SCENARIO ANALYSES FOR IURC REPORT TO THE 21ST CENTURY ENERGY POLICY TASK FORCE

Douglas J. Gotham, SUFG Director

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PURDUE UNIVERSITY | State Utility Forecasting Group

Background

State Utility Forecasting Group (SUFG)

SUFG

- Performs independent policy and economic analyses of issues affecting the electric utility industry
- Formed in 1985 by act of the Indiana General Assembly
- Housed at Purdue University, which has a contract with the Indiana Utility Regulatory Commission (IURC)
- Works proactively with Indiana utilities, state government, public interest groups, and other stakeholders
- Staff have backgrounds in electrical engineering, industrial engineering, economics, and public affairs

21st Century Energy Policy Task Force

Task Force

- Formed by the Indiana General Assembly to explore the potential impact of transitions in fuel sources and technologies on the state's electricity system
- Consisted of legislators and subject matter experts
- The IURC was tasked with preparing a report on the effects of emerging technologies on reliability, resilience, and costs
- SUFG was asked to prepare a report assessing future generation capacity and costs
- Lawrence Berkeley National Lab (distributed resources) and Indiana University (employment and local impacts) prepared reports on other focus areas

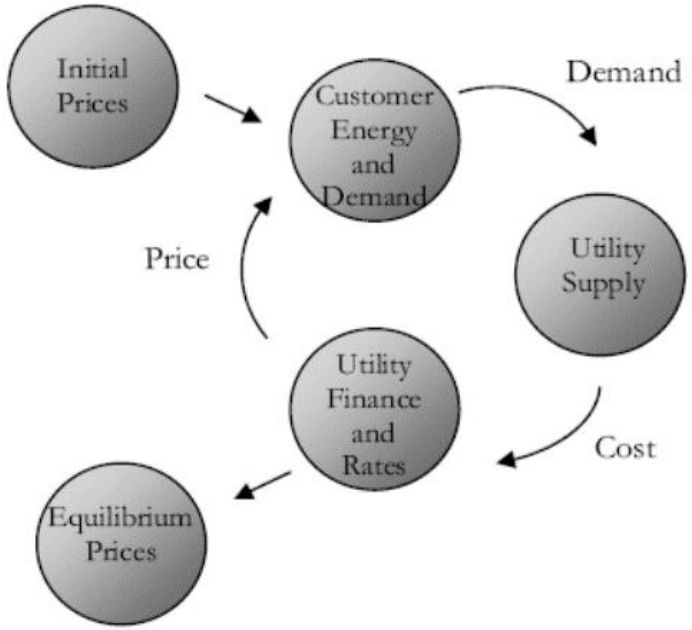
SUFG Scenario Analyses

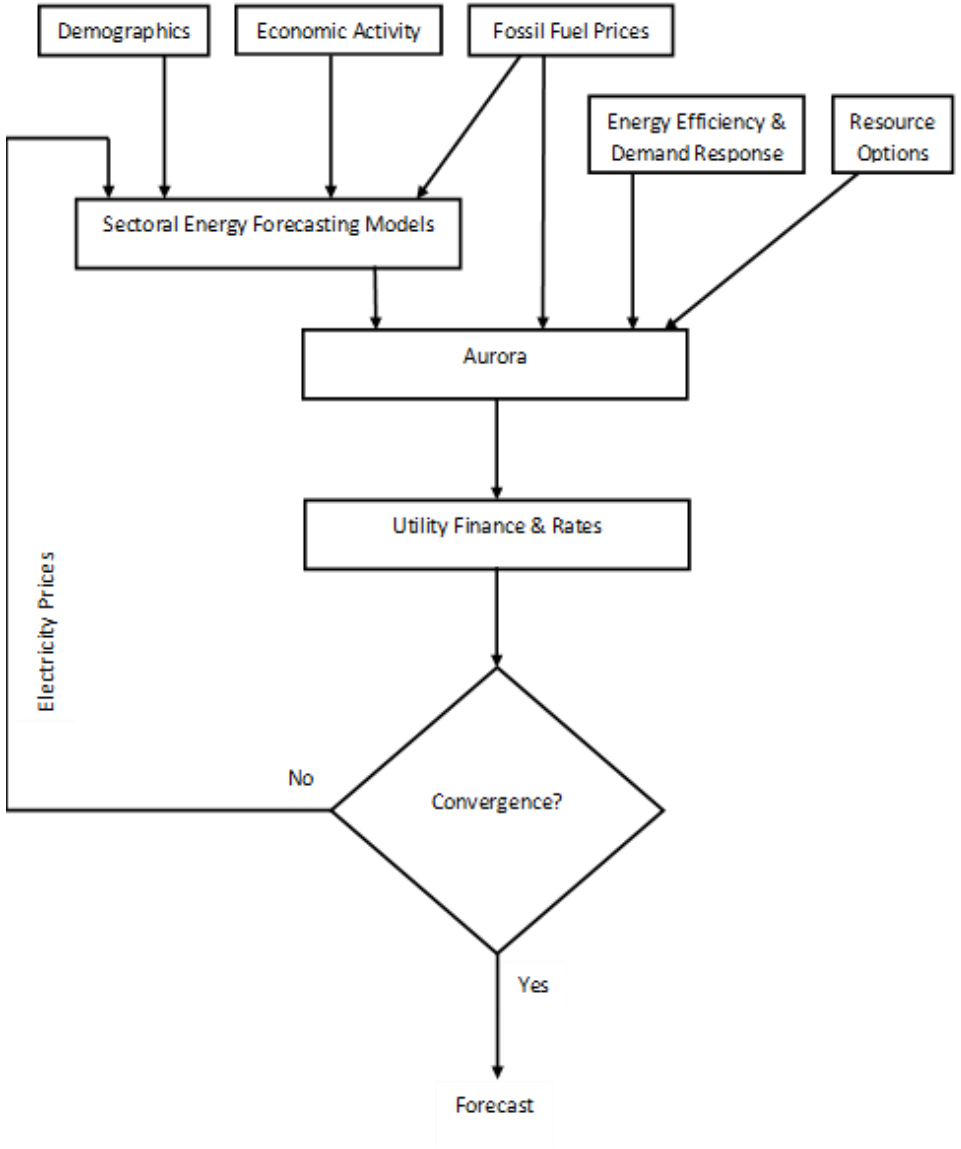
Scenario Selection

IURC asked us to look at various scenarios, using our forecasting models

- SUFG has developed a series of models that forecast future (20-year) electricity use, resource needs, and prices for Indiana
- The IURC conducted meetings to determine which scenarios were of interest to utilities and stakeholders
- Final scenarios and sensitivities were chosen by the IURC, with some input from stakeholders and SUFG
- Seven scenarios were selected, along with three sensitivities with a price on carbon dioxide emissions
- Purpose was not to model a set of specific future outcomes but to see the broader impacts of different factors

SUFG Forecasting Modeling System





Caveats

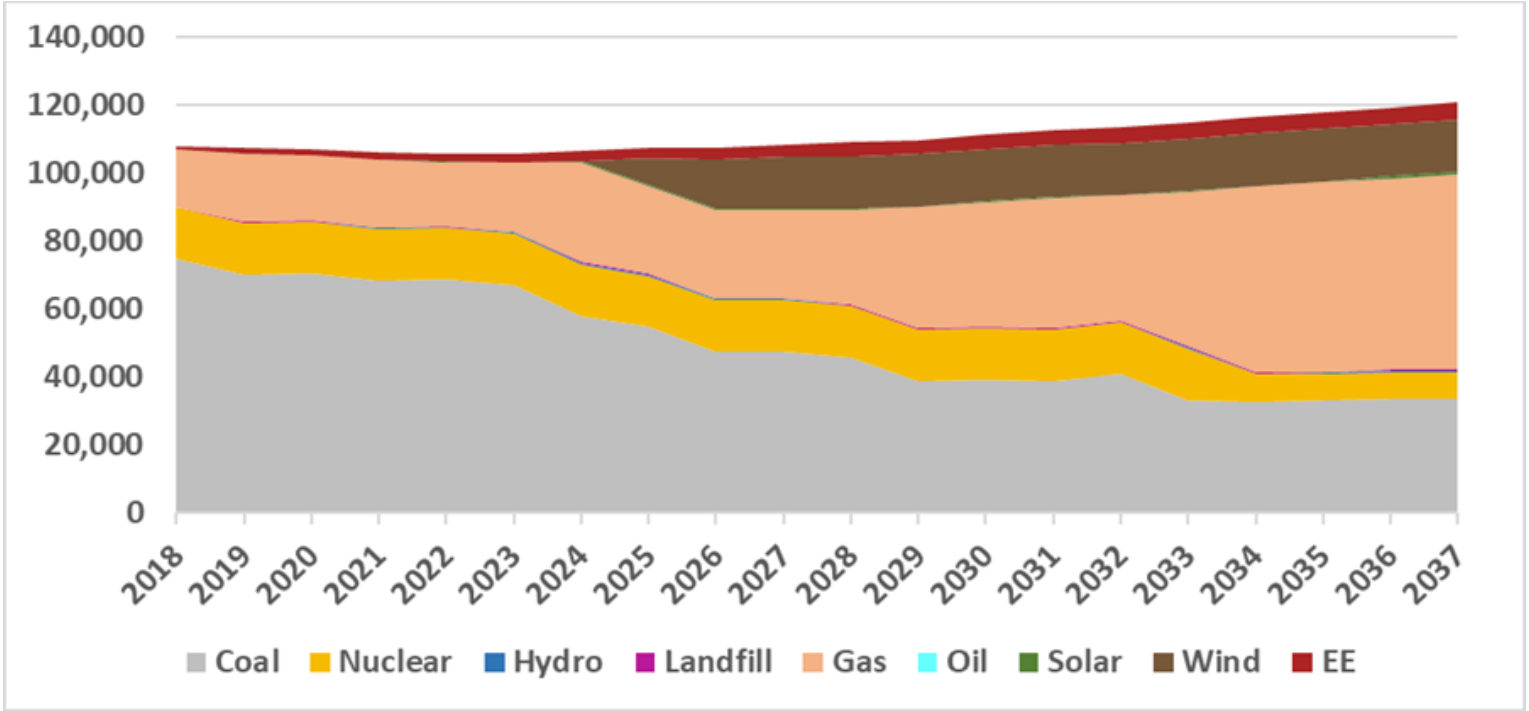
Limitations in the analyses

- It should be noted that some of the scenarios and sensitivities resulted in a large portion of the state's energy coming from intermittent, low inertia sources like wind and solar. The analysis did not address the operational challenges of very high reliance on these sources.
- Due to time and data limitations, SUFG did not allow the resource expansion model to select energy storage as a future resource option. It is possible that energy storage would have been selected if available, especially where large amounts of intermittent resources were chosen.

Reference Scenario

Business as usual

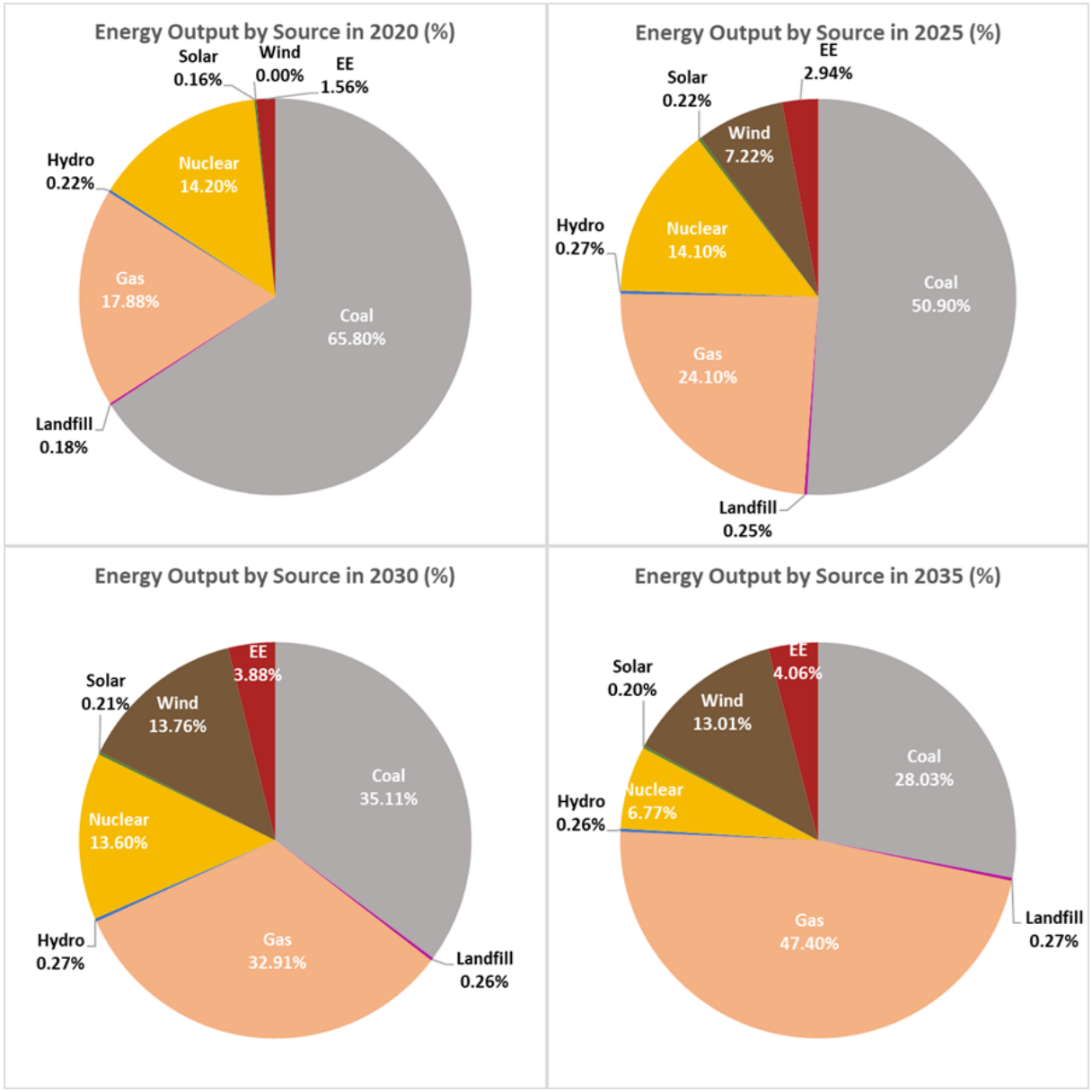
- Updated version of SUFG's 2019 electricity forecast
- Resource planning model selected a balanced mix of natural gas combustion turbine, natural gas combined cycle, and wind capacity
- Some solar photovoltaic (PV) was added in the last two years



* EE – Energy efficiency

Reference Scenario

- Share of generation from coal drops by roughly 50% from 2020 to 2030
- Share of generation from natural gas almost triples by 2035
- Share of generation from wind becomes significant
  - Note: the figure does not include energy from purchase power agreements, which is how Indiana utilities acquired wind energy as of 2020



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Low Renewables Cost Scenario

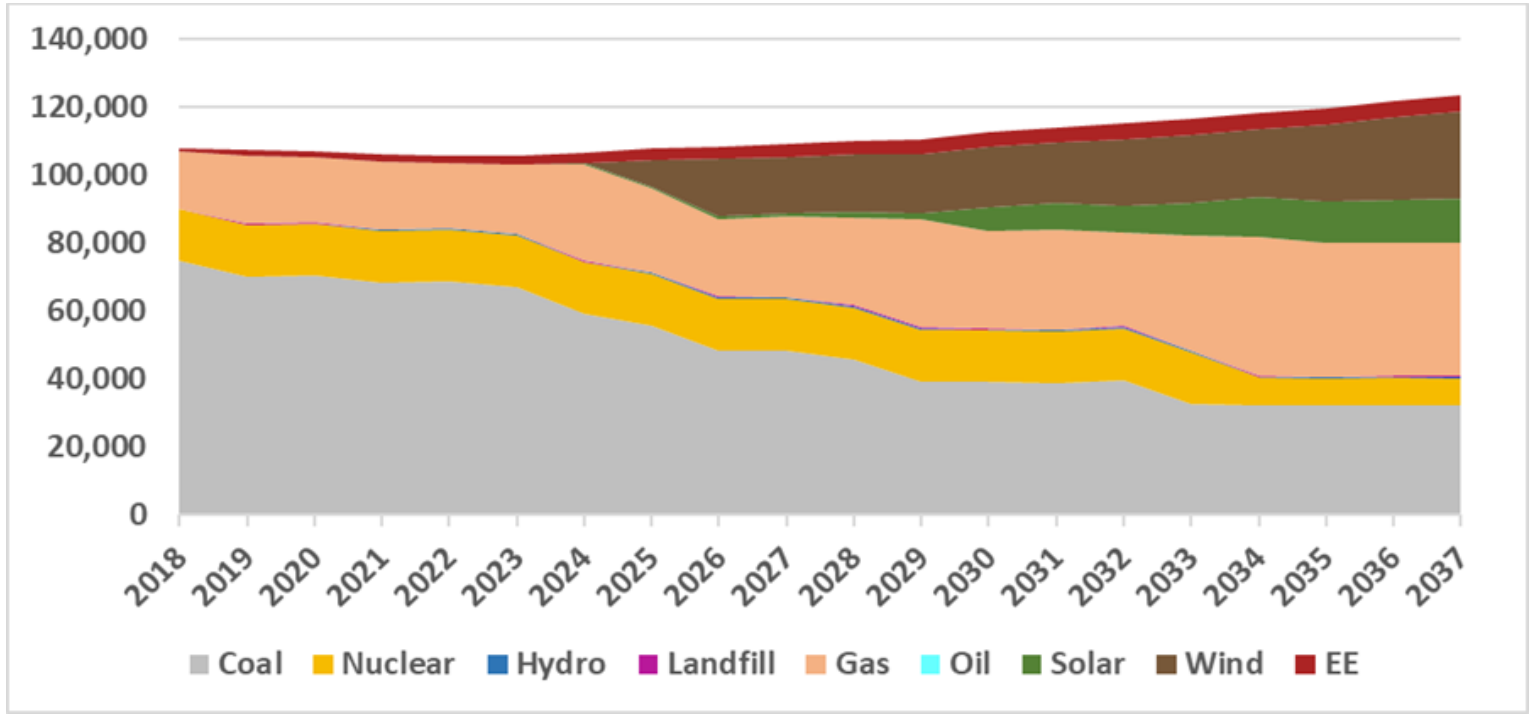
Stakeholders expressed concern about the costs of renewables in the Reference Scenario

- The Reference Scenario used capital costs for wind and PV from the Energy Information Administration (EIA), which seemed high compared to other public reports
- This scenario used capital costs from the National Renewable Energy Lab (NREL), which were lower
- More aggressive reductions of costs in the future were also modeled

Low Renewables Cost Scenario

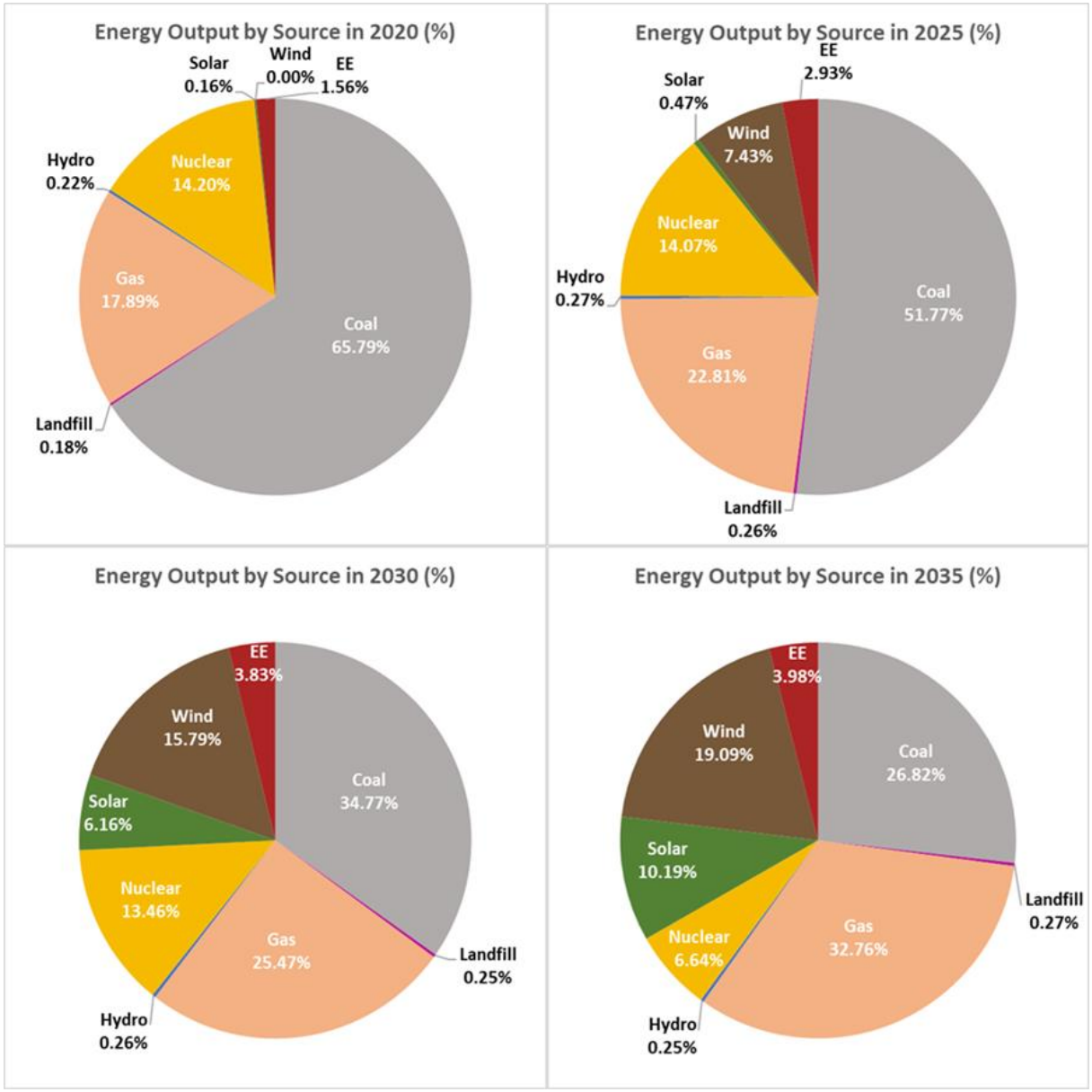
Wind & solar cost less to build

- As expected, lower capital costs for renewables resulted in more wind and solar being selected
- More than 8,200 MW of PV added vs. almost 600 MW in Reference Scenario
  - added earlier (2024 vs. 2036)
- Wind capacity increased from 5.7 GW to 9.5 GW
- Natural gas combined cycle down from 6.0 GW to 3.7 GW



Low Renewables Cost Scenario

- Energy from wind and solar is much higher relative to the Reference Scenario
  - About 30% vs. 13% by the end of the analysis period
- Renewables primarily displace natural gas, with coal largely unchanged
- This scenario achieves the most balanced portfolio of all scenarios analyzed
  - 27% coal, 33% natural gas, 29% wind/PV in 2035



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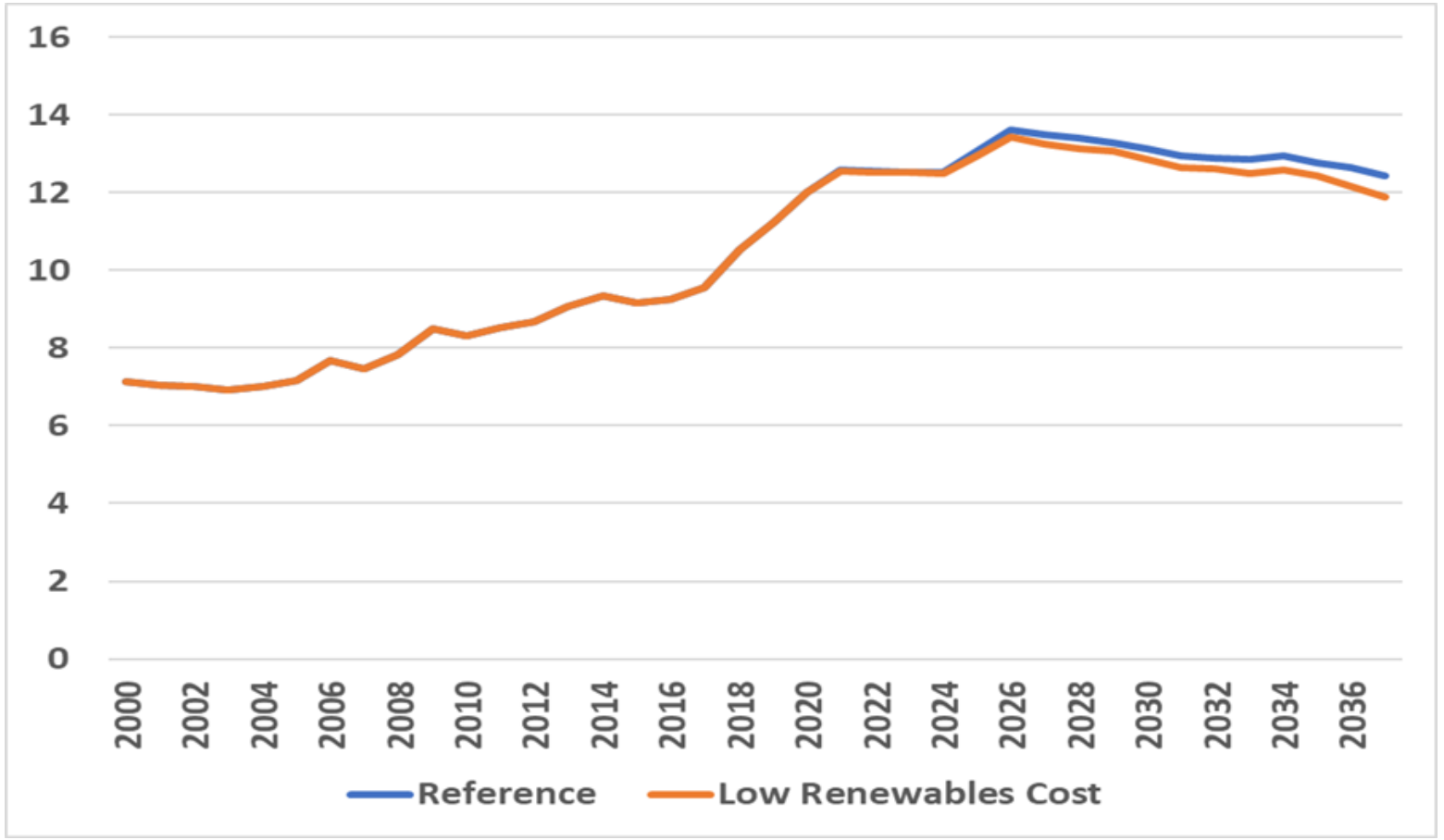
Indiana Electricity Price Projections (2017 cents/kWh)

Low Renewables Cost Scenario vs. Reference Scenario

- As expected, lower capital costs result in lower prices
- Price reduction grows over time, from about 1% in 2025 to 5% at the end of the analysis period
- Note: electricity prices are a weighted-average price across all customer classes for the 5 investor-owned utilities
  - Excludes rural cooperatives and municipal utilities



2025 Moratorium Scenario

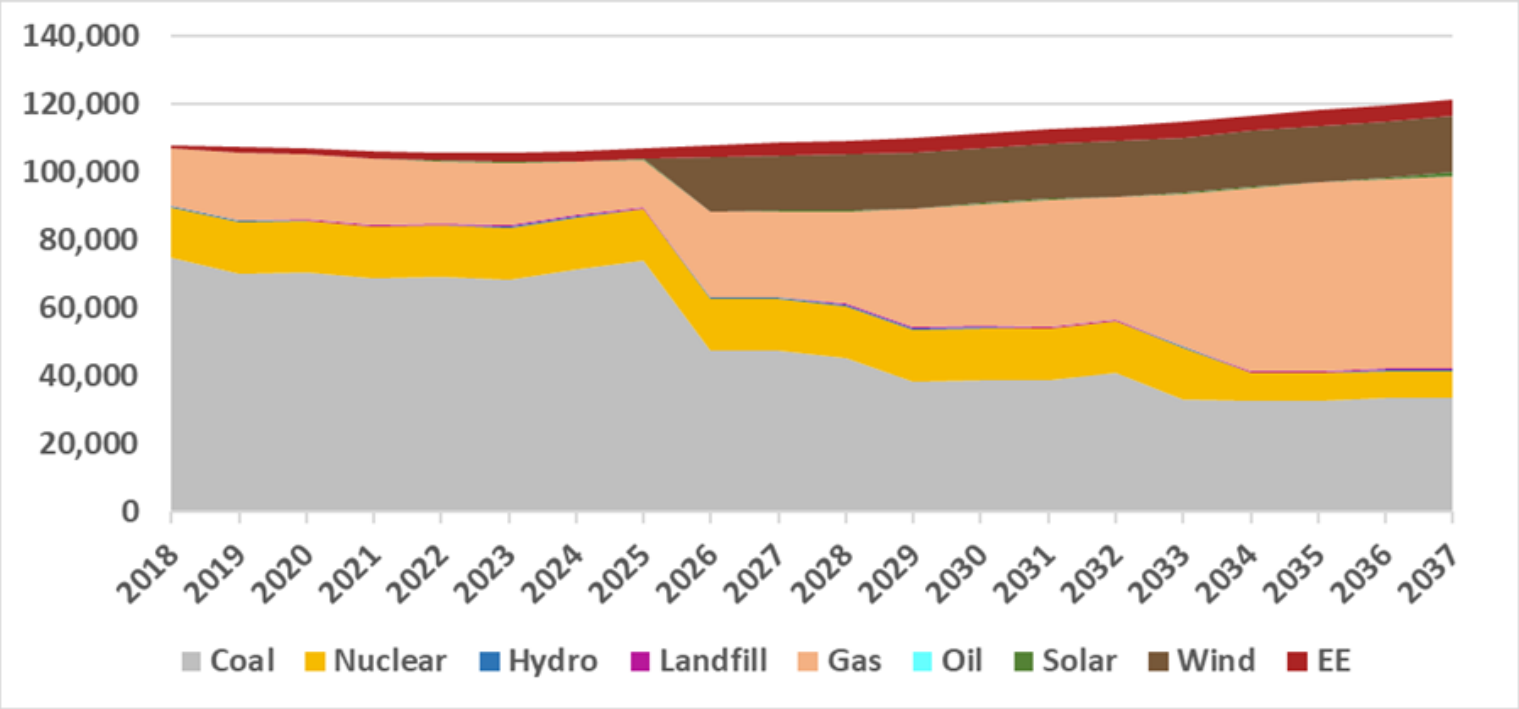
Utility plans include a significant amount of coal-fired generation retirements

- SUFG acquired data from the utilities about the costs that would be incurred to keep those units online through 2025
- For this scenario, units were not allowed to retire prior to the end of 2025
- The units affected by the moratorium were retired beginning in 2026
- Two units (Duke Energy's Gallagher units 2 & 4) could not be extended because of signed Consent Decrees
- Indiana Michigan Power leases its Rockport unit 2 and it will not be renewing the lease, so it was not extended

2025 Moratorium Scenario

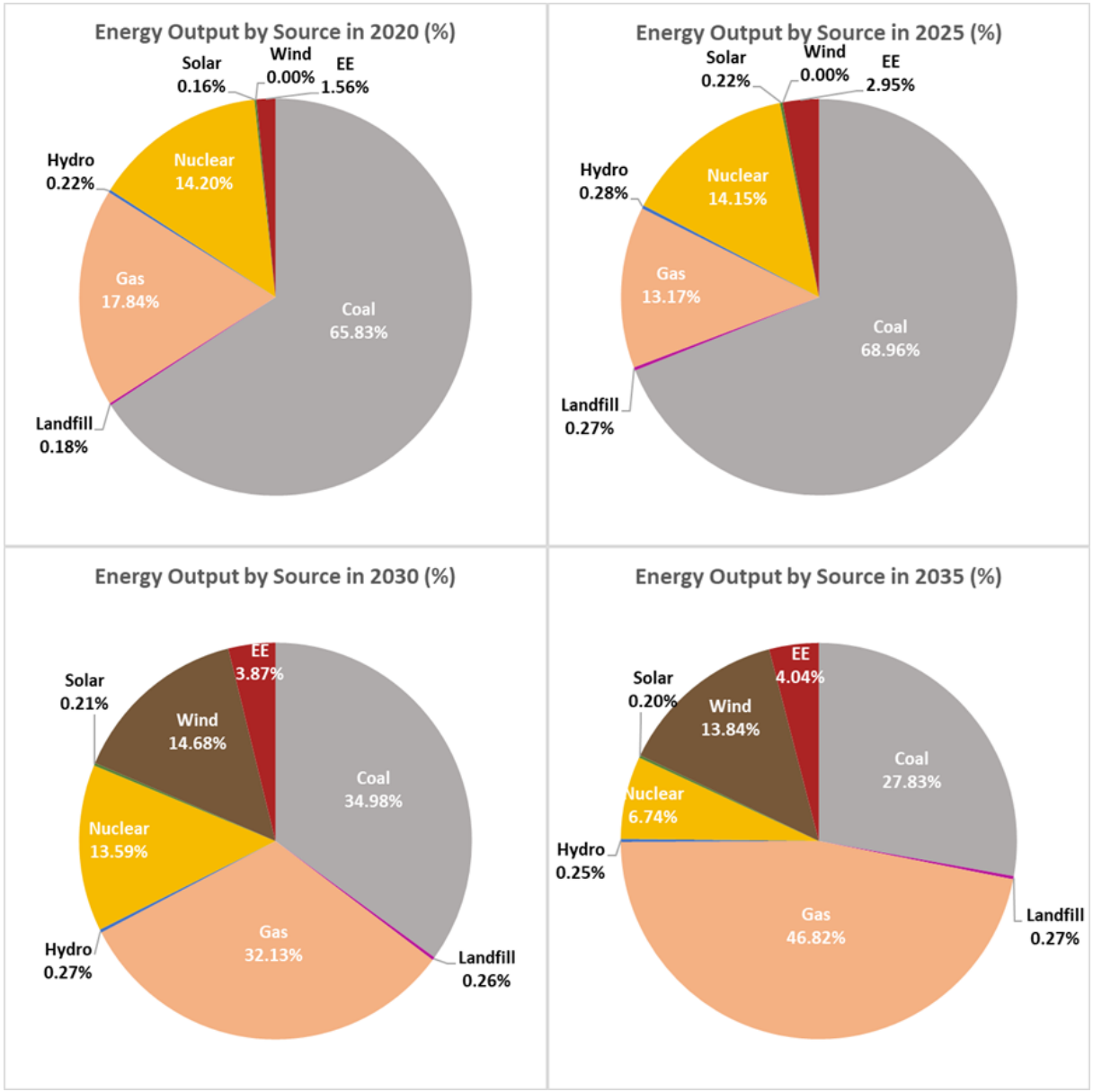
Delayed coal retirements

- While the moratorium pushed back the need for additional resources from 2024 to 2026, it had little long-term influence
- As in the Reference Scenario, a balanced mix of natural gas combustion turbine, natural gas combined cycle, and wind capacity



2025 Moratorium Scenario

- The energy mix in 2025 is quite different than in the Reference Scenario
  - Coal higher (69% vs. 51%)
  - Natural gas lower (13% vs. 24%)
  - No wind yet
- After the moratorium expires, the results are very similar to the Reference Scenario



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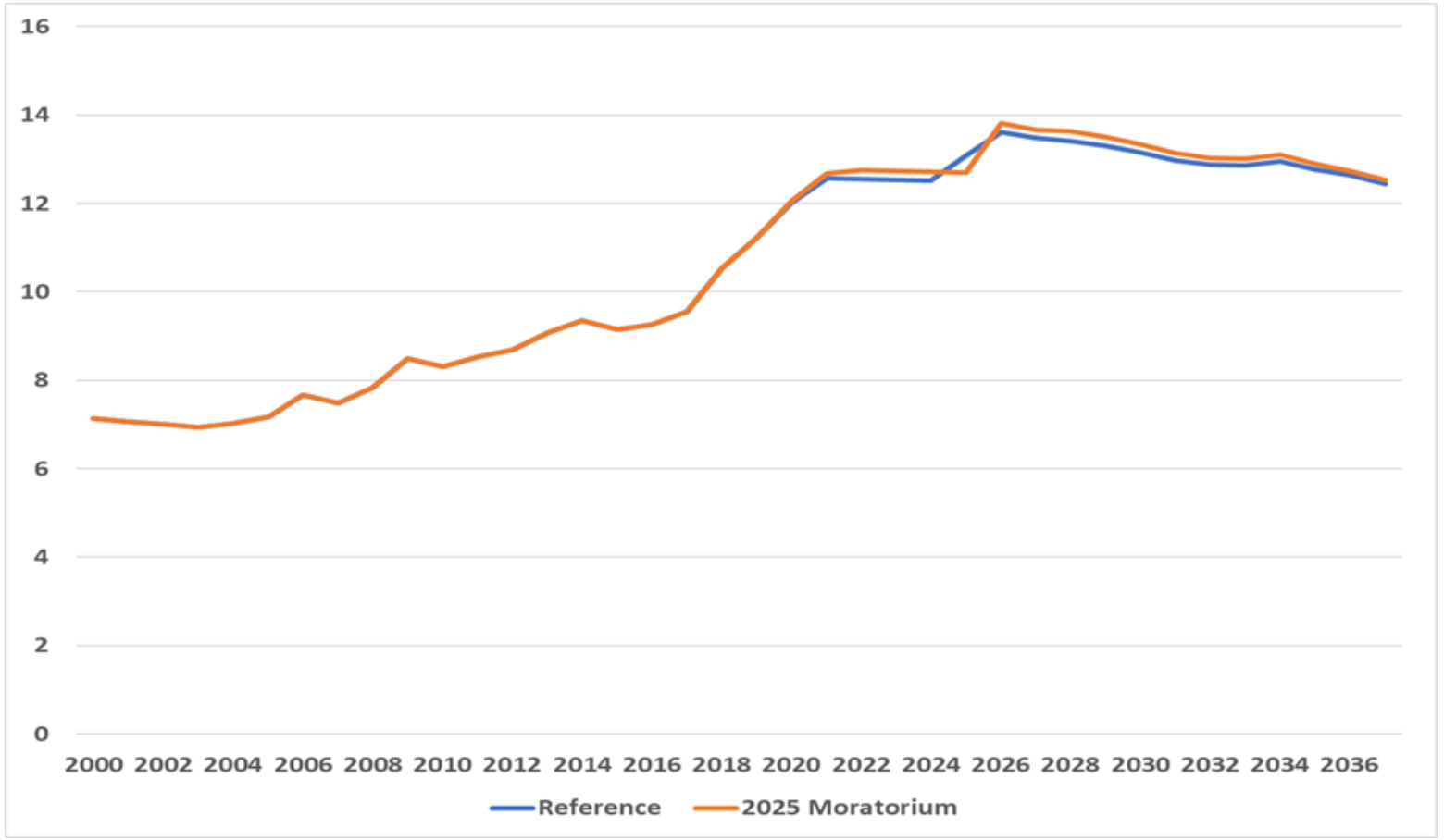
Indiana Electricity Price Projections (2017 cents/kWh)

2025 Moratorium Scenario vs. Reference Scenario

- Electricity prices are generally slightly higher (1-2%) than in the Reference Scenario
- The costs associated with extending the life of the affected units offset the cost of replacement capacity



2030 Moratorium Scenario

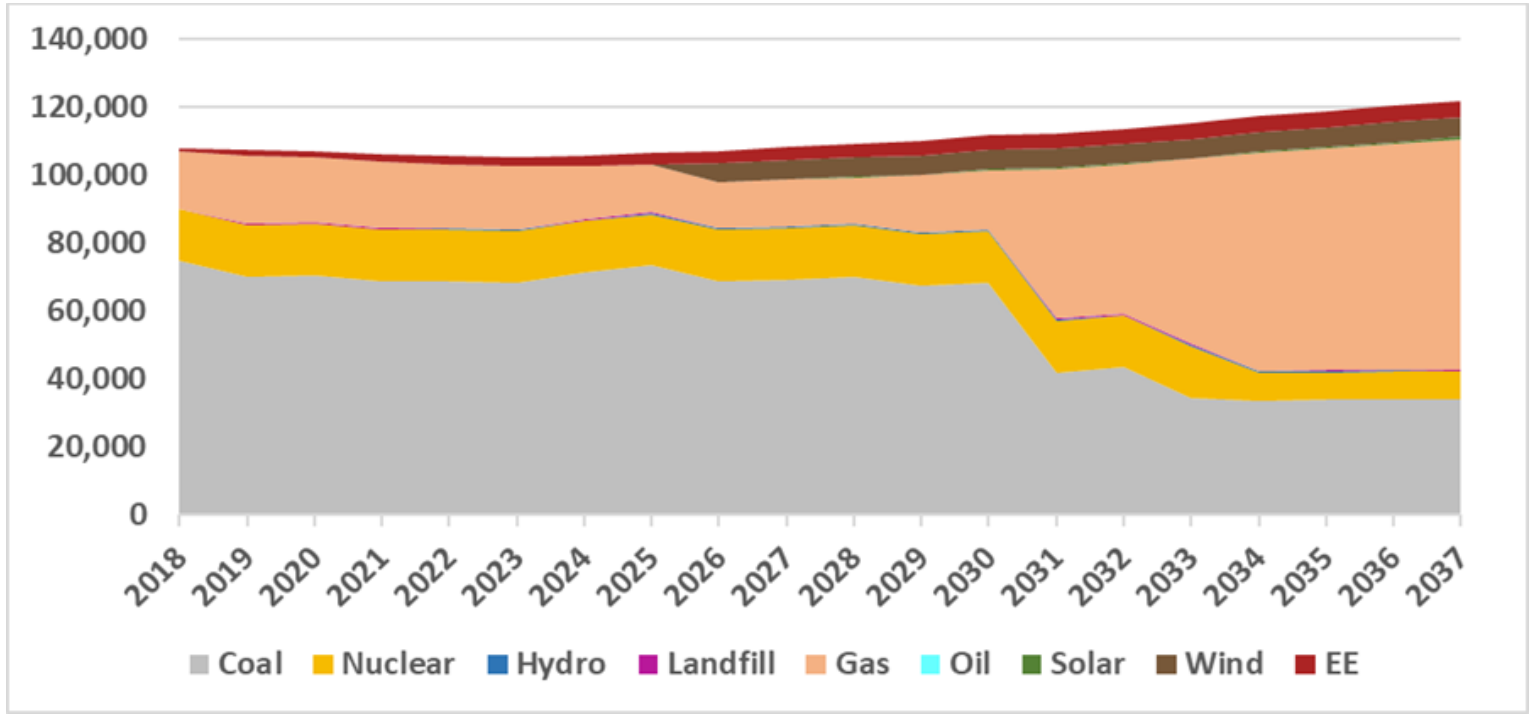
Longer extension of moratorium on coal-fired generation retirements

- This is similar to the 2025 Moratorium Scenario, but extends the restrictions on coal retirements to the end of 2030
- In addition to the three units exempted from the moratorium, Indiana Michigan Power's Rockport unit 1 is subject to a signed Consent Degree

2030 Moratorium Scenario

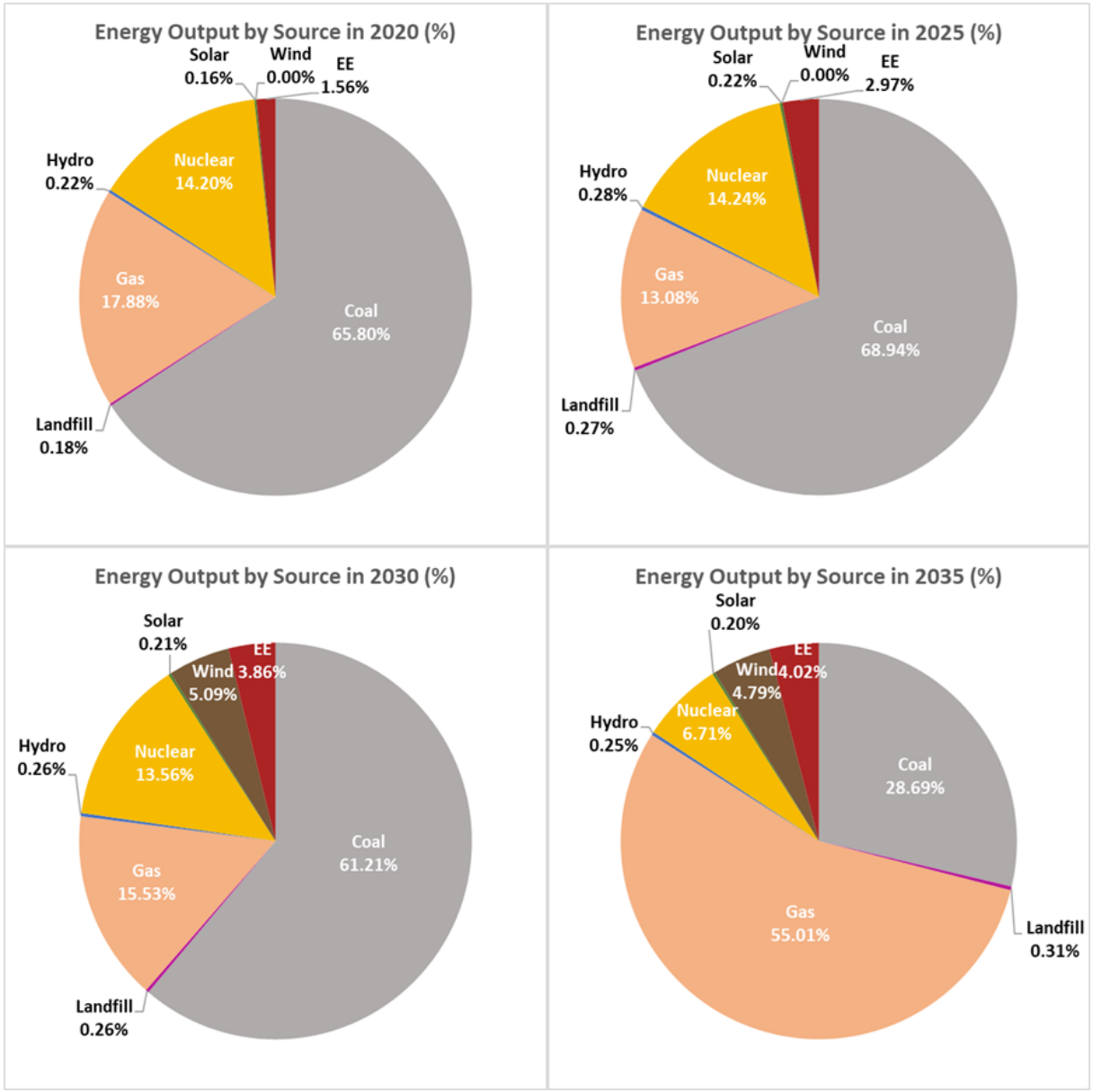
Further delayed coal retirements

- As in the previous scenario, new resources are not needed until 2026
- Significant new resources are needed in 2031 when the delayed retirements occur
- Wind capacity decreased from 5.7 GW in the Reference Scenario to 2.1 GW
- Combined cycle increased from 6.0 GW to 7.4 GW



2030 Moratorium Scenario

- Energy from coal stays strong through 2030, then drops
  - 61% in this scenario vs. 35% in Reference Scenario in 2030
- Switch to natural gas is delayed, but ends up being higher
  - 55% in this scenario vs. 47% in Reference Scenario in 2035
- Wind is significantly lower



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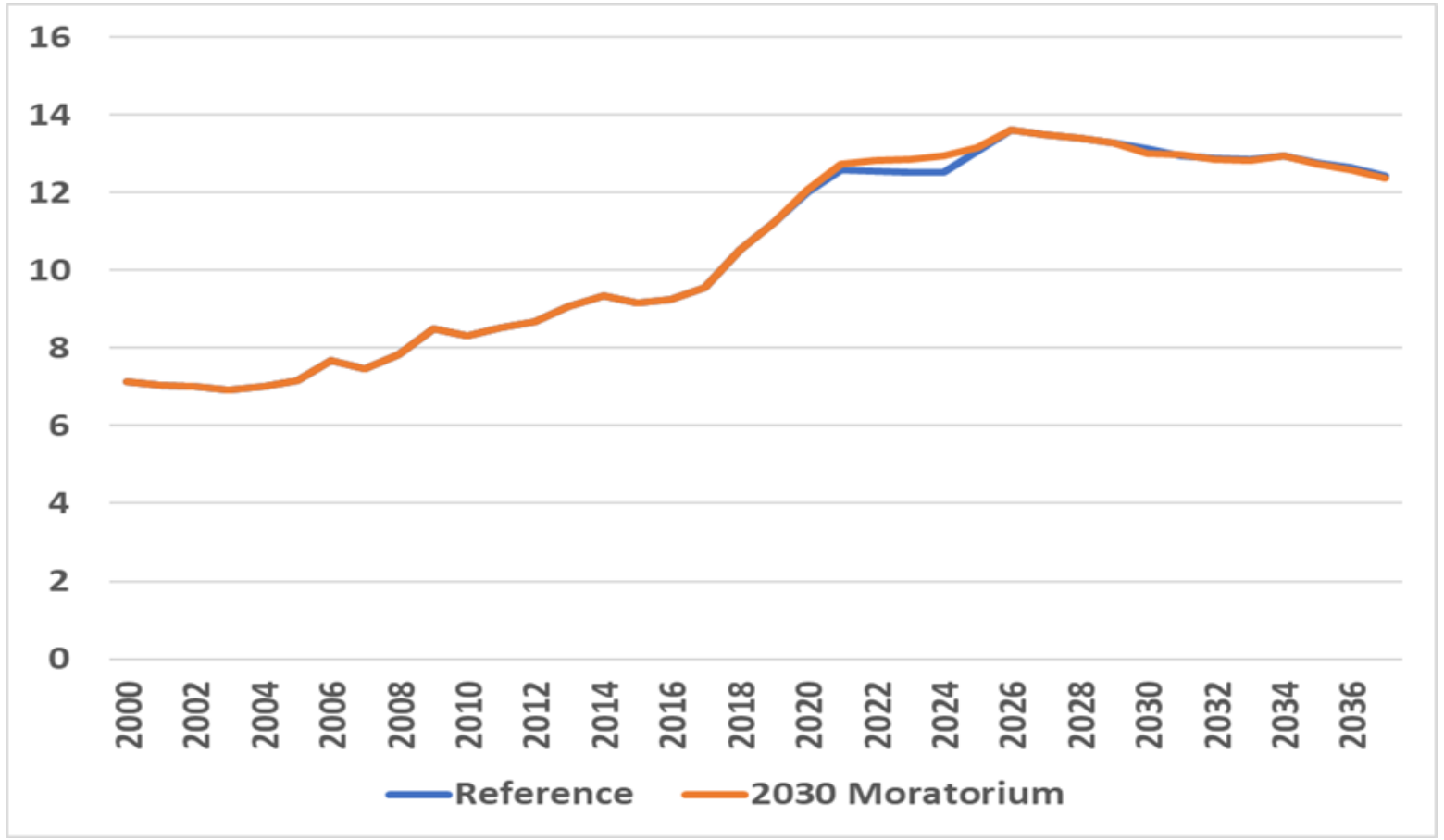
Indiana Electricity Price Projections (2017 cents/kWh)

2030 Moratorium Scenario vs. Reference Scenario

- Electricity prices are 1-4% higher in the short term and virtually unchanged in the long term



Additional EE Scenario

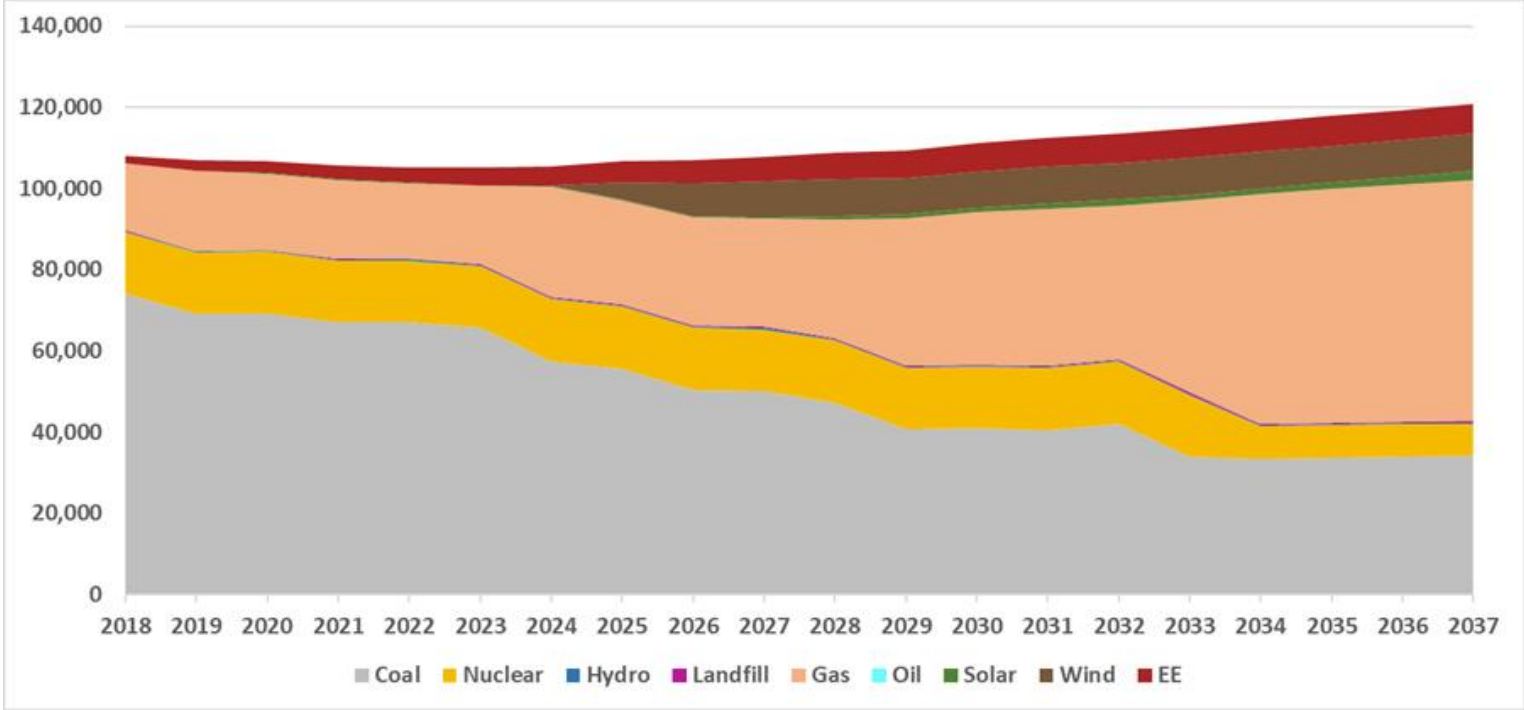
A scenario that examined the impact of more aggressive energy efficiency programs

- SUFG lacked information on the potential for and cost of higher levels of utility-sponsored EE, so a simplified approach was used
- SUFG doubled the amount of EE for each utility except NIPSCO, based on the EE in the utility's most recent Integrated Resource Plan (IRP)
  - NISPCO's EE levels were already high, so doubling caused very low net loads and very high prices
- EE program costs were also doubled, which understates costs
  - Adding incremental EE beyond the levels chosen in the IRPs would be more expensive than the programs that were selected

Additional EE Scenario

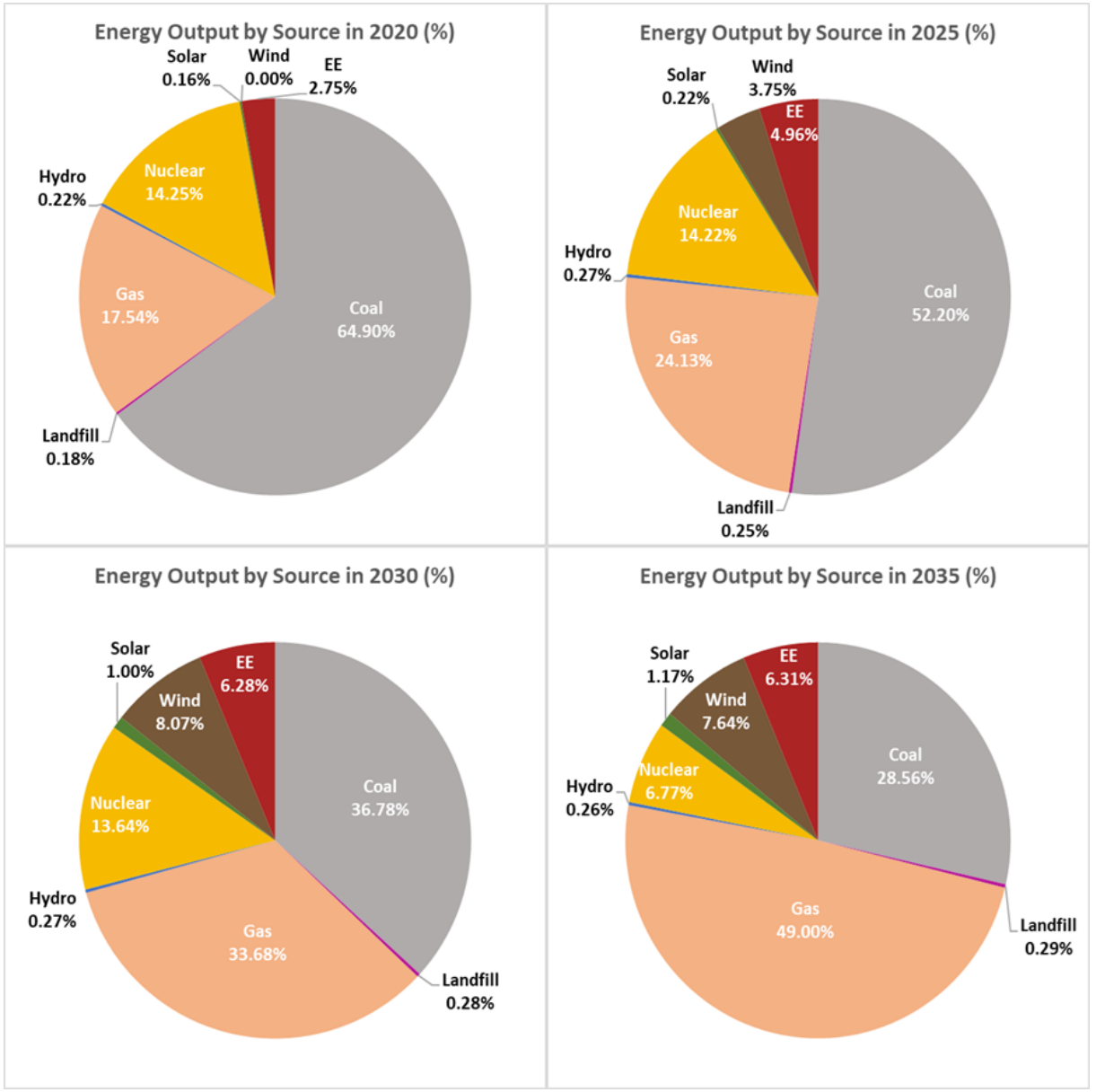
More aggressive EE

- The higher levels of EE displaced some of the additional generation resources
- Wind was lower compared to the Reference Scenario (3.3 GW vs. 5.7 GW)
- Combustion turbines were lower (3.8 GW vs. 5.0 GW)
- Combined cycle were slightly higher (6.3 GW vs. 6.0 GW)
- PV was higher (1.4 GW vs. 0.6 GW)



Additional EE Scenario

- As expected, EE represented a larger share of energy
  - 6.3% vs. about 4% in Reference Scenario in 2030 and 2035
- Wind was lower
  - About 8% vs. 13-14%
- Other sources were largely unchanged



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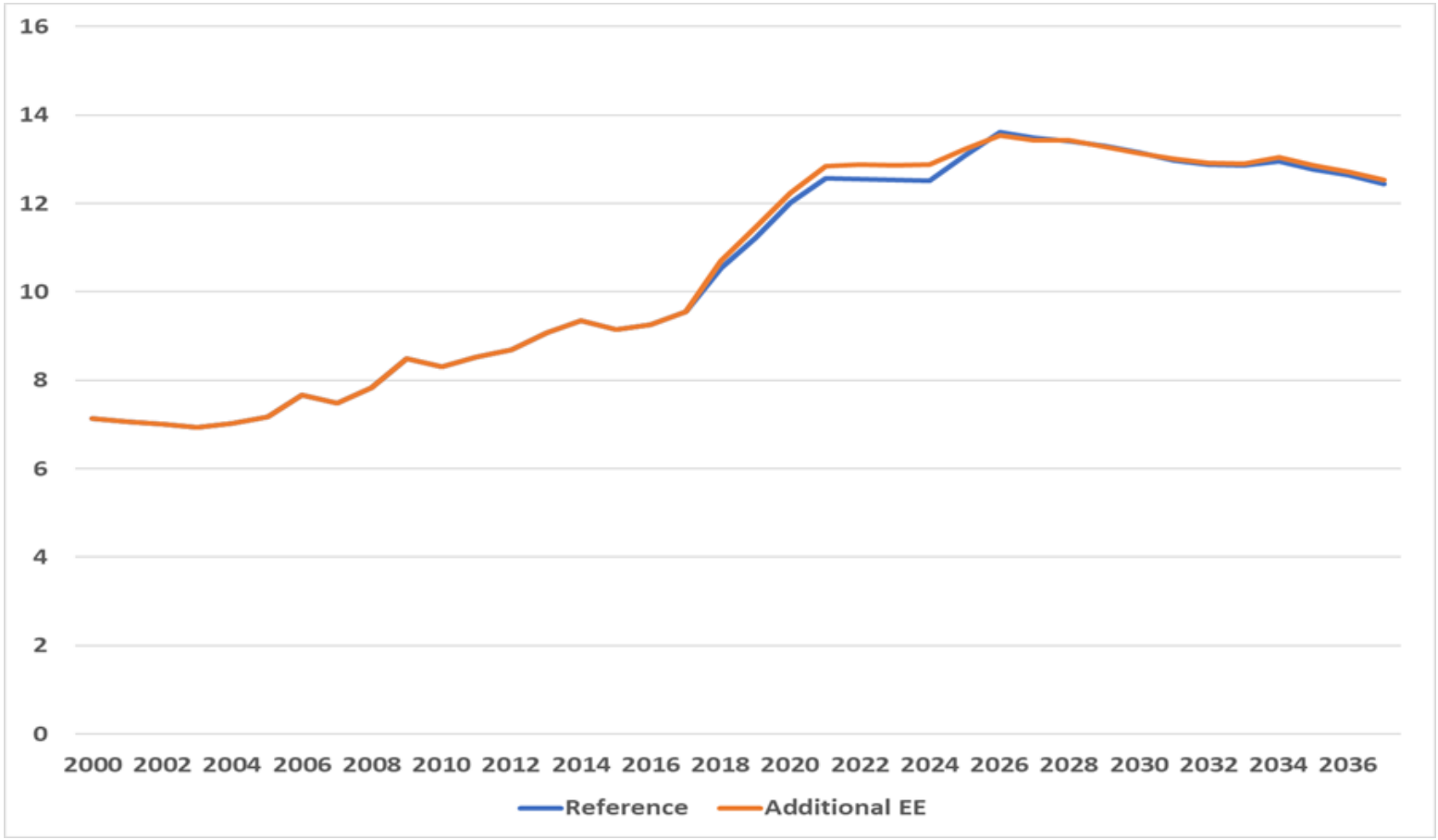
Indiana Electricity Price Projections (2017 cents/kWh)

Additional EE Scenario vs. Reference Scenario

- Prices are 2-3% higher through 2024, as there is little avoided cost of new generation during this time
- Prices are less than 1% higher in the long term
- Recall that the EE program costs are known to be understated, so actually price impacts may be slightly larger
- Note that higher prices do not mean higher bills, since usage is also reduced



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Industrial Self-Generation Scenario

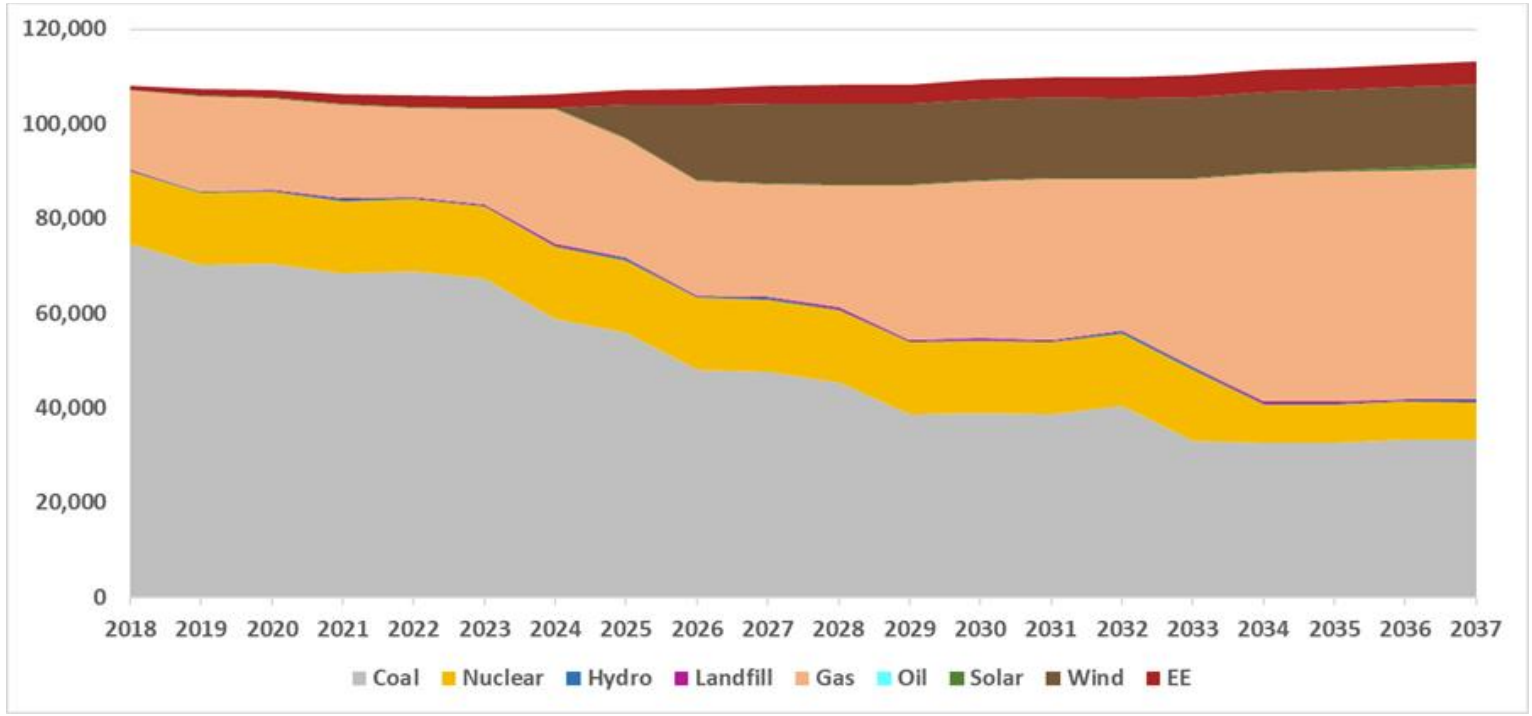
A scenario that examined the impact of significant industrial self-generation, co-generation, and combined heat & power

- Since industrial self and co-generation is highly uncertain and SUFG lacked the capability to credibly forecast these developments, a proxy was used
- Assumed that all future growth in industrial electricity consumption was completely offset (no load growth)
- This applied only to the investor-owned utilities, since SUFG does not forecast at the sector level for the not-for-profit utilities

Industrial Self-Generation Scenario

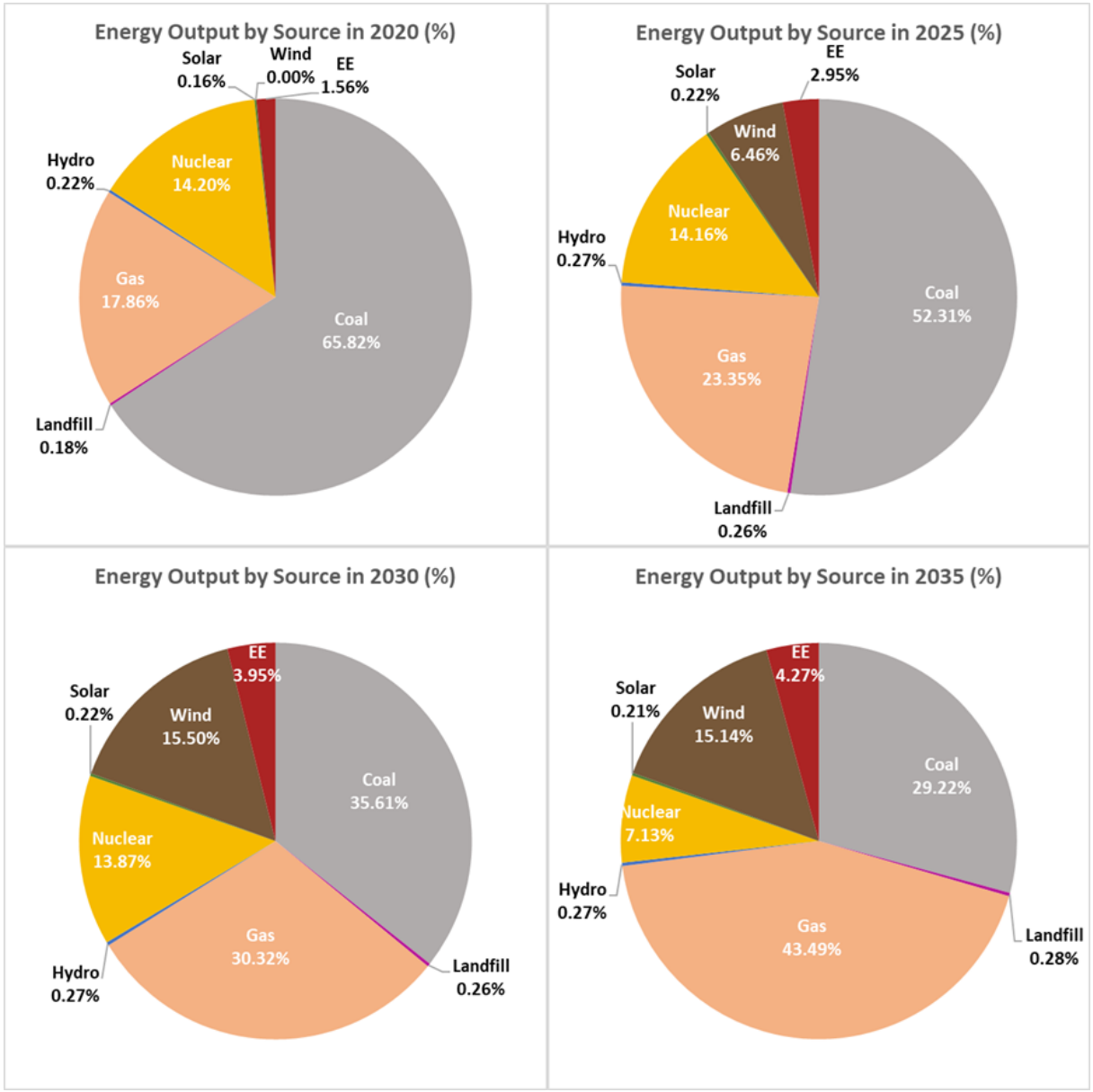
Flat industrial load

- Overall future resource needs were lower due to lower load
- Wind capacity was actually somewhat higher than in the Reference Scenario (6.3 GW vs. 5.7 GW)
- Combined cycle additions lower (4.9 GW vs. 6.0 GW)
- PV and combustion turbines slightly lower



Industrial Self-Generation Scenario

- Shares by source largely unaffected
- Wind increased somewhat
- Natural gas down slightly



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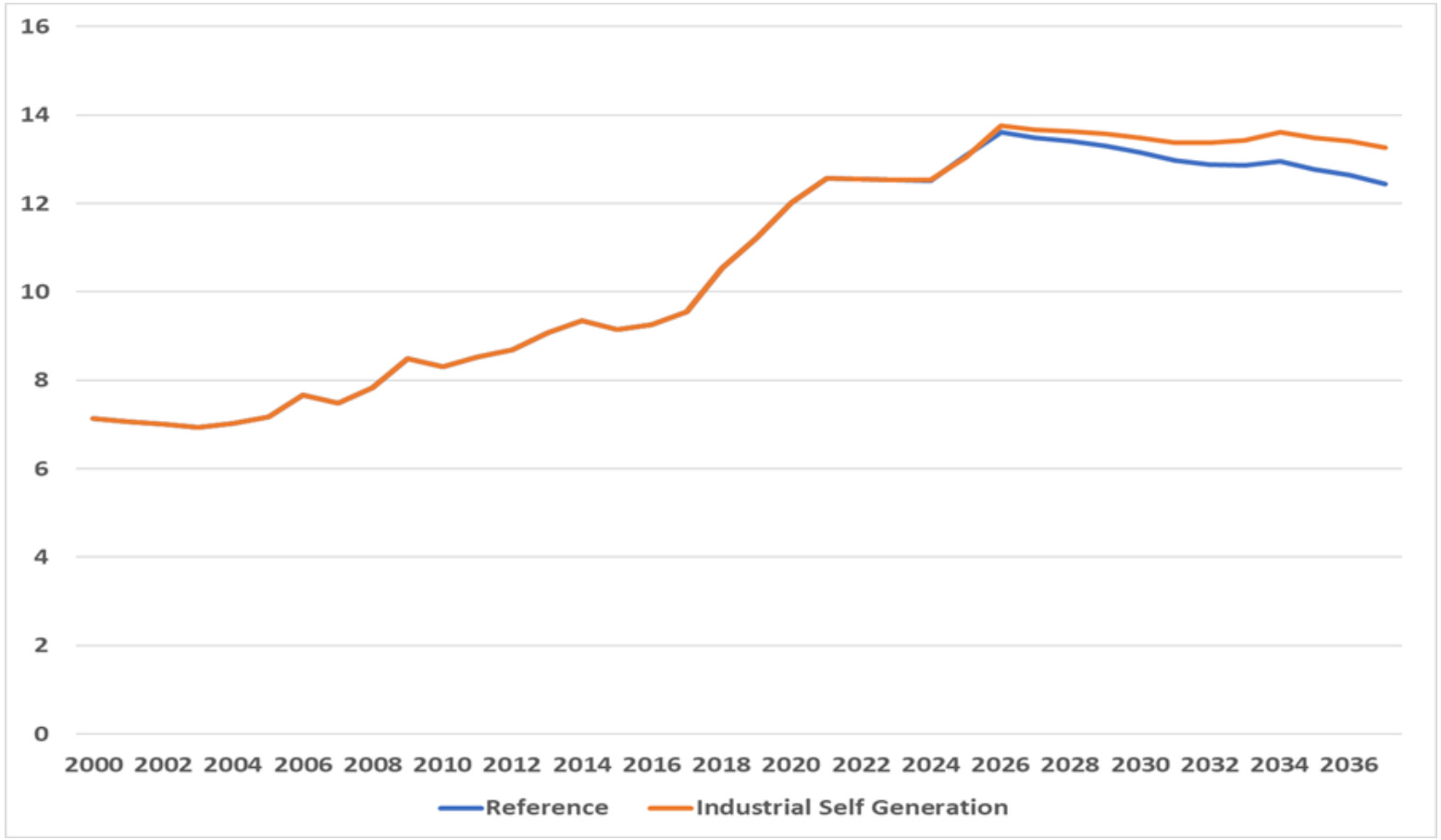
Indiana Electricity Price Projections (2017 cents/kWh)

Industrial Self-Generation Scenario vs. Reference Scenario

- Long-term prices were higher, relative to the Reference Scenario
  - 1% higher in 2026
  - 7% higher in 2037
- Reduction in sales was greater than the reduction in revenue requirements



High Natural Gas Price Scenario

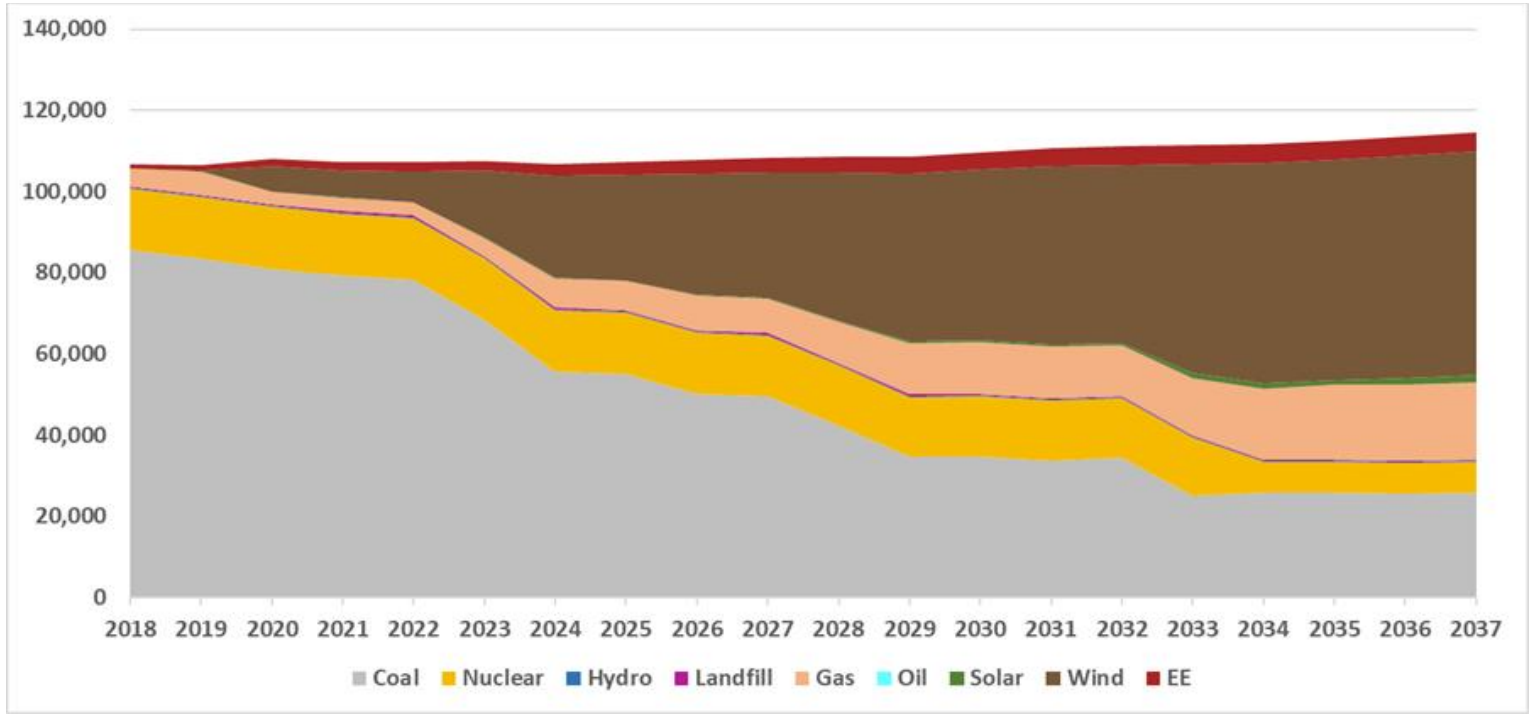
A scenario that examined the impacts of high natural gas prices that might occur if hydraulic fracturing (aka fracking) was banned

- The price of natural gas under a fracking ban would be purely speculative
- An arbitrary, very high price of $10/mmBtu for the electricity sector was used
- An equivalent natural gas price was also used for the forecasting models using typical differences in distribution costs

High Natural Gas Price Scenario

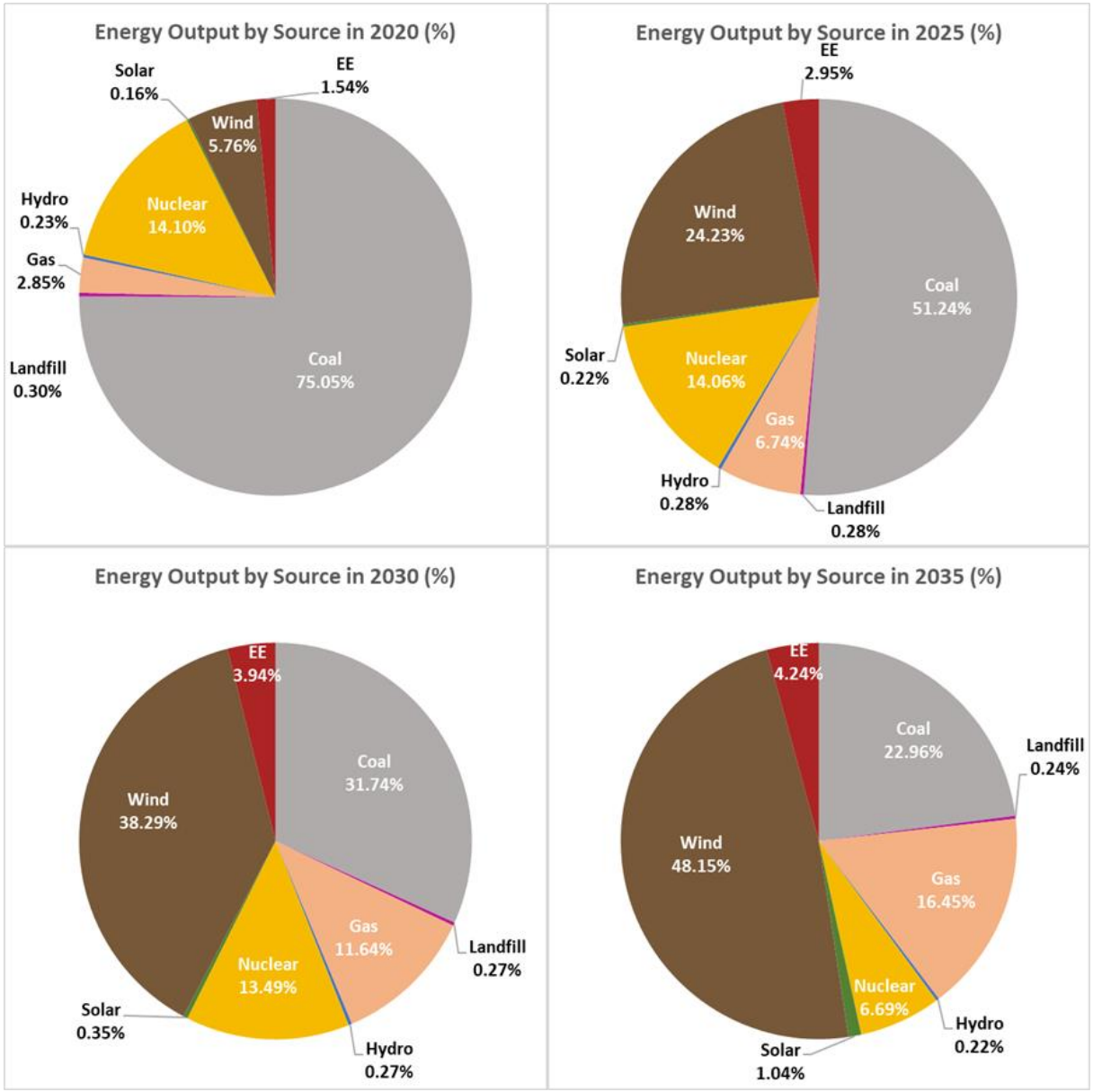
Fracking ban

- Of all scenarios, this one had the largest impact on resource selection
- Wind capacity quadrupled from the Reference Scenario from 5.7 GW to 22.8 GW, with over 2 GW added immediately
- PV roughly doubled from 0.6 GW vs. 1.1 GW
- Combined cycle dropped from 6.0 GW to 0.8 GW
- Combustion turbines increased from 5.0 GW to 6.5 GW
- New coal/nuclear were still not selected



High Natural Gas Price Scenario

- Wind became the dominant source of energy, accounting for almost half by 2035
- Energy from natural gas dropped to about 1/3 of the amount in the Reference Scenario
- The share of energy from coal was down somewhat as those units were cycled more to adjust for the variability of wind output



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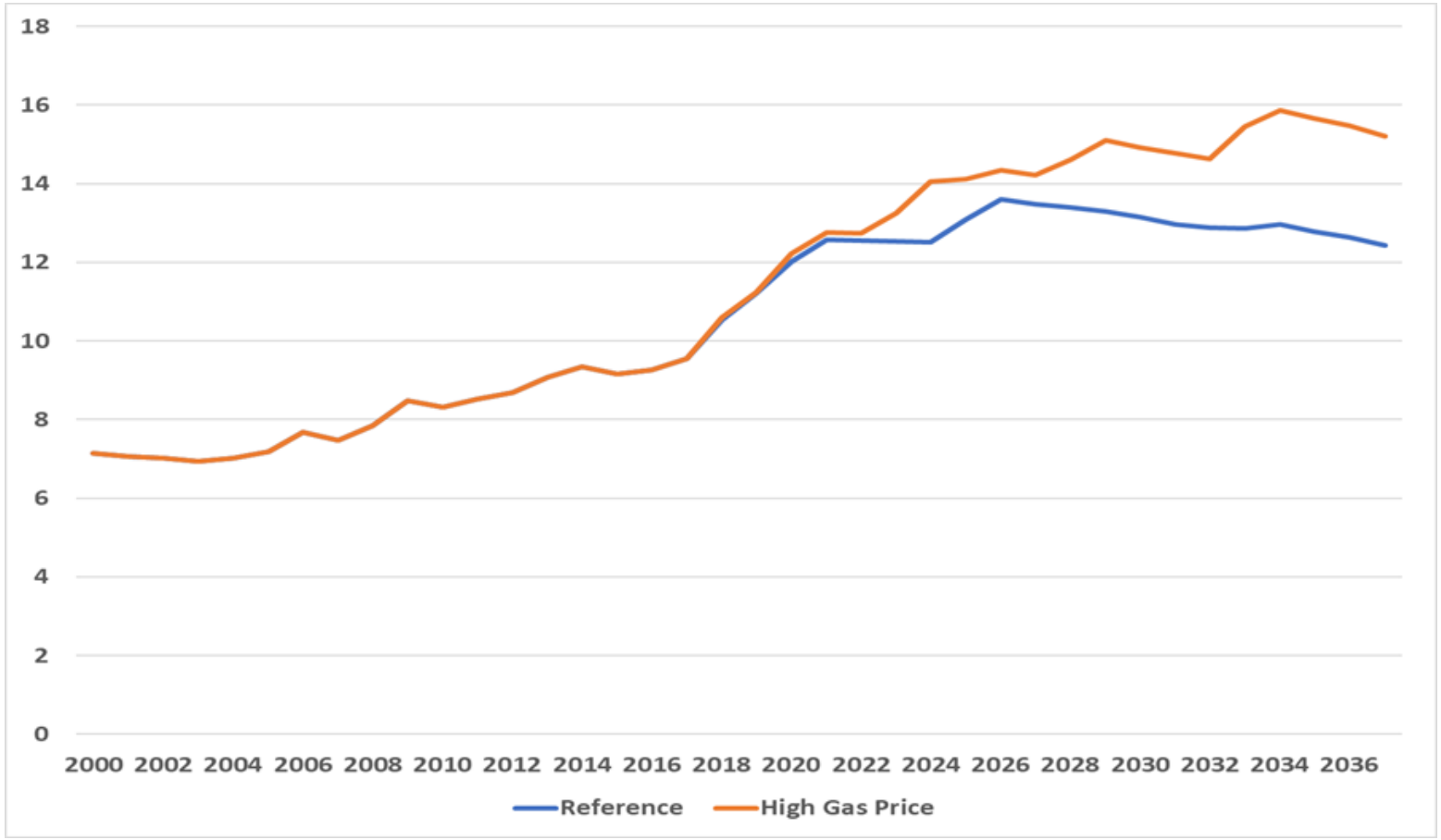
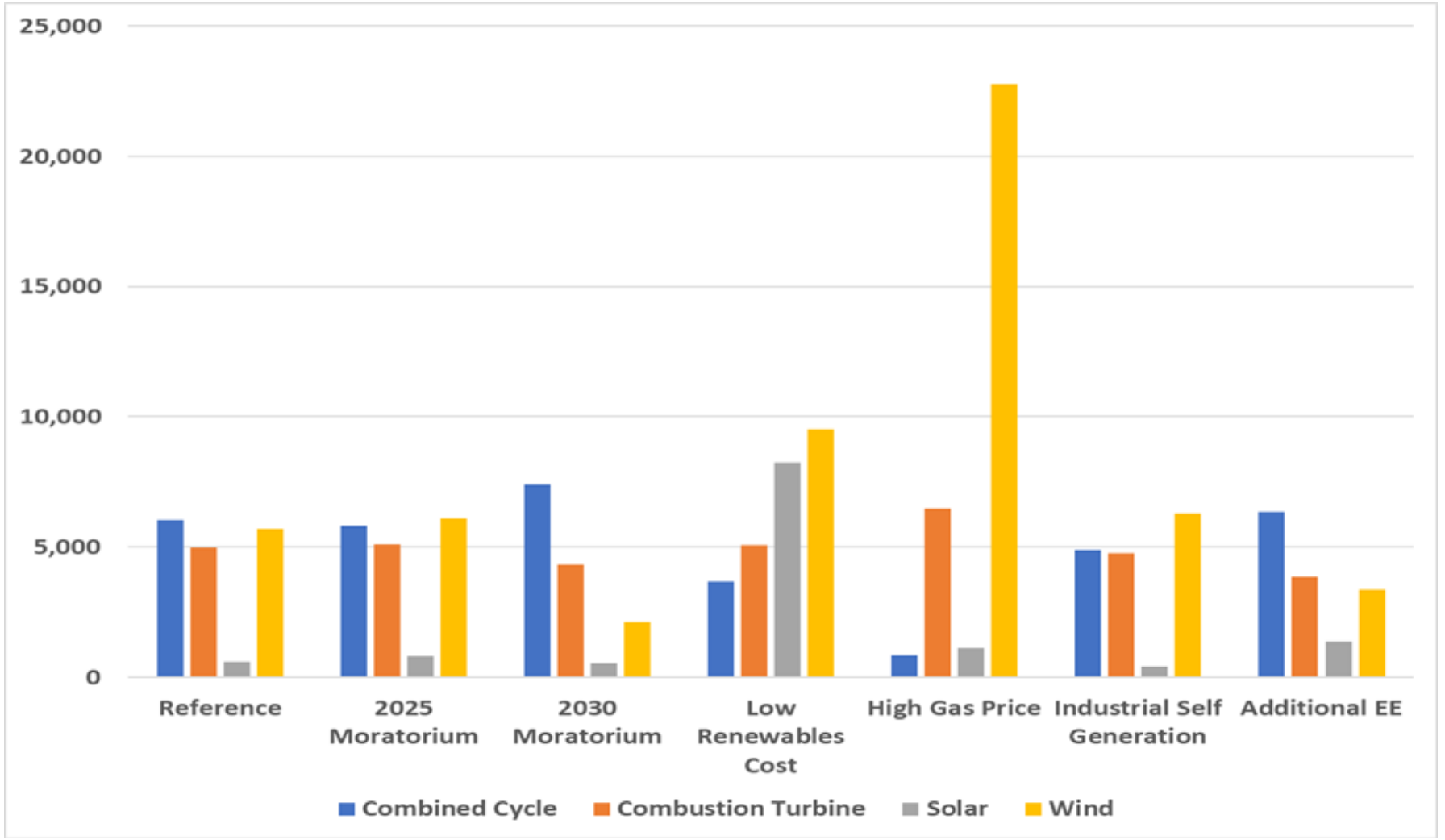
Indiana Electricity Price Projections (2017 cents/kWh)

High Natural Gas Price Scenario vs. Reference Scenario

- This scenario also saw the largest price impact
- Prices were 1-2% higher initially, then increased to over 20% higher late in the analysis period



Total Resource Additions for All Scenarios (MW)



Carbon Price Sensitivities

Carbon Price Sensitivities

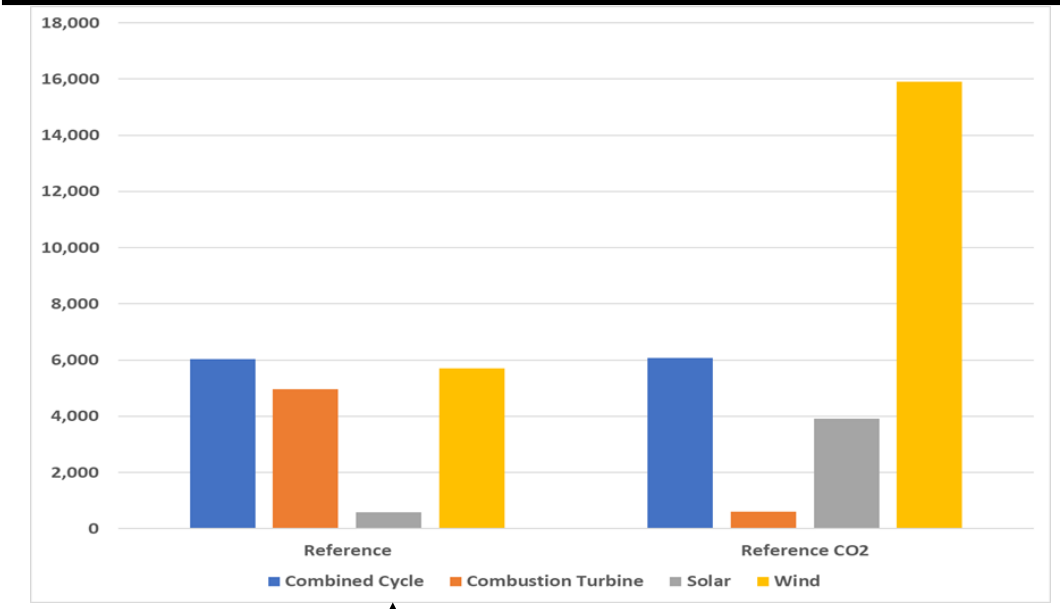
A price on CO2 emissions was added to 3 of the scenarios

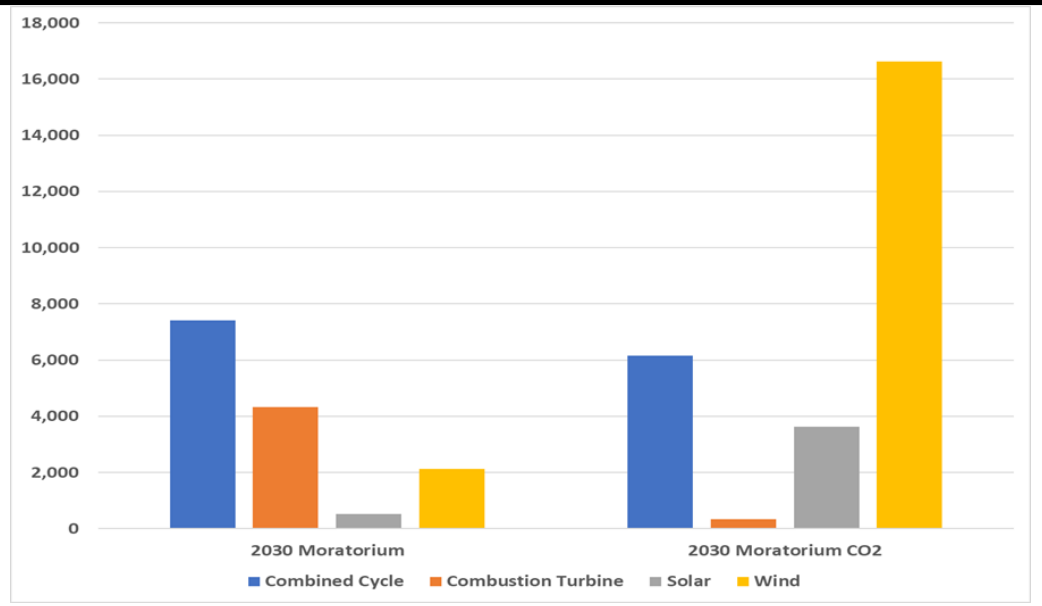
- The price trajectory was developed collaboratively by the SUFG and IURC, not to try to model any specific proposal, but to see the broader impacts
- A low initial price was chosen, which would grow to higher levels
- CO2 prices start at $2.50/ton in 2025 and grow by $2.50/ton/year thereafter
- The three scenarios selected were the Reference Scenario, the 2030 Moratorium Scenario, and the Low Renewables Cost Scenario

Carbon Price Sensitivities

- Reference Scenario
  - Significant increase in wind/solar and decrease in combustion turbines selected, combined cycles relatively unchanged
  - Energy shares in 2035: 40% natural gas, 33% wind, 9% coal
  - Electricity price: 1% higher in 2025, 14% higher in 2037 (relative to no carbon cost)
- 2030 Moratorium Scenario
  - Significant increase in wind/solar and decrease in combustion turbines selected, combined cycles down slightly
  - Energy shares in 2035: 41% natural gas, 33% wind, 9% coal
  - Electricity price: 2% higher in 2025, 19% higher in 2037 (relative to no carbon cost)
- Low Renewables Cost Scenario
  - Extremely large amount of wind selected, less solar and combustion turbines, combined cycles relatively unchanged
  - Energy shares in 2035: 59% wind, 18% natural gas, 6% coal
  - Electricity price: 2% higher in 2025, 27% higher in 2037 (relative to no carbon cost)

Carbon Price Sensitivities – Future Resources

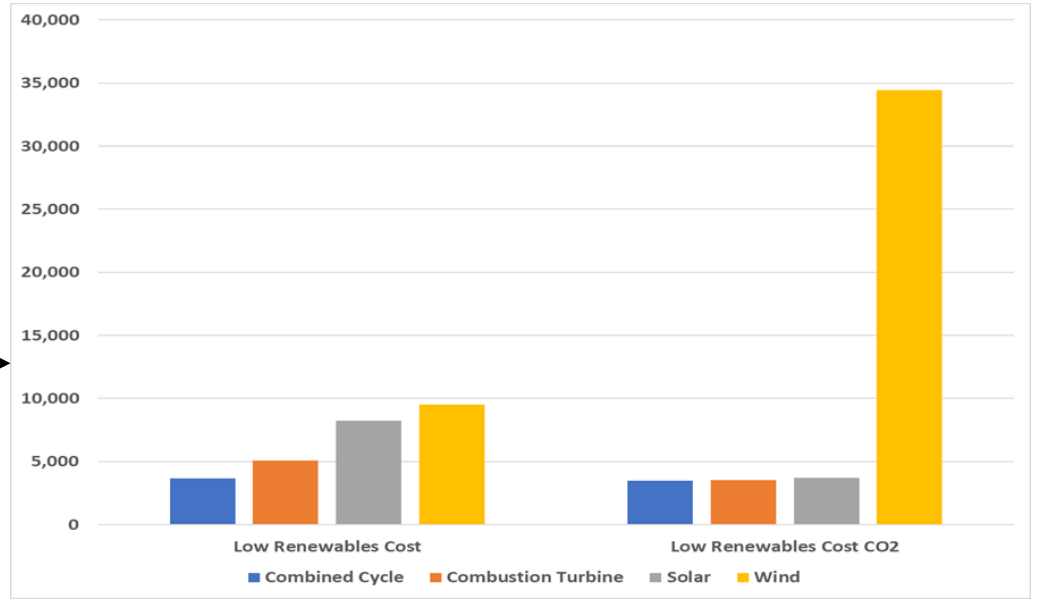




Reference

2030 Moratorium

Low Renewables Cost



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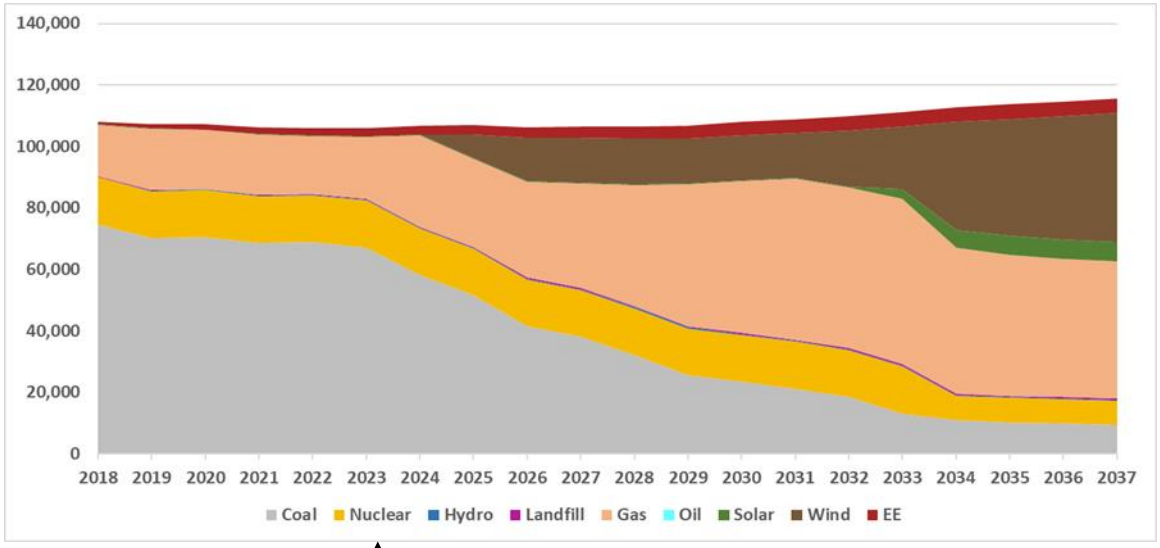
Carbon Price Sensitivities – Energy Supply



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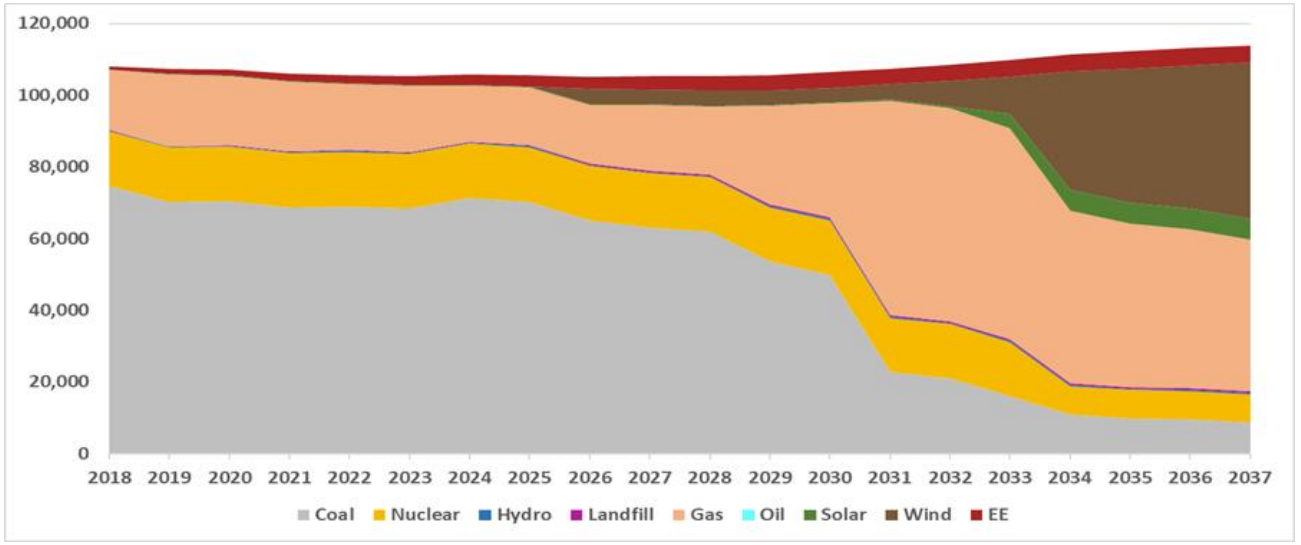
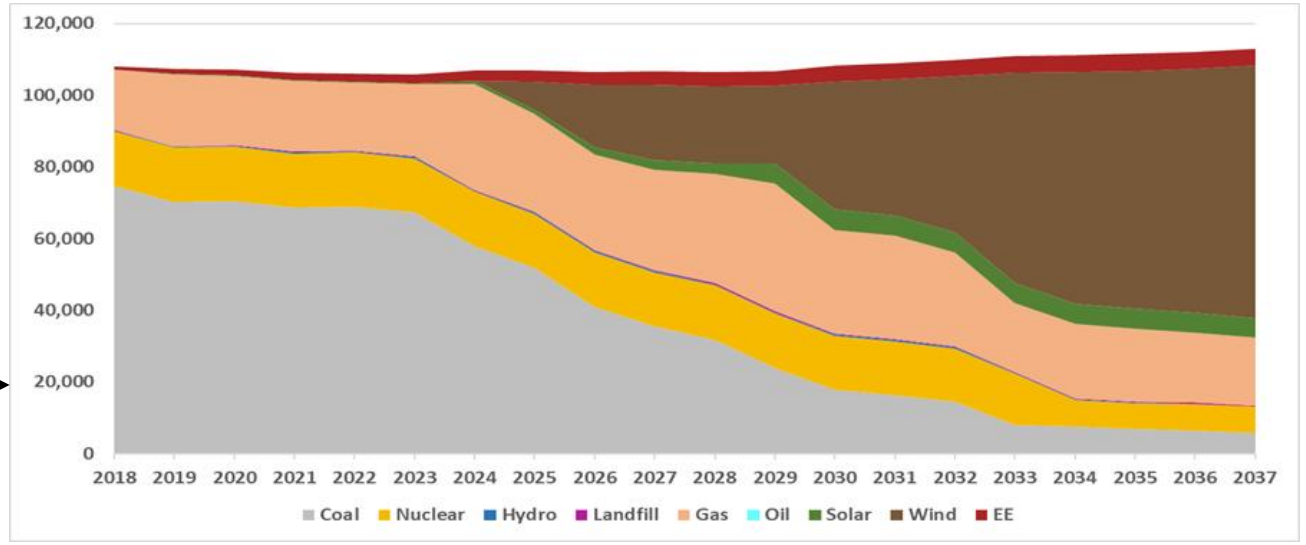
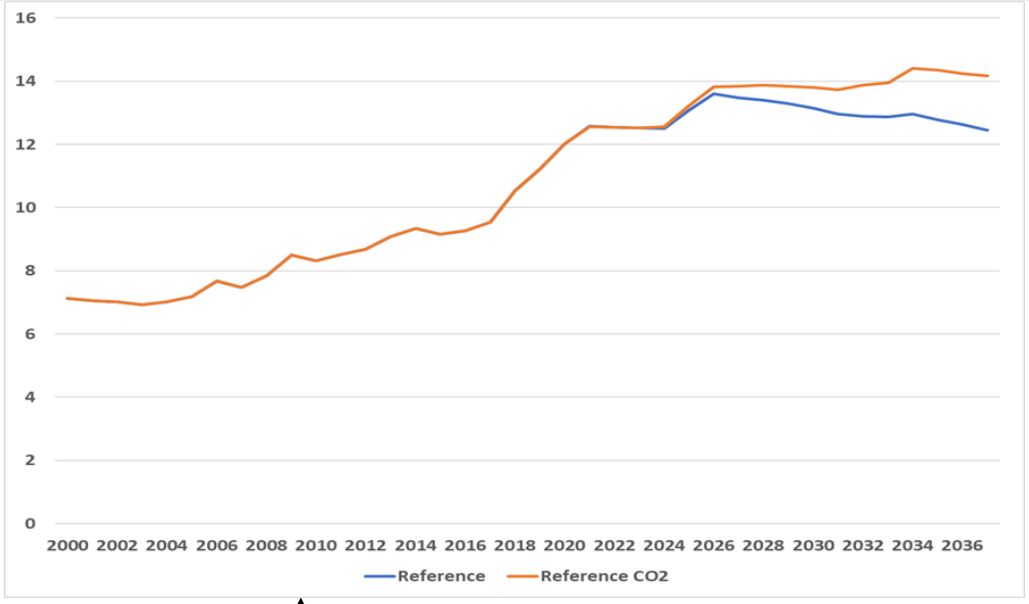


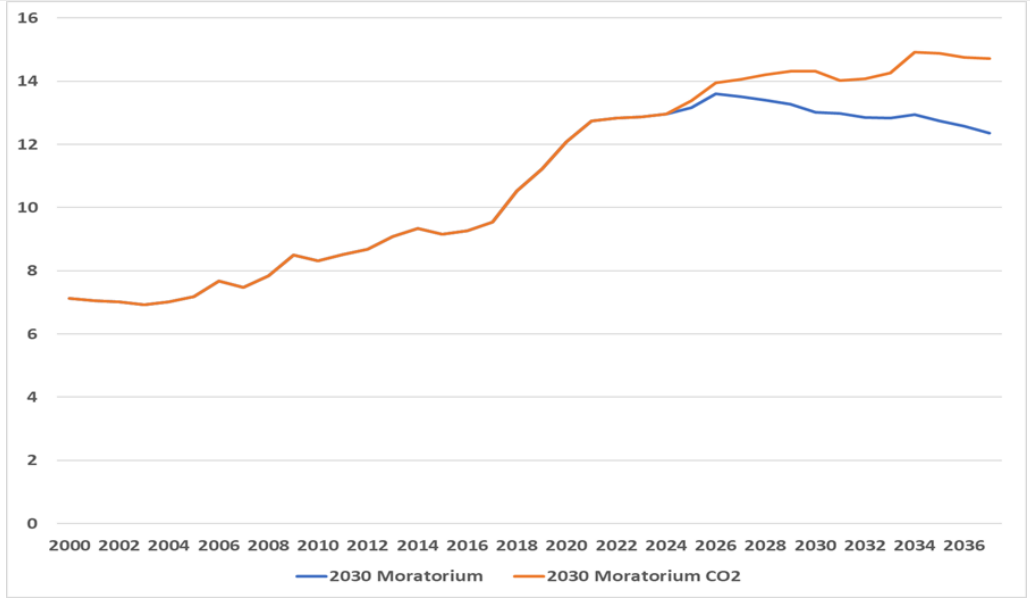
2030 Moratorium

Low Renewables Cost



Carbon Price Sensitivities – Electricity Prices





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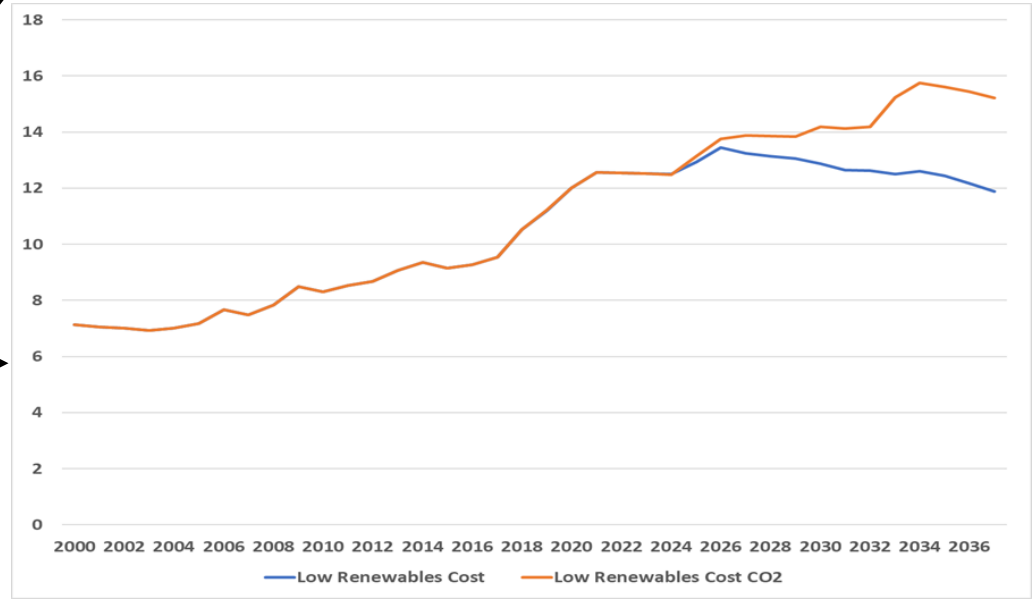
2030 Moratorium

Low Renewables Cost



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Observations

Observations

- Resource selection – Future resource selections in all scenarios and sensitivities are a combination of natural gas-fired generation (combustion turbines and combined cycle units), wind, and solar in largely predictable fashion. Coal and nuclear options were never chosen, even in the high natural gas price scenario.
- Renewable resources – Results were highly sensitive to the price assumptions for renewable resources.
- Energy from coal – Energy derived from coal decreases over time in all scenarios, which is driven by a combination of retirements of existing generators and economic competition from natural gas and renewables. The imposition of retirement moratoria provides a boost to coal while they are in place, but energy from coal drops to roughly the same level in all non-carbon price scenarios. The imposition of a carbon price results in large additional decreases in coal utilization. Energy from coal represents 6-9% of total in 2035 for the three carbon price sensitivities.
- Effect of carbon prices – The lower carbon prices in earlier years tend to cause a shift from coal to natural gas-fired generation. The higher carbon prices in the later years show renewables displacing both coal and natural gas.

Doug Gotham
gotham@purdue.edu
765-494-0851
https://www.purdue.edu/discoverypark/sufg/