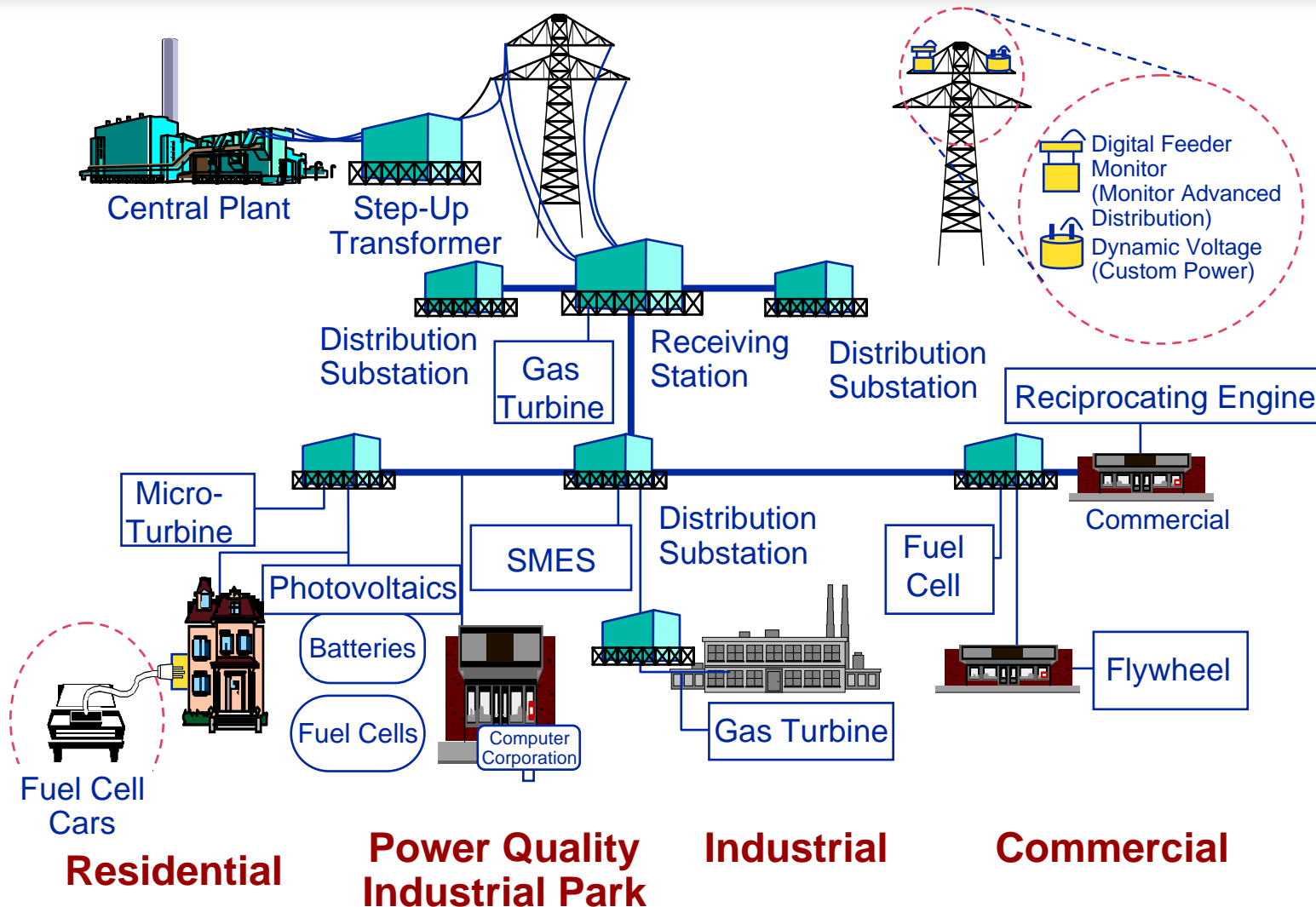
Carbon sequestration

Advanced nuclear power

Distributed renewable
power systems

Electricity/hydrogen

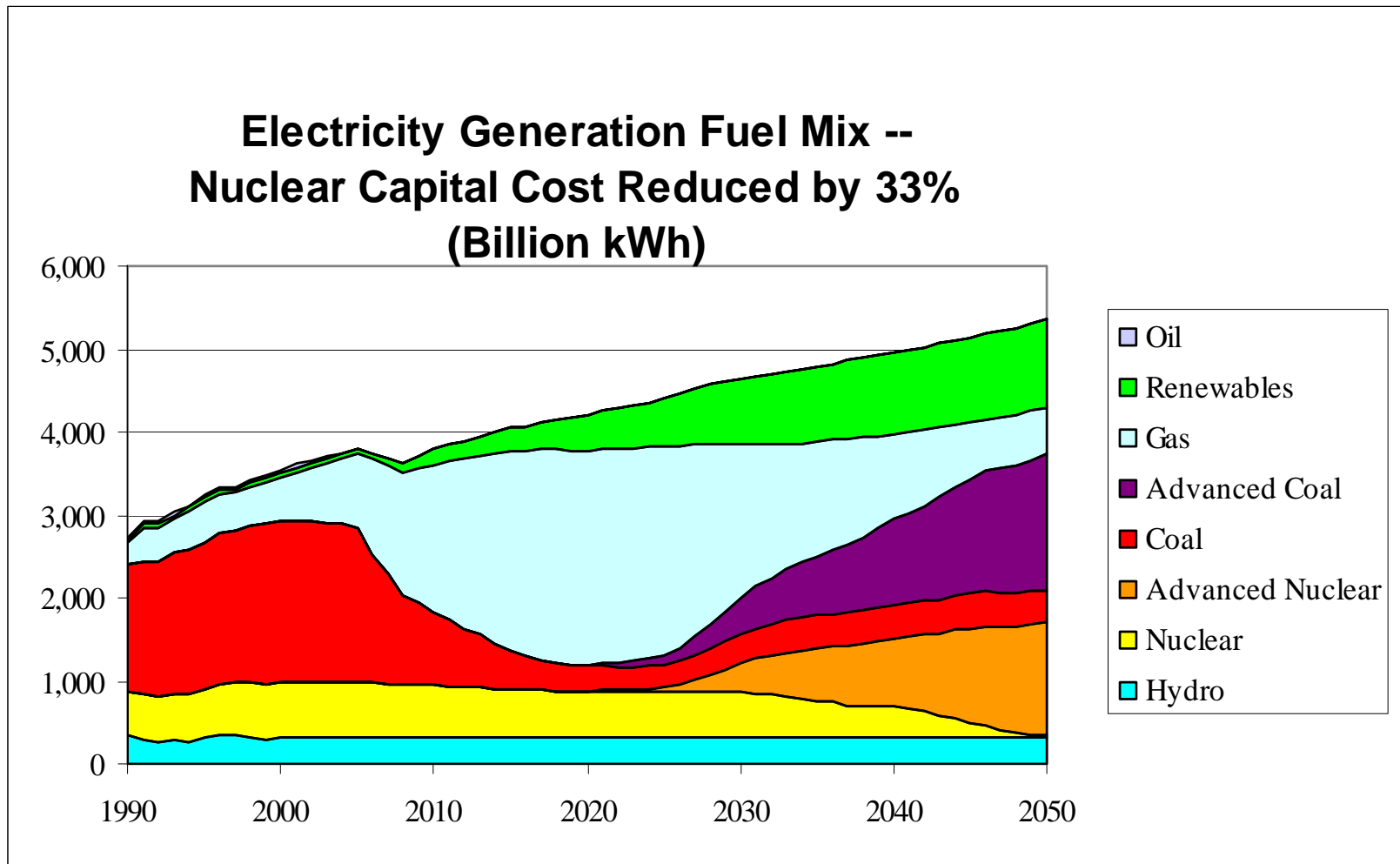
Tomorrow's Grid May Bear Little Resemblance to Today's



Issues -- Future Coal-Based Generation

- Competitiveness with natural gas combined cycle generation
- CO₂ emissions
- Upcoming environmental regulations
- Technology development programs are not adequately funded
- Surviving the long dry spell
- Public perception that “coal” is a dirty word

Wide Swings in Generation Mix under Current Policy Direction



Source: EPRI

Coal Generation Options

- Advanced pulverized coal plant--advanced steam conditions
- Scaled-up fluid bed combustion
- Pressurized combustion
- IGCC
- Low-CO₂, near-zero emissions IGCC
- “Power Plex”

Selected R&D Issues in Non-Nuclear Generation

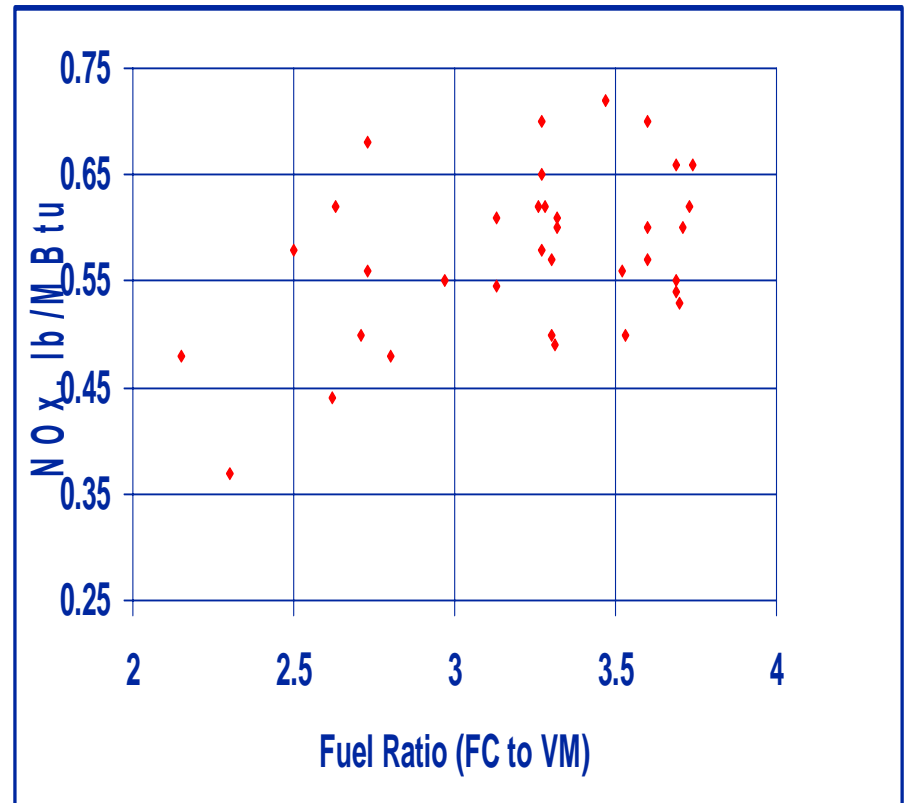
- Aggressively push Advanced Gas Turbine development
 - key component in every scenario, though timing varies
- Hot gas clean-up
- Improved metals for high-temperature service
- CO₂ capture, sequestration
- Scale-up experience across the board

Potential Coal Quality Issues

- Corrosion
- Tube deposition
- Insufficient ash viscosity, responsiveness to fluxing
- HAPs
- Refractory life
- Grinding/drying issues
- Feedstock variability

Recommendations--What Do We Need to Know? Case Study 1

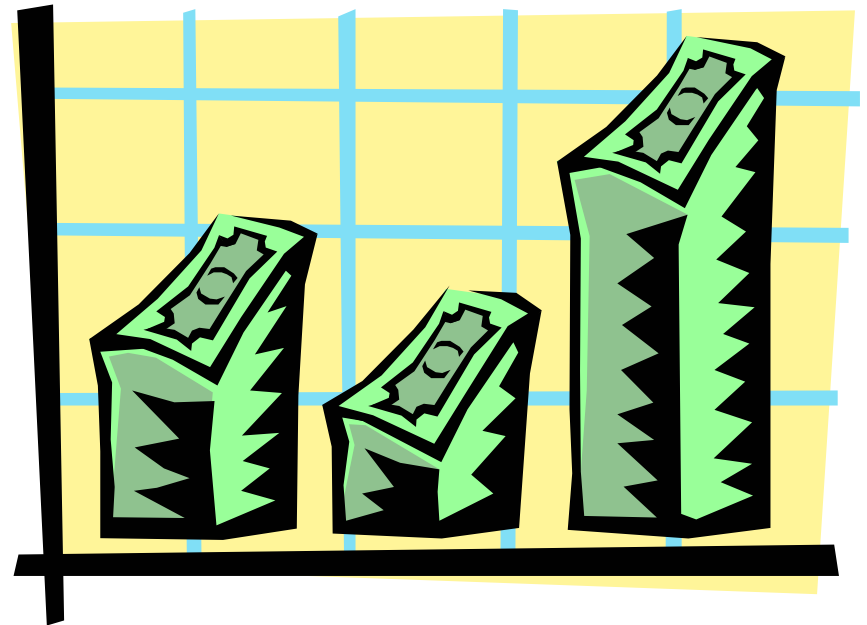
- Prediction of NOx emissions has been problematic--N, FR, VM, all ineffective in predicting NOx emissions
- Understanding of combustion process has revealed failings, led to new tools to predict NOx which use common analyses
- Similar problem moving forward?



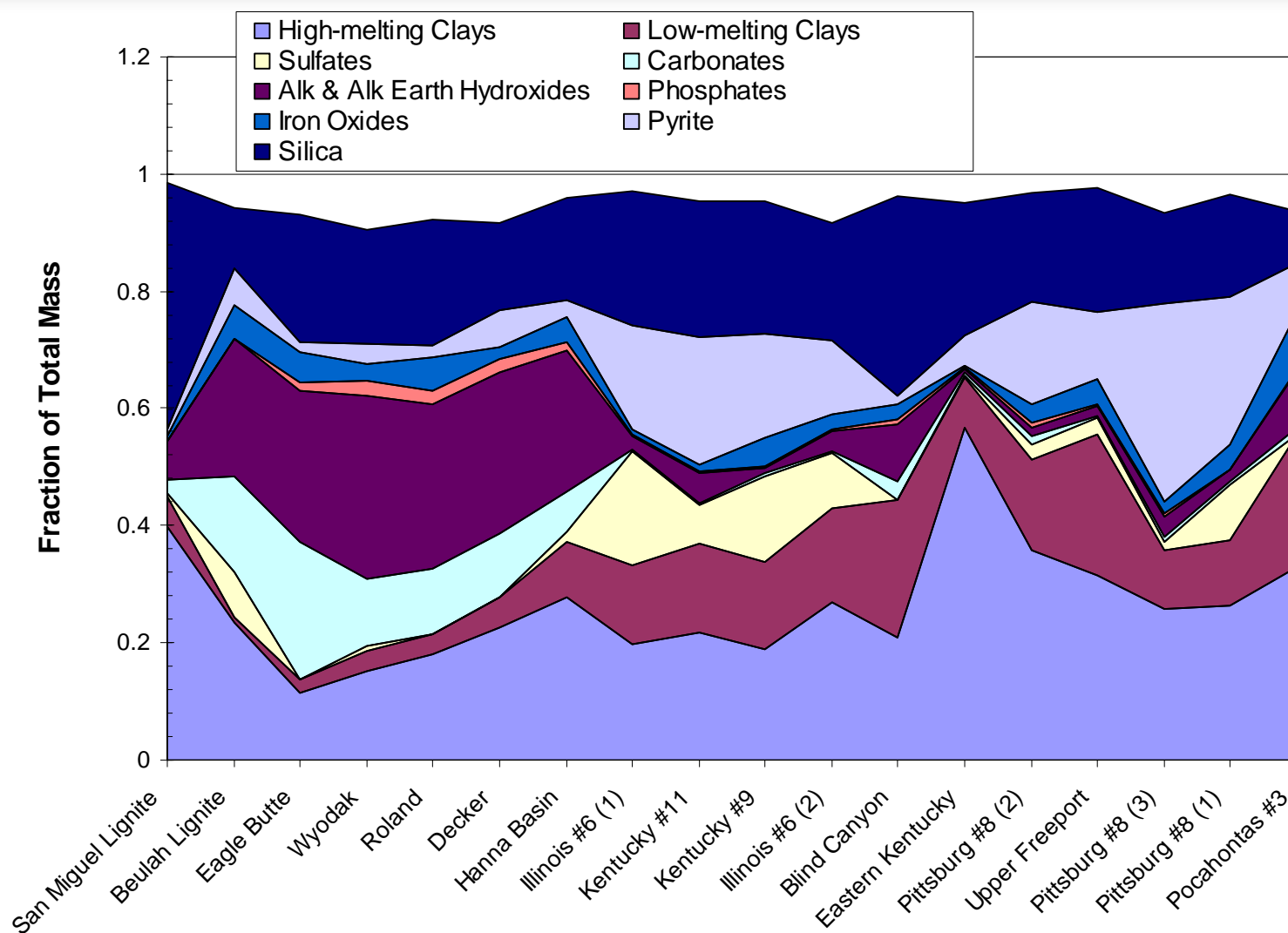
$$R^2 = 0.56$$

Required Coal Analyses for Furnace Deposition--Case Study 2

- Standardized analyses
 - proximate, ultimate, Cl, HV, ash elemental, sulfur forms, size distribution
- Non-standard analysis
 - Chemical fractionation, CCSEM
- Other useful or common analyses
 - Fusion temperatures,, Mossbauer spectroscopy, XAFS, DTA, NAA

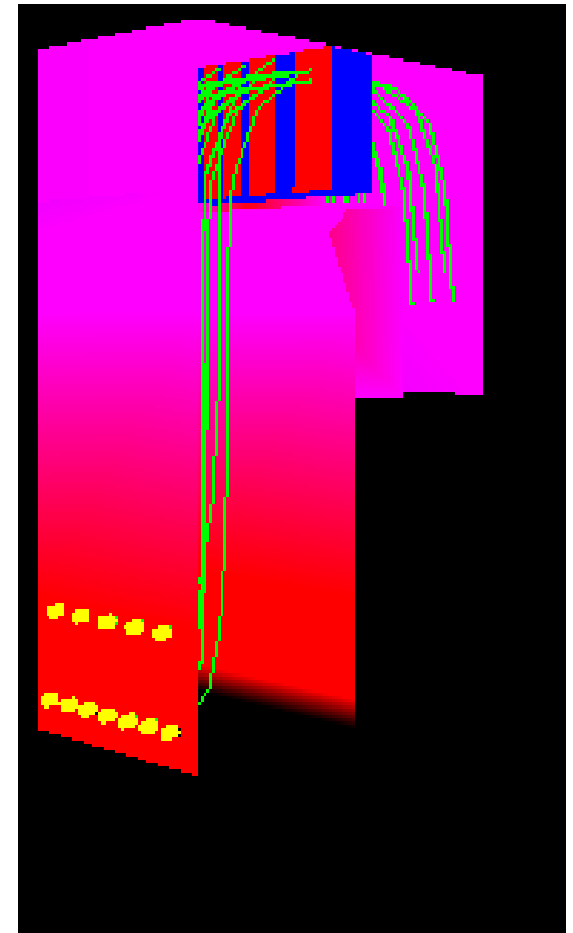
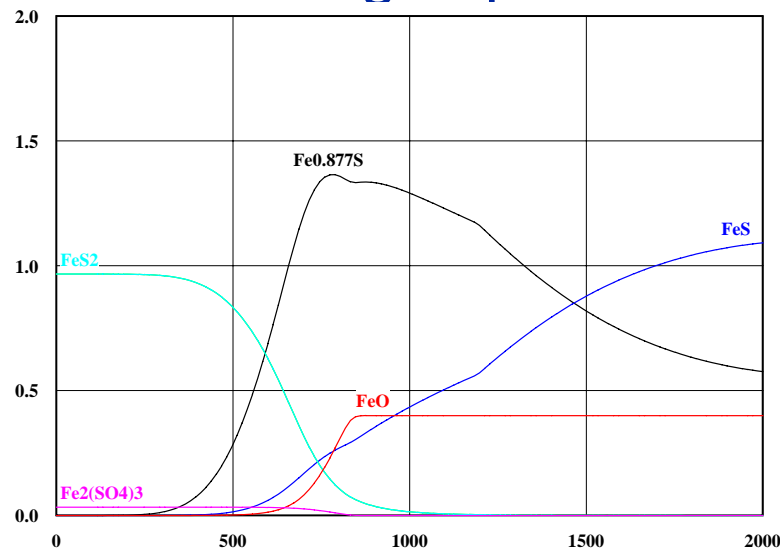


Inorganic Classes Are Evident



Detailed look at Mineralogy Provides Dramatically Improved Predictions

- Thorough understanding of minerals allows:
 - look at reactions (below)
 - computing transformations, particle trajectories (right)
 - determining deposition rates



Information Requirements for Coal Quality in Next Generation

- Standard analysis provides good starting point
- Cleanability needed, as cleaning will still be economically attractive
- Mineralogical information truly useful for deposition, erosion, abrasion
- Trace elements
- Reactivity information
- Ash properties under different atmospheres
- Indication of variability

Recommendations, Discussion Topics

- Ongoing communication between coal resource community and power plant developers
- Ability to flag “unusual” coals--Air Products fluid bed combustor
- Ability to estimate “as-delivered” coal quality
 - cleaning, blending, dilution
- Recognize additional information may be required--build in flexibility
 - Other tests, indices, very likely to be required as process intelligence grows

Acknowledgments

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