Indiana Electricity Projections and Renewable Energy

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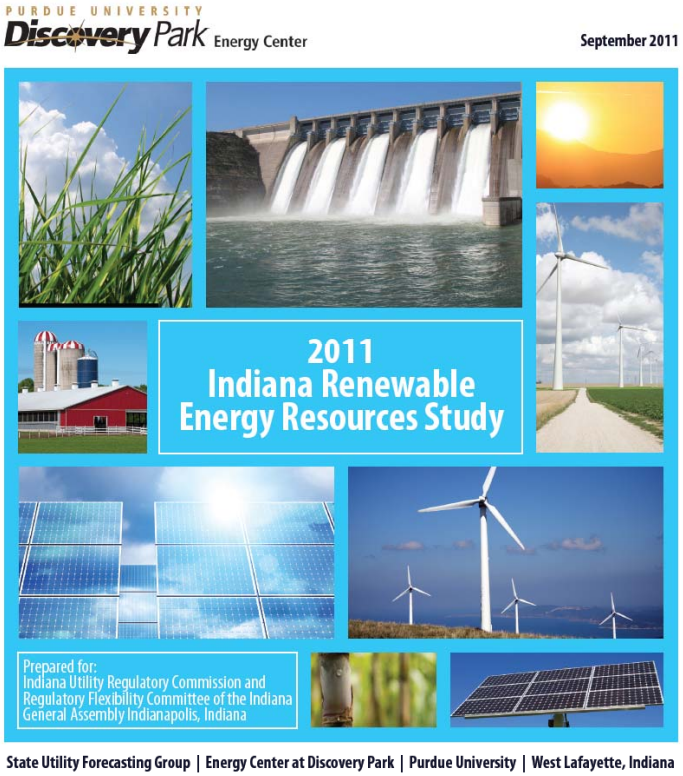
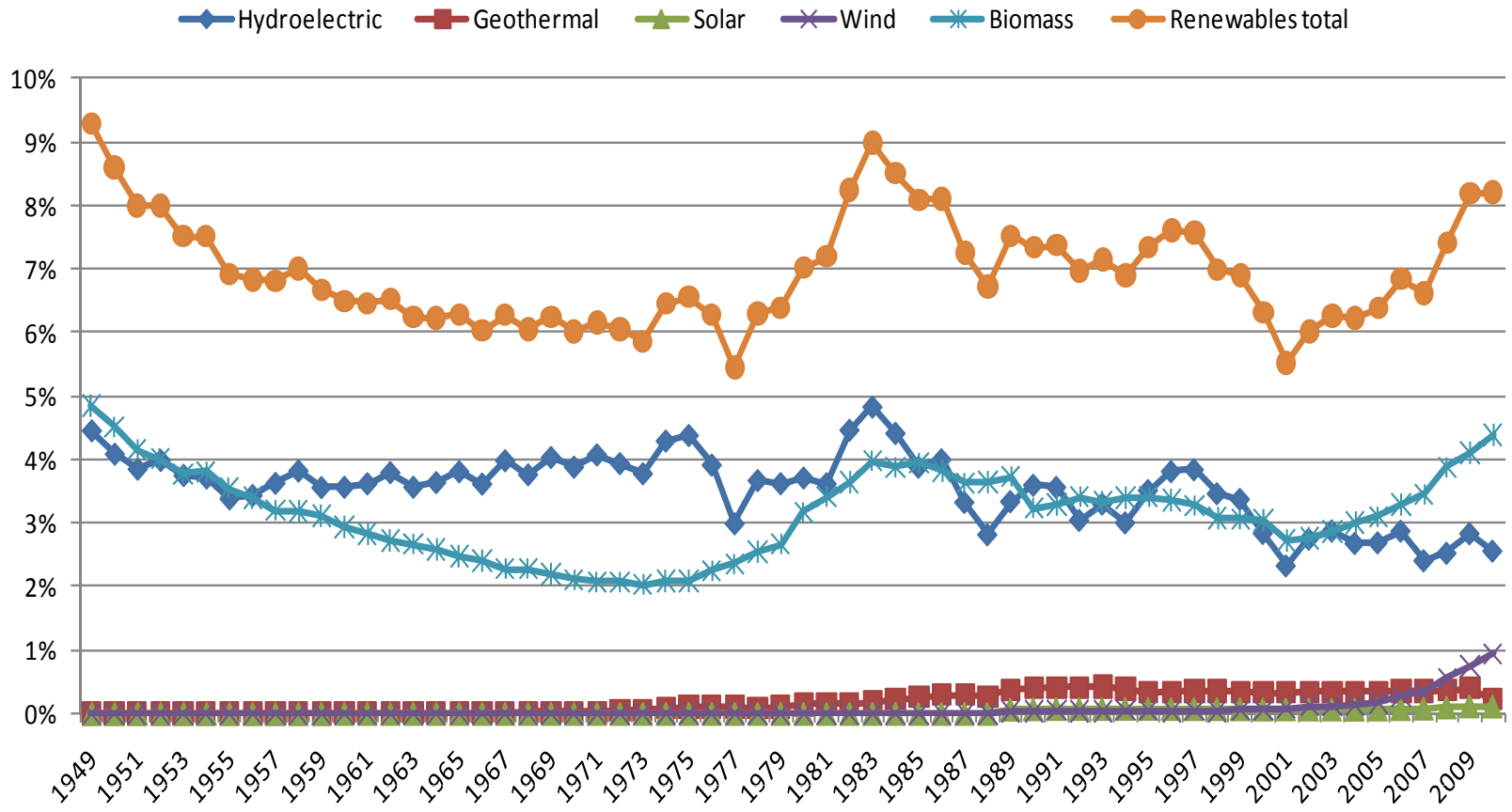
2011 Renewable Resources Study

- Renewable energy trends
- Barriers to development
- Individual renewable resources
  - Wind
  - Energy crops
  - Organic waste
  - Solar
  - Photovoltaics
  - Hydropower

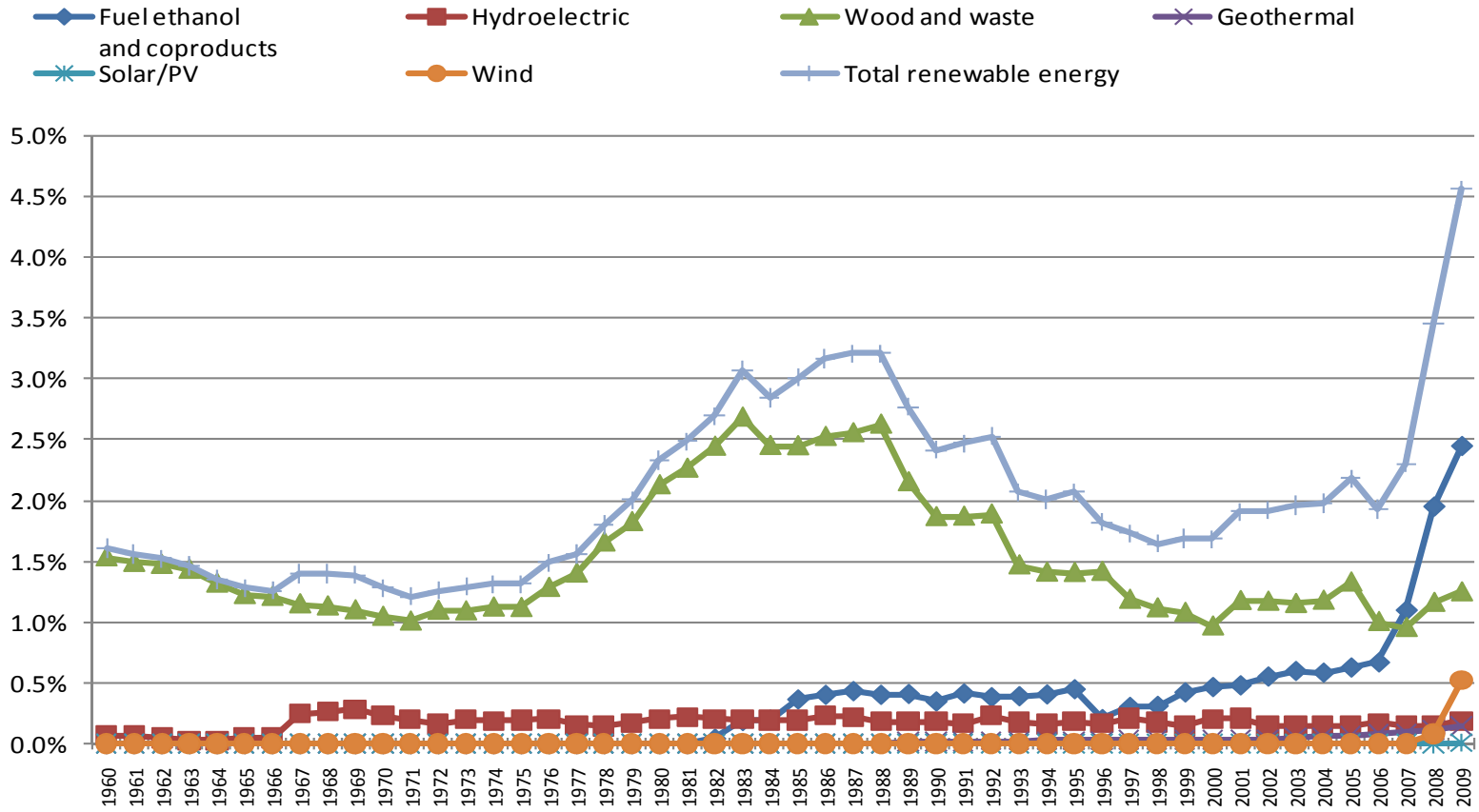


Renewables Share of U.S. Energy Consumption



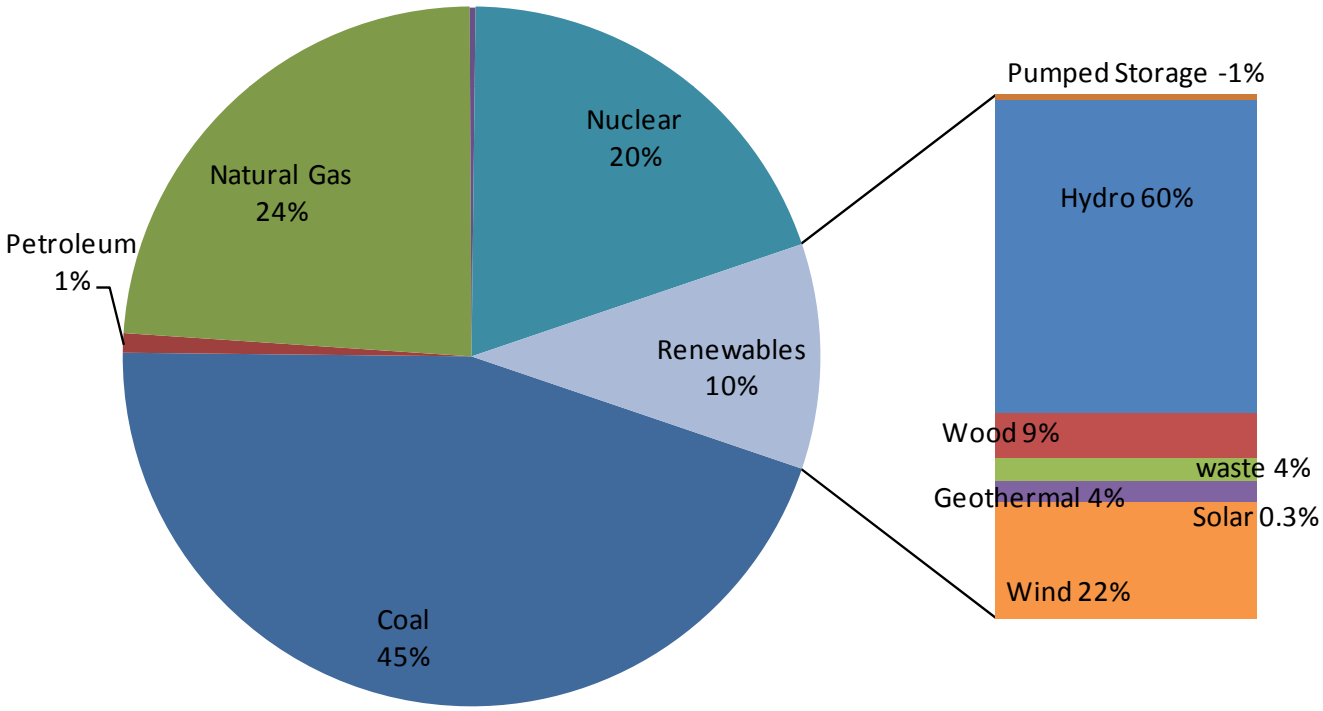
Source: Energy Information Administration (EIA)

Renewables Share of Indiana Energy Consumption



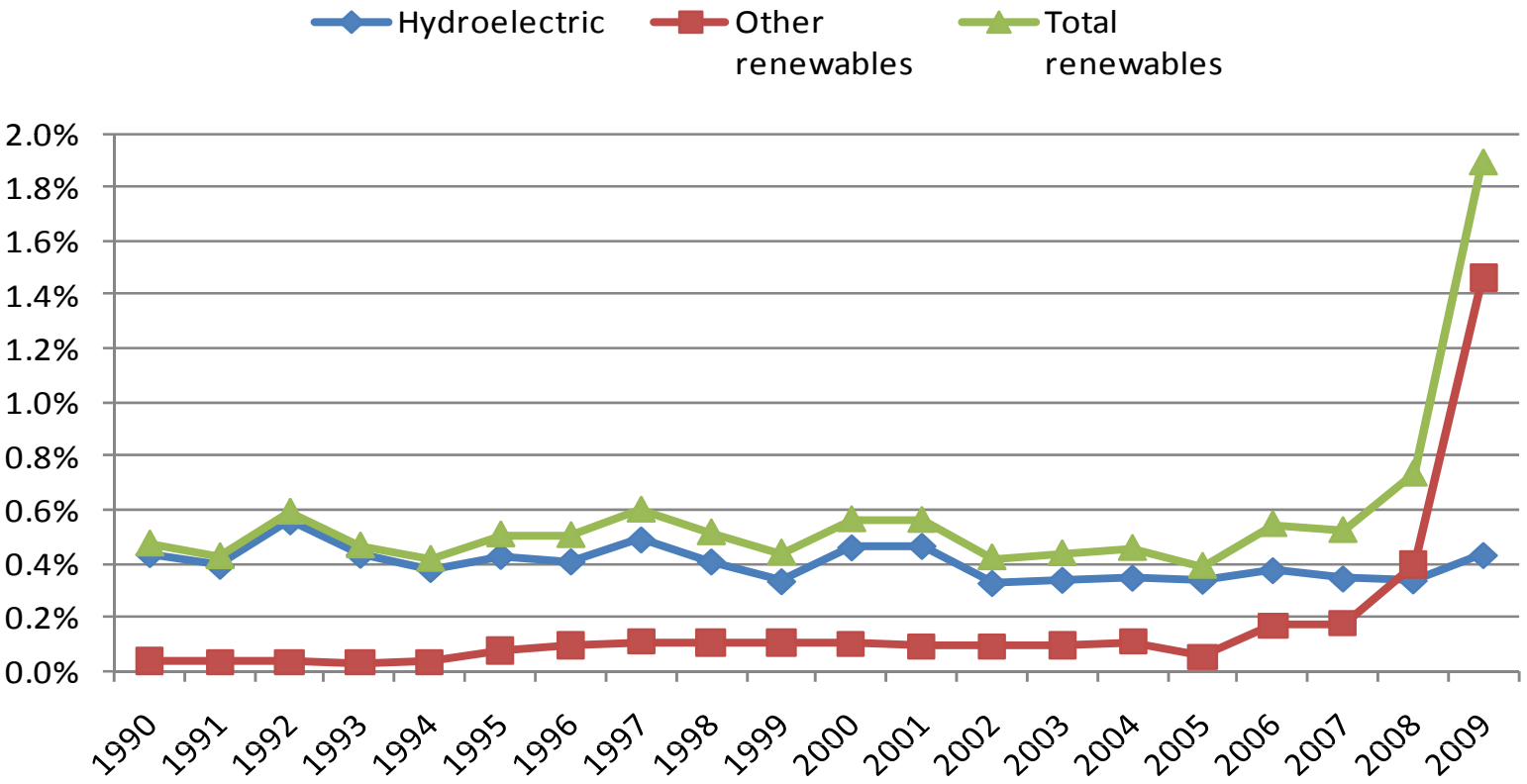
Source: EIA

2010 U.S. Electricity Generation by Energy Source



Source: EIA

Renewables Share of Indiana Electricity Generation

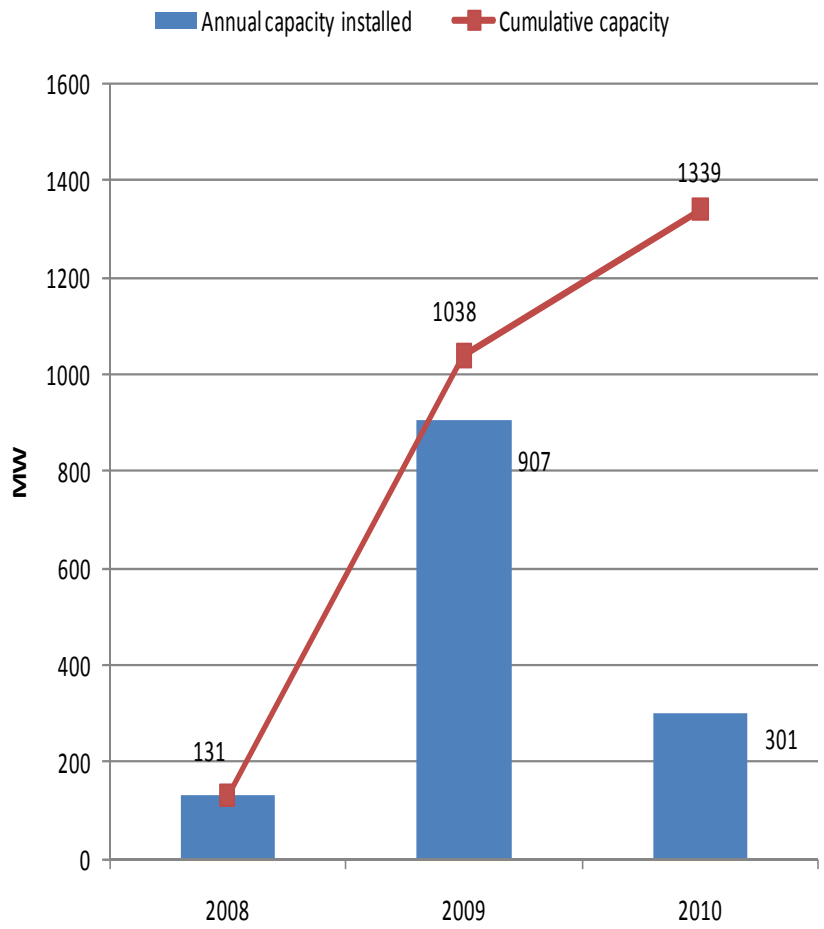


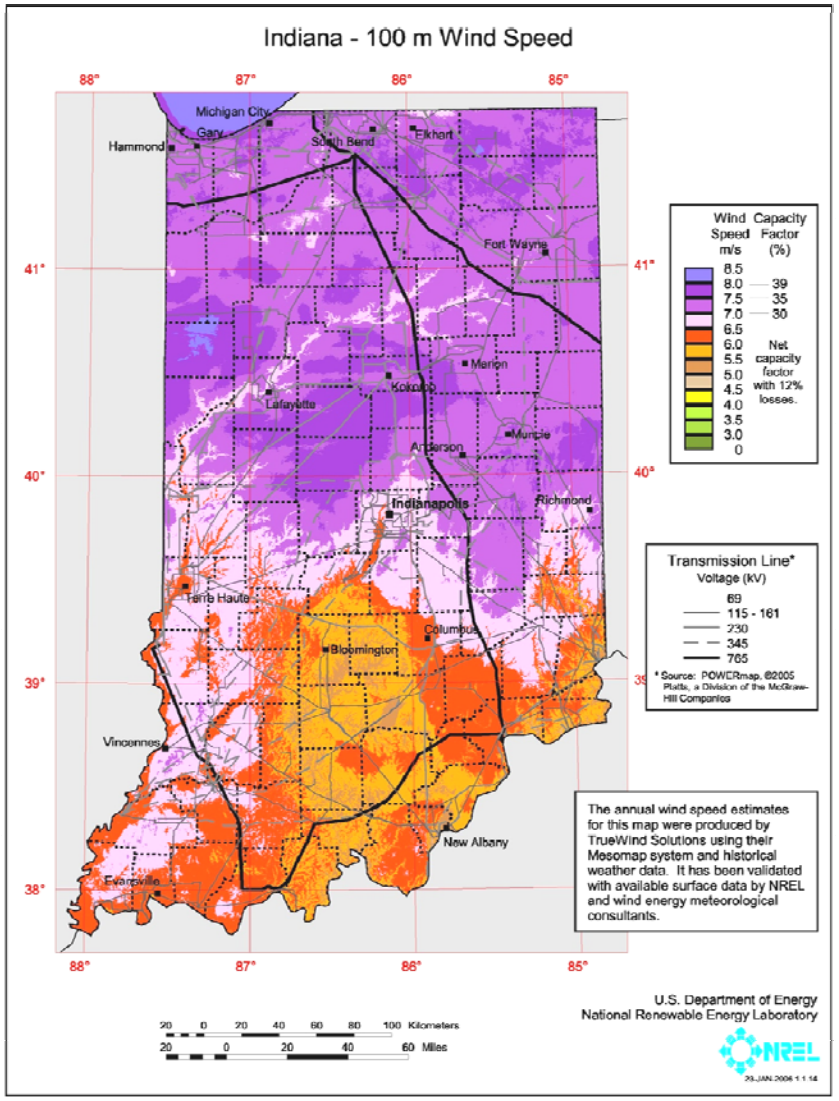
Source: EIA

Barriers to Renewables

- Major barrier is cost
  - Most renewable technologies have high capital costs
  - According to EIA Indiana's average electric rate in 2009 was 7.62 cents/kWh vs. the national average of 9.82 cents/kWh
- Limited availability for some resources
  - Solar/photovoltaics, hydropower
- Intermittency for some resources
  - Solar/photovoltaics, wind

Wind


Annual capacity installed
Cumulative capacity
MW
1600
1400
1200
1000
800
600
400
200
0
131
1038
1339
907
301
2008
2009
2010


Indiana - 100 m Wind Speed
88°
87°
86°
85°
41°
40°
39°
38°
Michigan City
Gary
Hammond
South Bend
Elkhart
Fort Wayne
Lafayette
Kokomo
Marion
Muncie
Anderson
Indianapolis
Richmond
Terre Haute
Bloomington
Columbus
Vincennes
New Albany
Evansville
Wind Capacity
Speed Factor
m/s (%)
8.5
8.0 39
7.5 35
7.0 30
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
0
Net capacity factor with 12% losses.
Transmission Line*
Voltage (kV)
69
115 - 161
230
345
765
* Source: POWERmap, ©2005 Platts, a Division of the McGraw-Hill Companies
The annual wind speed estimates for this map were produced by TrueWind Solutions using their Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.
20 0 20 40 60 80 100 Kilometers
20 0 20 40 60 Miles
U.S. Department of Energy
National Renewable Energy Laboratory
NREL

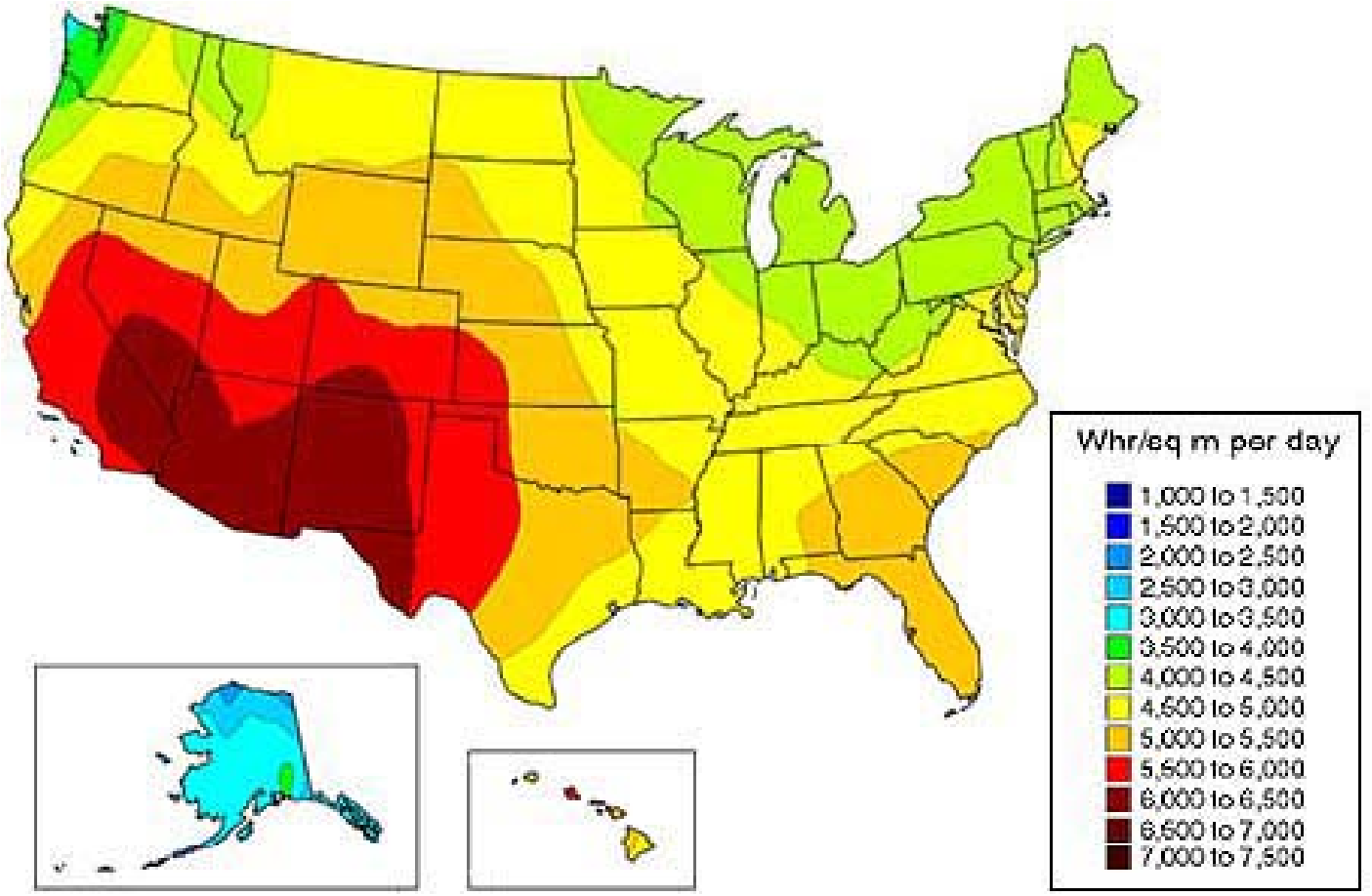
Energy Crops

- Transportation fuels
  - Ethanol
  - Biodiesel
- Other possibilities
  - Fast growing hardwood trees (hybrid poplar/willow)
  - Grasses (switchgrass)
- Barriers to be overcome
  - Other high-value uses for the land
  - Harvesting and transportation costs
  - Price of competing fossil fuels

Organic Waste Biomass

- Until the recent increase in ethanol production, this resource was the largest source of renewable energy in Indiana
  - Primarily due to the use of wood waste
- It is the 3rd largest source of renewable electricity generation in the state
  - Landfill gas
  - Municipal solid waste
  - Animal waste biogas
  - Wastewater treatment

Solar Energy



Solar resource for a flat-plate collector

Source: DOE

Photovoltaics

- Growing rapidly in Indiana, but still a small contributor overall
- 75 installations totaling over 2.6 MW of capacity
  - Fort Harrison Federal Compound
  - Johnson Melloh

Hydroelectric Power

- Indiana has 73 MW of hydroelectric generating capacity.
  - mostly run-of-the-river (no dam)
  - 2nd largest source of renewable electricity
- American Municipal Power is constructing an 84 MW facility at the Cannelton Locks on the Ohio River
  - expected to be operational in Fall 2013

2011 Forecast

- Electricity demand
- Peak demand
- Resource needs
- Electricity prices

PURDUE UNIVERSITY

2011 Forecast

Indiana Electricity Projections

State Utility Forecasting Group

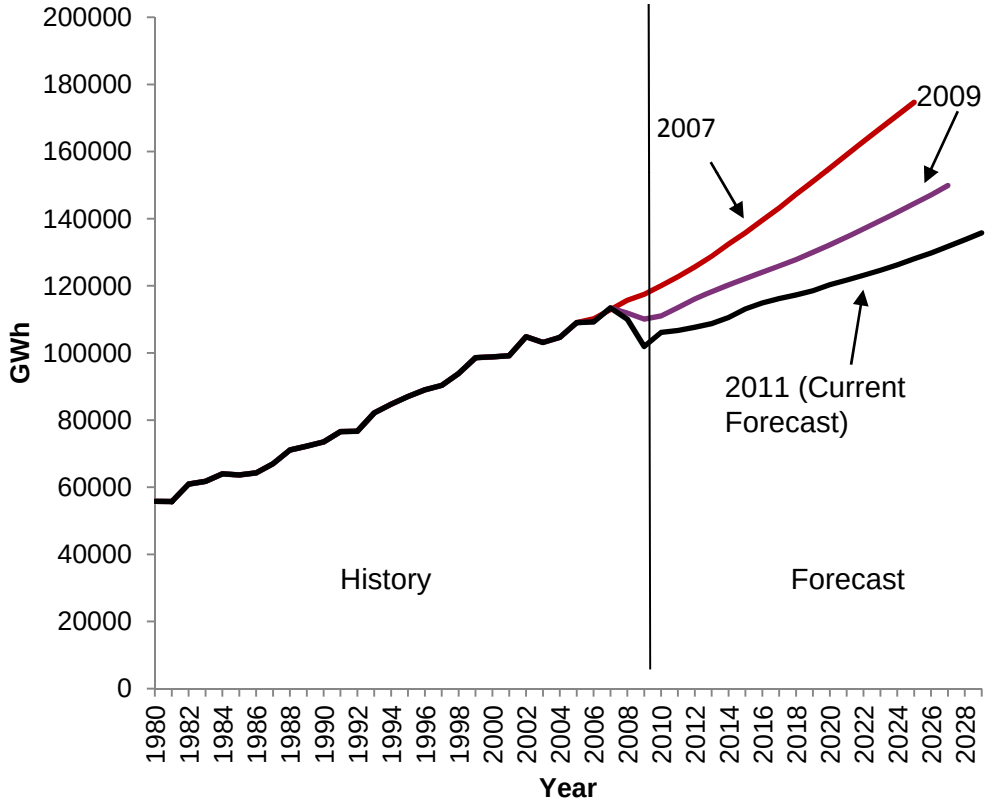
PURDUE UNIVERSITY Discovery Park Energy Center

West Lafayette, Indiana

September 2011

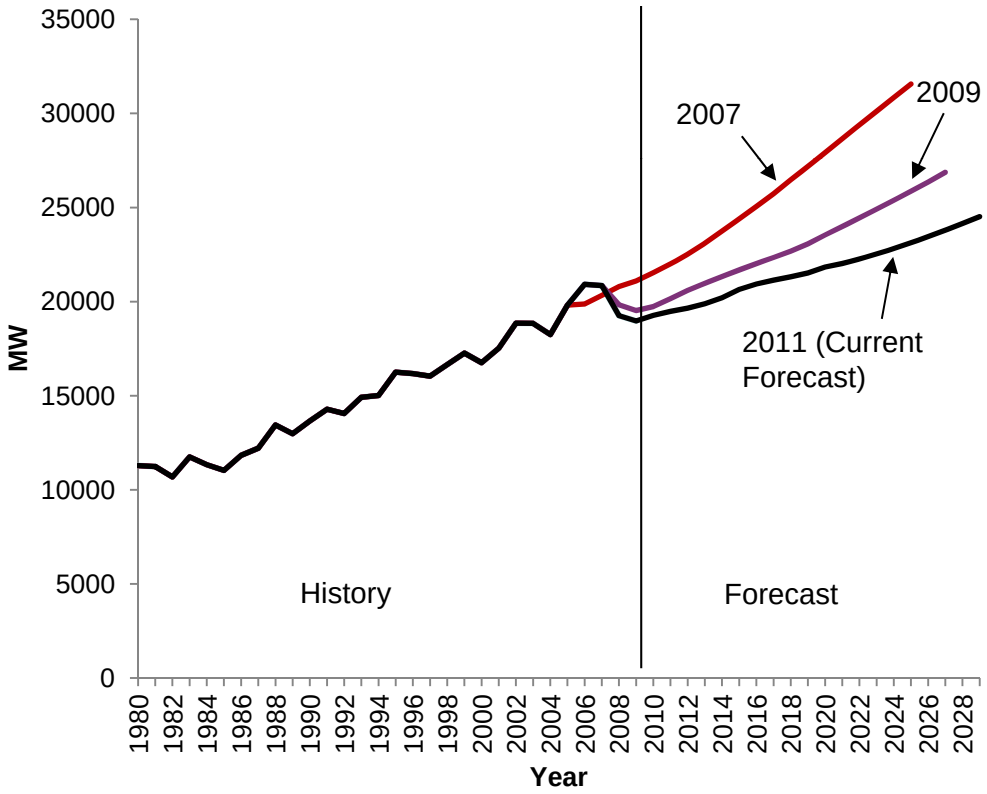
Indiana Electricity Requirements

- Retail sales by investor owned and not-for-profit utilities
- Includes estimated transmission and distribution losses
- Growth rates
  - 2011 forecast: 1.30%
  - 2009 forecast: 1.55%
  - 2007 forecast: 2.46%



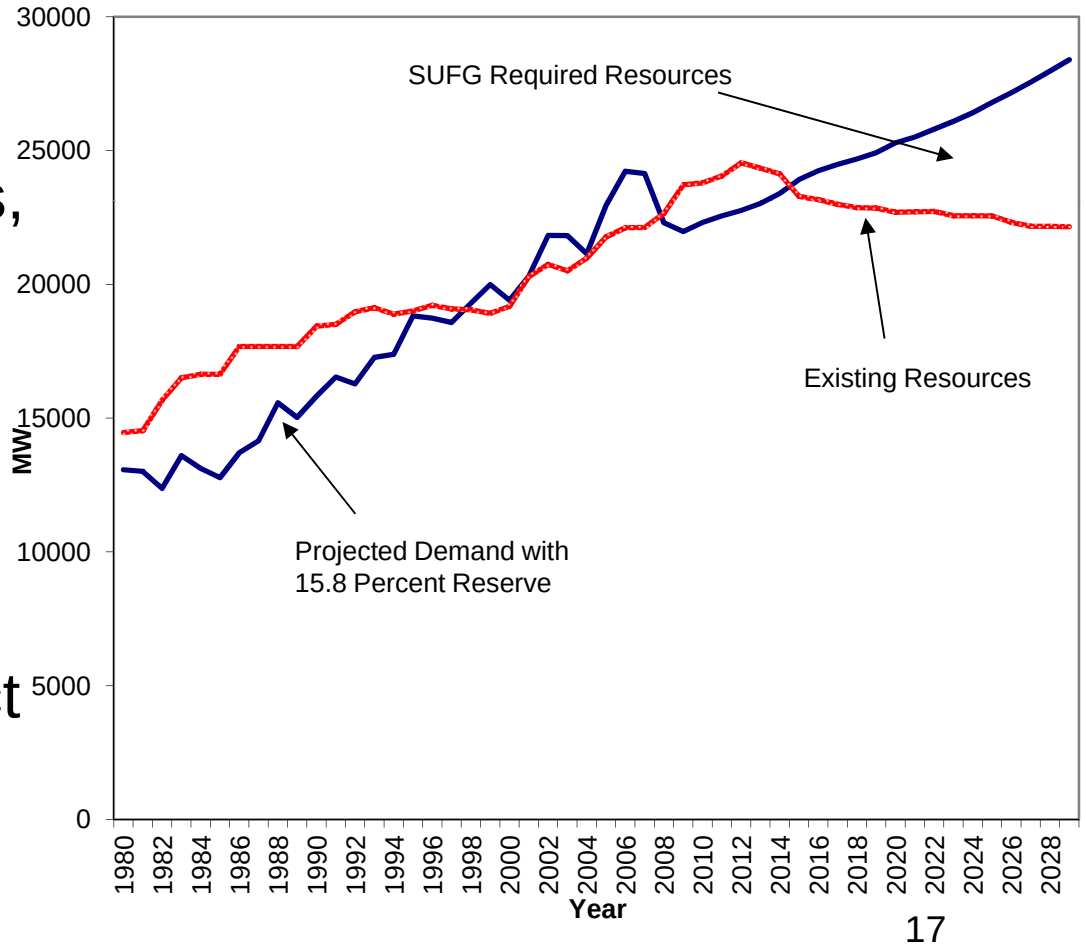
Indiana Peak Demand Requirements

- Peak demand is net of DSM and interruptible loads
- Growth rates
  - 2011 forecast: 1.28%
  - 2009 forecast: 1.61%
  - 2007 forecast: 2.46%



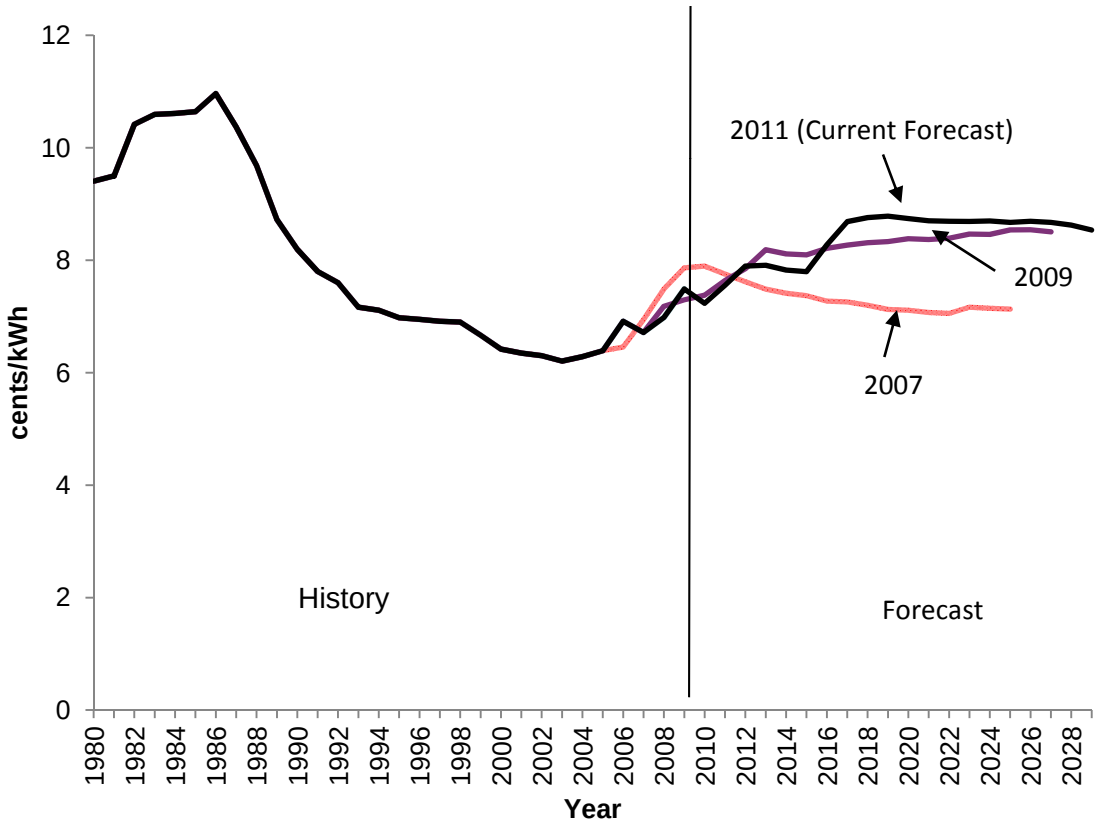
Indiana Resource Requirements

- Resources may be provided by conservation measures, contractual purchases, purchases of existing assets, or new construction
- Existing resources are adjusted into the future for retirements, contract expirations, and IURC approved new resources



Indiana Real Price Projections (2009 $)

- Effect of inflation removed
- Includes the cost of new resources
- Does not include cost of expected EPA regulations
  - unless utility has already taken steps or included costs in data request



Environmental Regulations

- SUFG performed a follow up study of the expected impacts of recent, proposed, and expected EPA regulations
  - Cross-State Air Pollution Rule
  - Mercury and Air Toxics Standards
  - Greenhouse gases
  - Cooling water
  - Coal ash

Cross-State Air Pollution Rule

- Final rule issued in July 2011
- Appealed & currently stayed by federal court
- Reduces emissions caps for sulfur dioxide (SO_2) and nitrogen oxides (NO_x) in 2012
- Further reductions in 2014

Mercury and Air Toxics Standards

- Final rule issued in December 2011
- Replaces court vacated Clean Air Mercury Rule
- Reduces emissions from mercury, acid gases, and other pollutants
- Prevents release of 91% of mercury
- Expected to go into effect in 2015-16

Greenhouse Gases

- Final rule issued in March 2012
  - after SUFG study released
- Establishes carbon dioxide (CO_2) emissions standards for new sources

Cooling Water Intake Structures

- Proposed rule issued in April 2011
- Final rule expected in July 2012
- Intended to reduce damage to aquatic life
  - impingement – trapping against inlet screen
  - entrainment – drawn into cooling system
- Compliance actions include enhanced screening, reducing water flow rate, and installing cooling towers
- Uncertainty over timing

Coal Combustion Residuals

- Proposed rule issued in June 2010
- No date has been released for final rule
- In response to concerns over the potential failure of coal ash facilities
- Two options
  - classify as special hazardous waste (~2020)
  - regulate as non-hazardous waste (~2018)

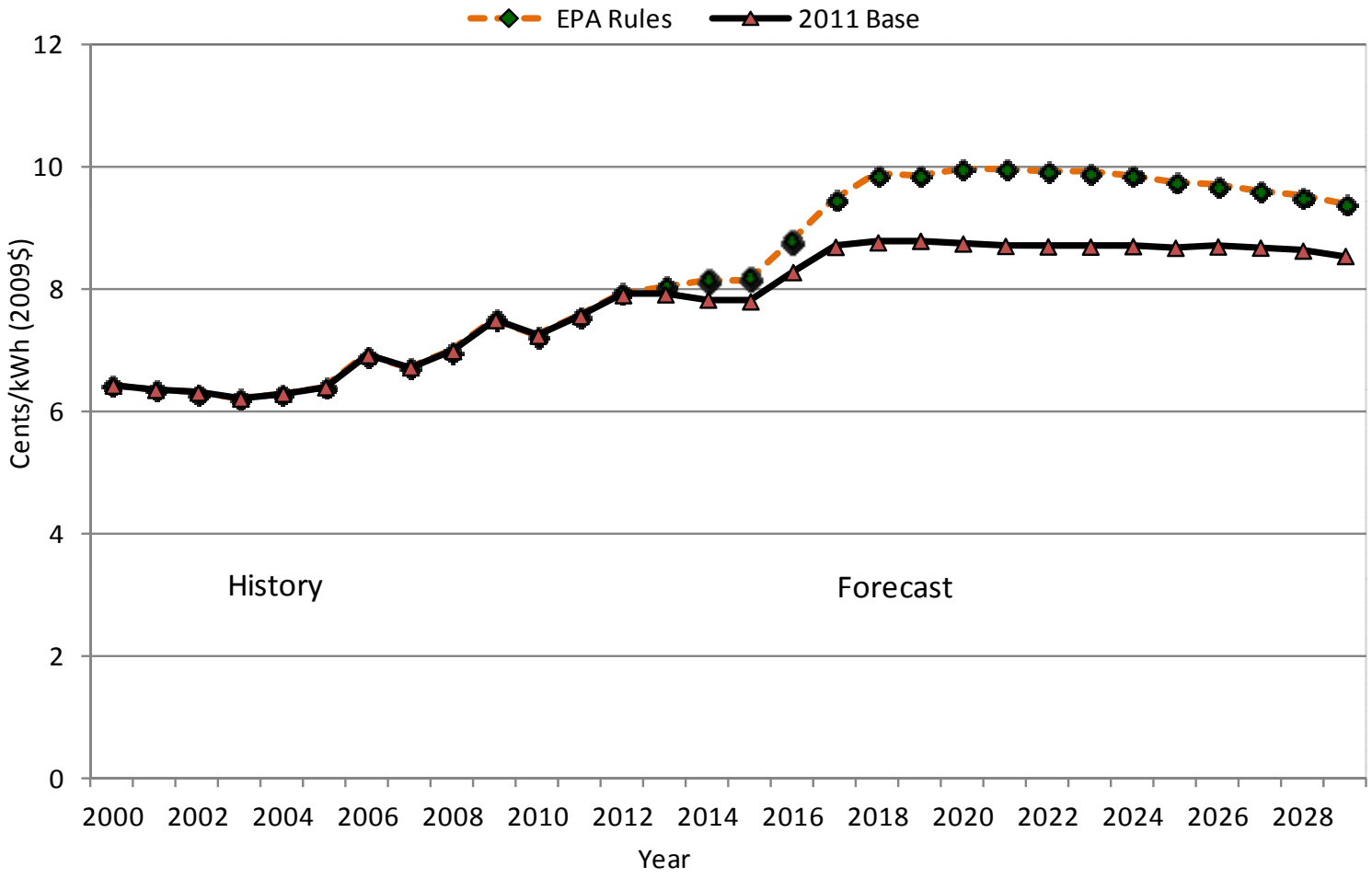
SUFG Study Inputs

- Model inclusion of SO_2 scrubbers (wet FGD), NO_x control (SCR), and mercury control (activated charcoal injection with bag house)
- Conversion of cooling water systems to recirculating
- Conversion of ash disposal from wet to dry

Retire vs. Retrofit

- For each unit, if the cost of retrofitting was greater than the cost of replacing it with a natural gas combined cycle facility, the unit was considered retired for the study
- If not, the retrofit costs were included
- Approximately 2,280 MW modeled as retired

Results


EPA Rules
2011 Base
12
10
8
6
4
2
0
Cents/kWh (2009$)
History
Forecast
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024
2026
2028
Year

Comparison to Base Forecast (2009 cents/kWh)

Year	2011 Base	EPA Rules	Change
2015	7.80	8.14	4.4%
2020	8.74	9.96	13.9%
2025	8.67	9.76	12.5%

Caveats

- Uncertainty in EPA rules
- Impact on transmission investment
- Fuel switching option
- Accuracy of price elasticity modeled
- Macroeconomic effects
- Technological innovations
- Compliance strategies
- Engineering considerations
- Materials and labor premiums
- Efficiency and outage impacts

Further Information

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