Natural Gas Market Update

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Joel Bluestein
Senior Vice President
Fuel and Power
703-934-3381

Joel.Bluestein@icfi.com

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Key Take Away Points

- Growth in gas-fired power generation will be dependent on electric load growth, and thus energy efficiency (EE). **Penetration of energy efficiency and electric load growth** have been and are likely to remain the most significant drivers for gas-based electricity generation over time.
- Within the framework of the CPP, selection of either Rate or Mass-based standards by the States strongly affect gas use. Results from the two approaches can look very different.
- States heavily reliant on coal generation (e.g., the Midwest States) will potentially experience much greater impacts from the CPP.
- States where gas-fired generation is already a relatively large portion of the generation mix are likely to experience much less impact from the CPP.
- While the CPP alters gas use in the power sector, these changes are very likely to be overwhelmed by other factors that impact North America's gas markets.
  - Evolution of global gas markets that drive LNG exports.
  - Oil prices.
  - Exports of U.S. gas to Mexico.

Natural Gas Market Trends

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Overview of the North American Gas Markets

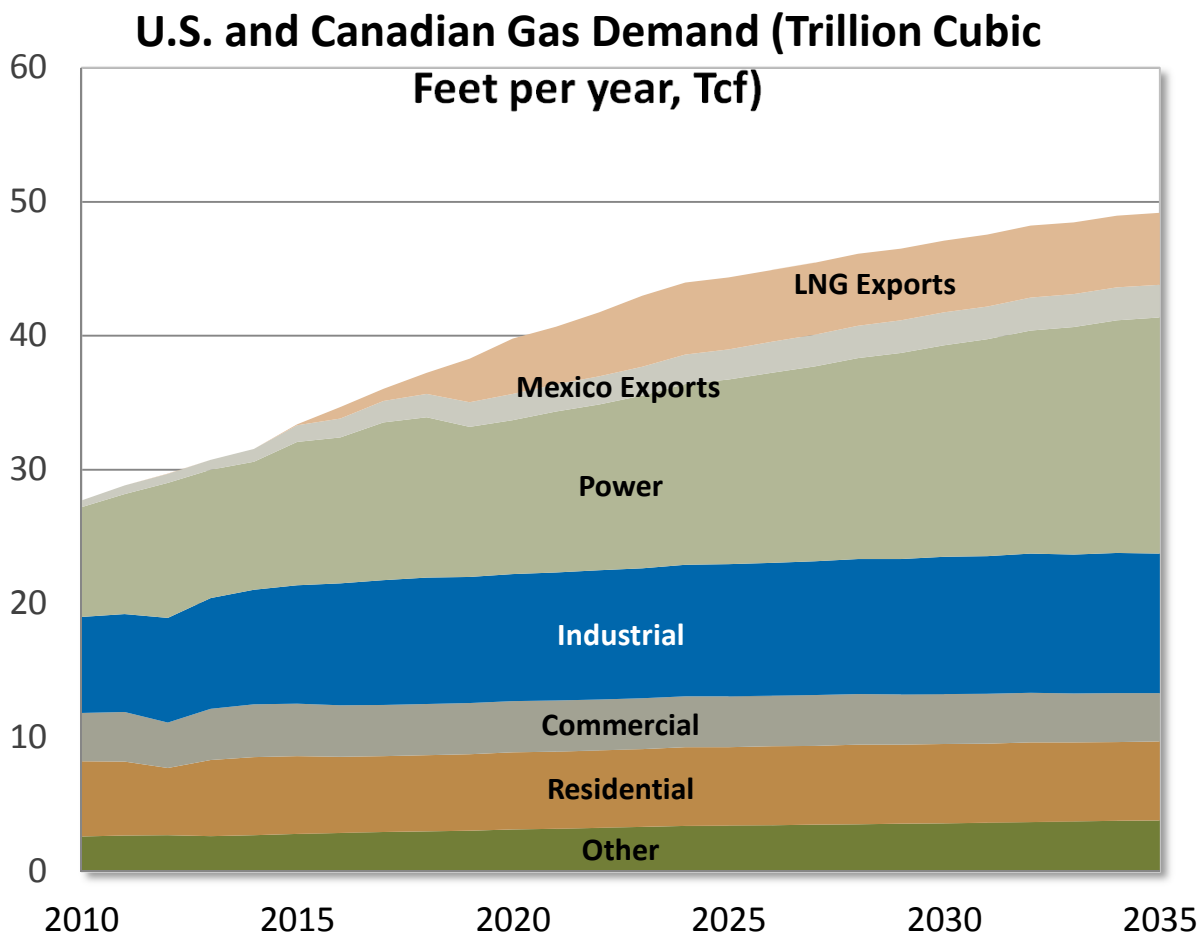
- Natural gas demand likely to grow robustly.
  - Several LNG export facilities are expected to come on line over the next five years.
  - Exports to Mexico have been growing, and will continue to grow.
- Abundant lower cost gas supplies available from shale resources.
- Gas market likely to remain in lower price environment, more consistent with recent price levels and less consistent with relatively high price levels observed from 2005-08.
- Marcellus/Utica leading the way, with production from the basin currently at about 20 billion cubic feet per day.
  - Continued increases in gas production expected despite lower drilling activity.
- Coal plants retiring, leading to incremental gas use in the power sector.
  - Amount of coal plant retirement uncertain, subject to environmental policies like the CPP.

Slide 5

CA1 We are challenging any of these? I don't think so. Maybe the title can be changed. Not everyone in the audience may hold these views.
Chikkatur, Ananth, 10/15/2015

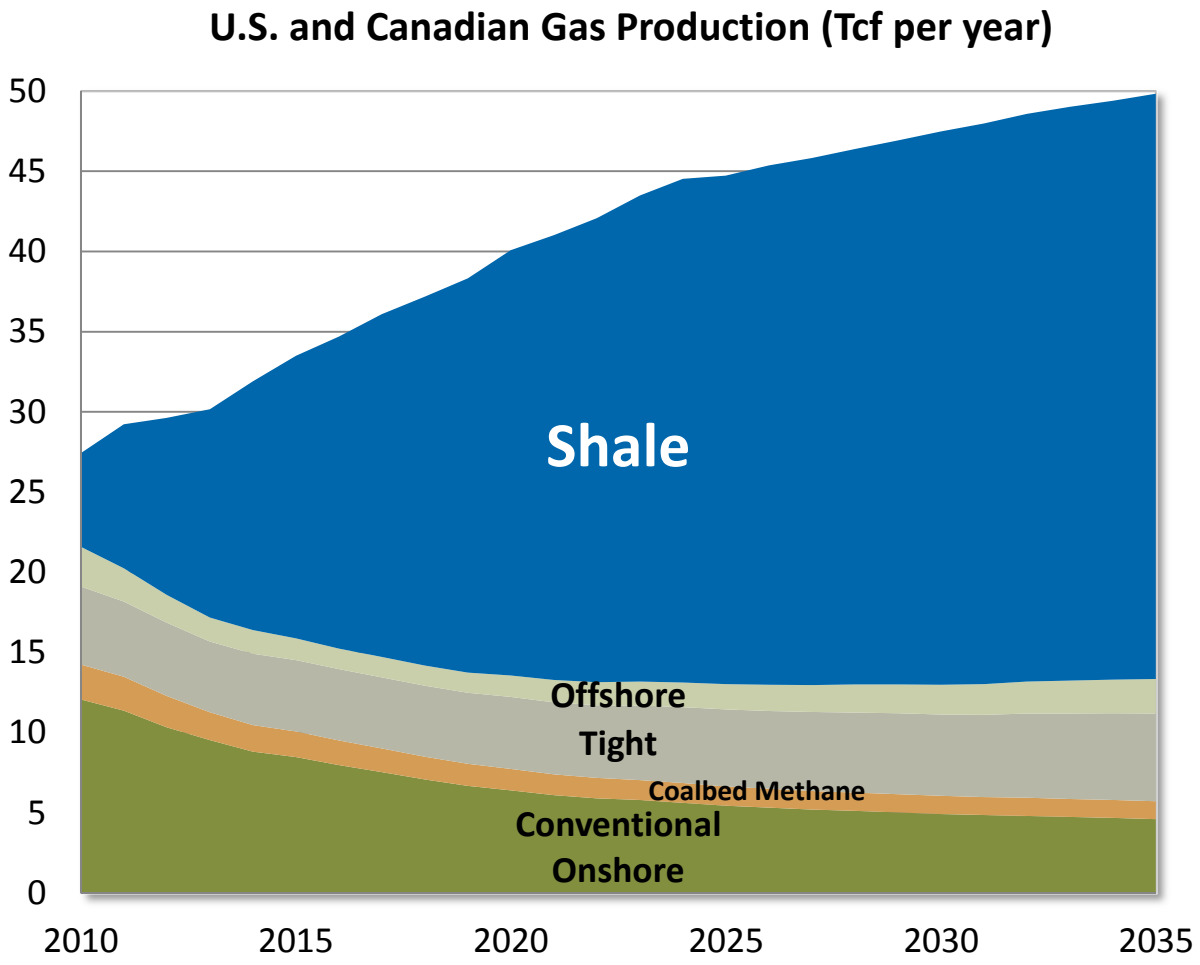
Projected Market Growth

- By 2035, U.S. and Canadian gas consumption is projected to increase by nearly 18 Tcf (48 Bcfd), versus today's level, exhibiting an average growth rate of roughly 2.1% per year.
  - Roughly 46% of the growth comes from the power sector, which grows to nearly 18 Tcf (48 Bcfd) by 2035.
- Gas exports also create significant demand growth.
  - LNG exports reach 5.4 Tcf (14.7 Bcfd) by 2025.
  - Mexican Exports grow to 2.4 Tcf (6.7 Bcfd) by 2035.



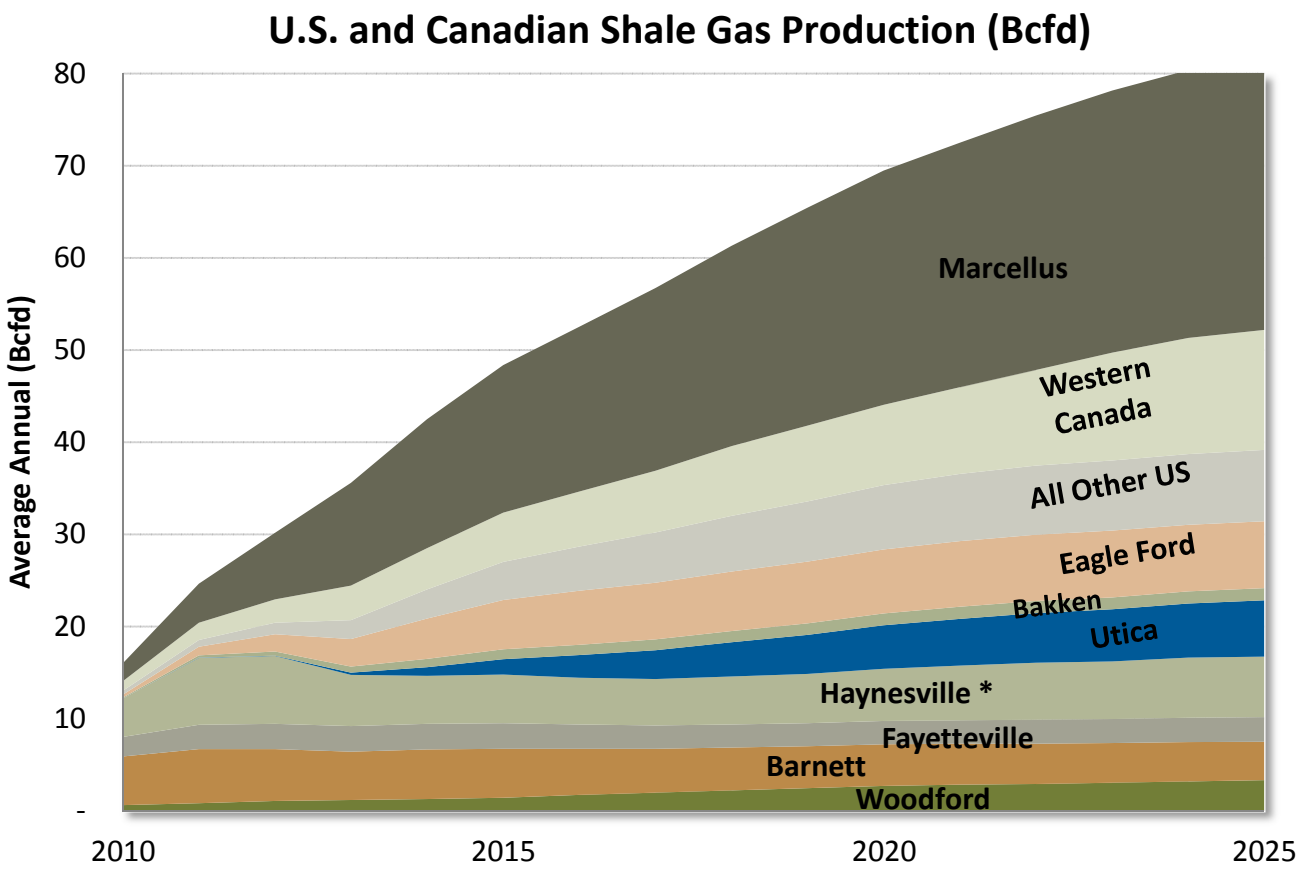
Projected Gas Supply

- Total gas production increases by 2.1% per year, primarily from shale gas production, which grows by 4.2% annually.
  - By 2020, shale gas production accounts for about two-thirds of all U.S. and Canada gas production.
- Other unconventional gas production remains fairly constant:
  - Tight gas increases modestly while CBM declines.
- Conventional production continues to decline by 3% annually.
- Offshore production exhibits modest increases, mostly toward the end of the analysis period.



Shale Gas Resource Development

- Total U.S. and Canada shale gas production is projected to increase by more than 90% from about 42 Bcfd in 2014 to about 80 Bcfd in 2025.
- The Marcellus and Utica Shale account for roughly 50 percent of the incremental production growth from shale formations.
- Major growth is also expected from Western Canadian shale plays (the Montney, Horn River, Cordova & Liard), which grow to nearly 13 Bcfd by 2025 from their current level of roughly 4 Bcfd, but lower oil prices pose a greater risk for development of these resources.

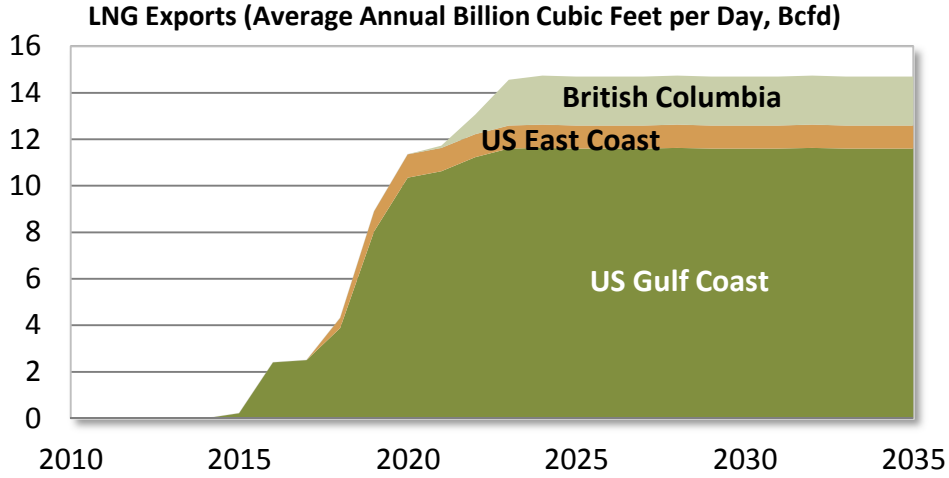


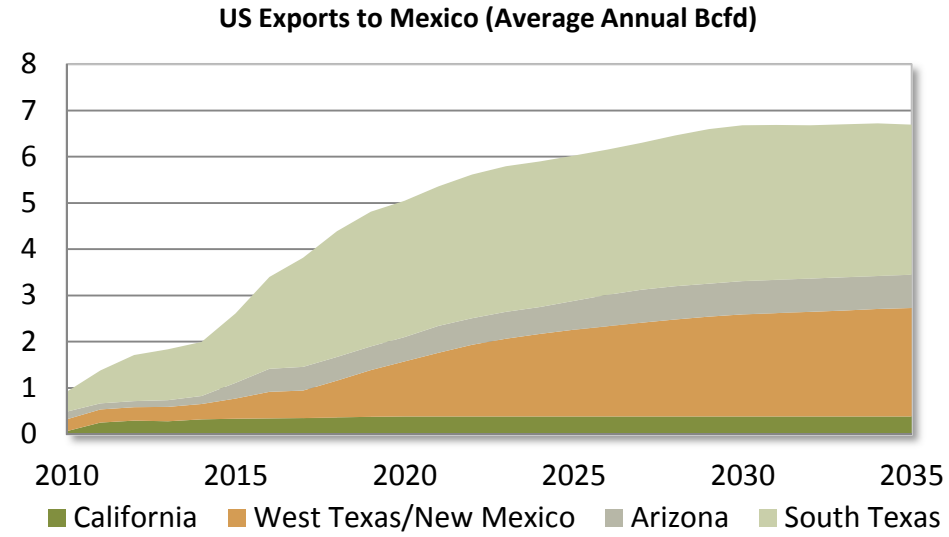
*Haynesville values shown here include production from other shales in the vicinity, e.g., the Bossier Shale.

Projected Exports

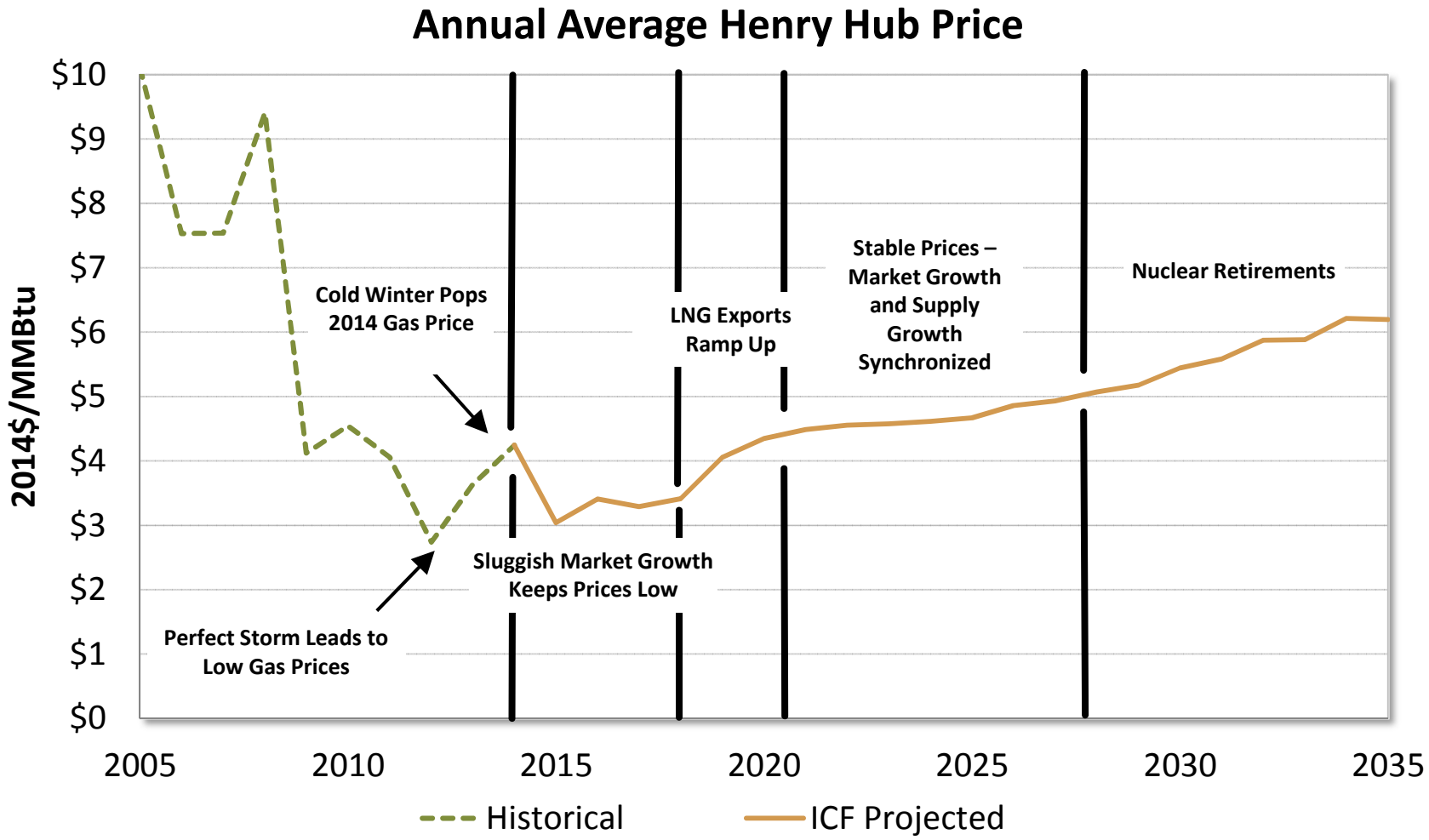
- Since 2012, DOE has approved non-FTA exports for 9 U.S. LNG terminals: Sabine Pass, Freeport, Lake Charles, Carib Energy*, Cove Point, Cameron LNG, Jordan Cove, Oregon LNG, and Corpus Christi.
  - ICF's current projection assumes U.S. LNG exports reach 12.6 Bcfd by 2025, primarily due to higher assumed Gulf Coast exports.
  - LNG exports from British Columbia are expected to reach 2.1 Bcfd.
- U.S. exports to Mexico will continue to grow, driven by increases in U.S. production and growth in Mexican gas use.
  - Mexican gas demand is being driven by replacement of oil-fired generation.

* Carib Energy is a small facility, with planned exports of less than 0.1 Bcfd.





Projected Natural Gas Prices



Potential Impacts of the CPP

Overview of the CPP

- Developed under Section 111(d) of Clean Air Act.
  - Requires federal-state approach.
- Highlights of the Final Clean Power Plan Rule issued on Aug. 3, 2015.
  - EPA sets state-specific emission rate standards covering existing generating sources (online prior to Jan. 8, 2015).
  - States submit "compliance plans" for EPA approval.
  - Rule offers states several plan options, including mass-based caps.
- EPA's projected results of state plans:
  - Overall reduction of power sector CO_2 emissions by 32% by 2030 from 2005 levels.
    - Corresponds to an approximate reduction of 19% from 2013 levels.

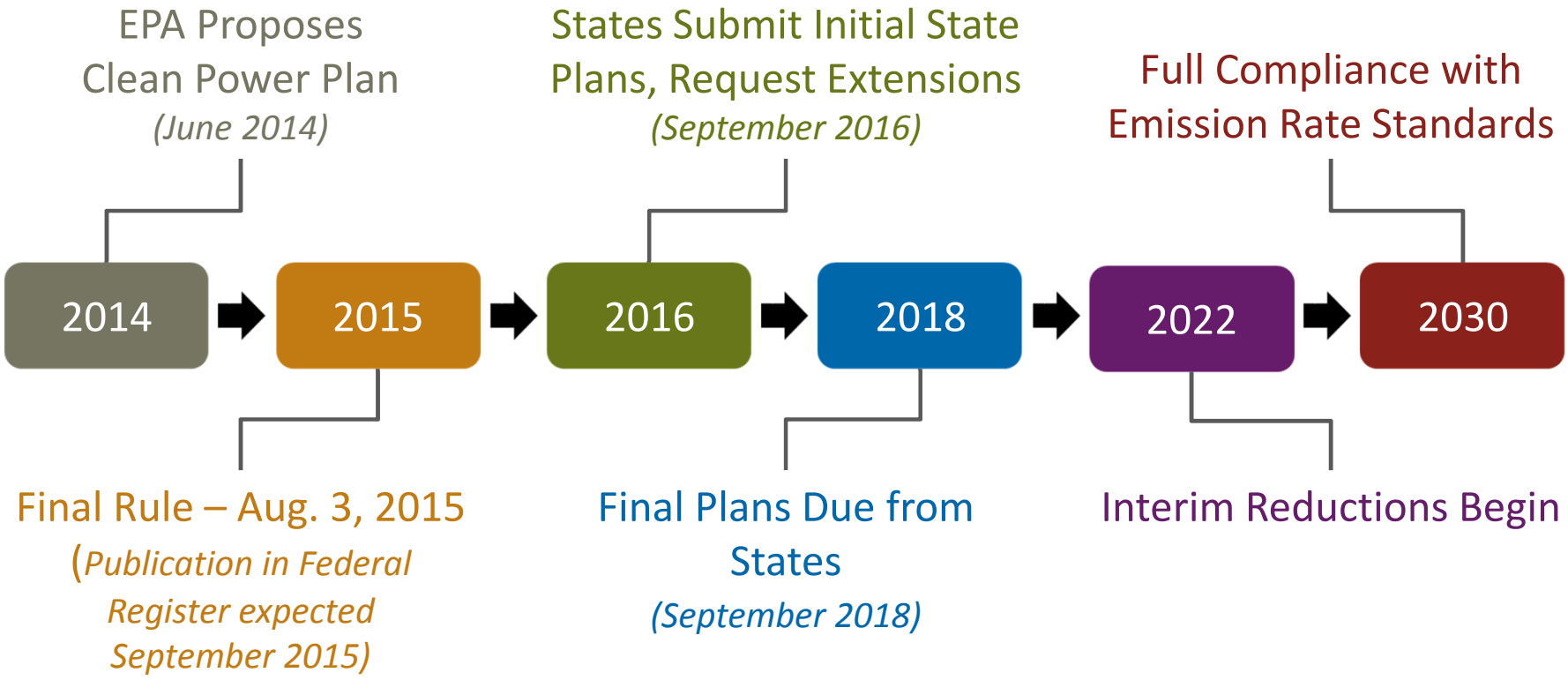
Noteworthy Changes from Proposed to Final Rule

Component	Proposed Rule	Final Rule
Due date for state plans	2016 – initial 2017 – final, if single state 2018 – final, if regional	2016 – initial 2017 – update 2018 – final
Implementation	2020	2022
Interim standards	1 step, 2020-2029	3 steps, 2022-2024, 2025-2027, 2028-2029
BSER Building Blocks	Four	Three (removed nuclear and existing RE from BB3 and all of BB4-EE)
Best System of Emission Reduction (BSER) application	State-specific	Interconnection, to develop national technology-specific standards
State standard derivation	BSER applied to 2012 baseline	National technology-specific rates applied to 2012 adjusted baseline
Standard types	Rate-based, but states can calculate mass	Rate- and mass-based
Potential for trading	Allowed with joint plan	Allowed with joint plan or trading-ready option

Changes to Best System of Emission Reduction (BSER) – Determines State Targets, Does Not Dictate Compliance

Proposed Rule	What Changed?	Final Rule
Building Block #1 Heat Rate Improvements at Coal Plants	Building Block #1 Change in details	Building Block #1 Heat Rate Improvements at Coal Plants
Building Block #2 Shift Generation from Coal to Natural Gas	Building Block #2 Change in details	Building Block #2 Shift Generation from Coal to Natural Gas
Building Block #3 (a) Credit for Existing and Planned Nuclear Generation (b) Generation from Existing and New Renewables	Building Block #3 (a) Removed (b) Post-2012 Renewable Generation Only	Building Block #3 Credit for New Renewable Generation and New Renewables
Building Block #4 Energy Efficiency	Removed from BSER	

Timing of the CPP

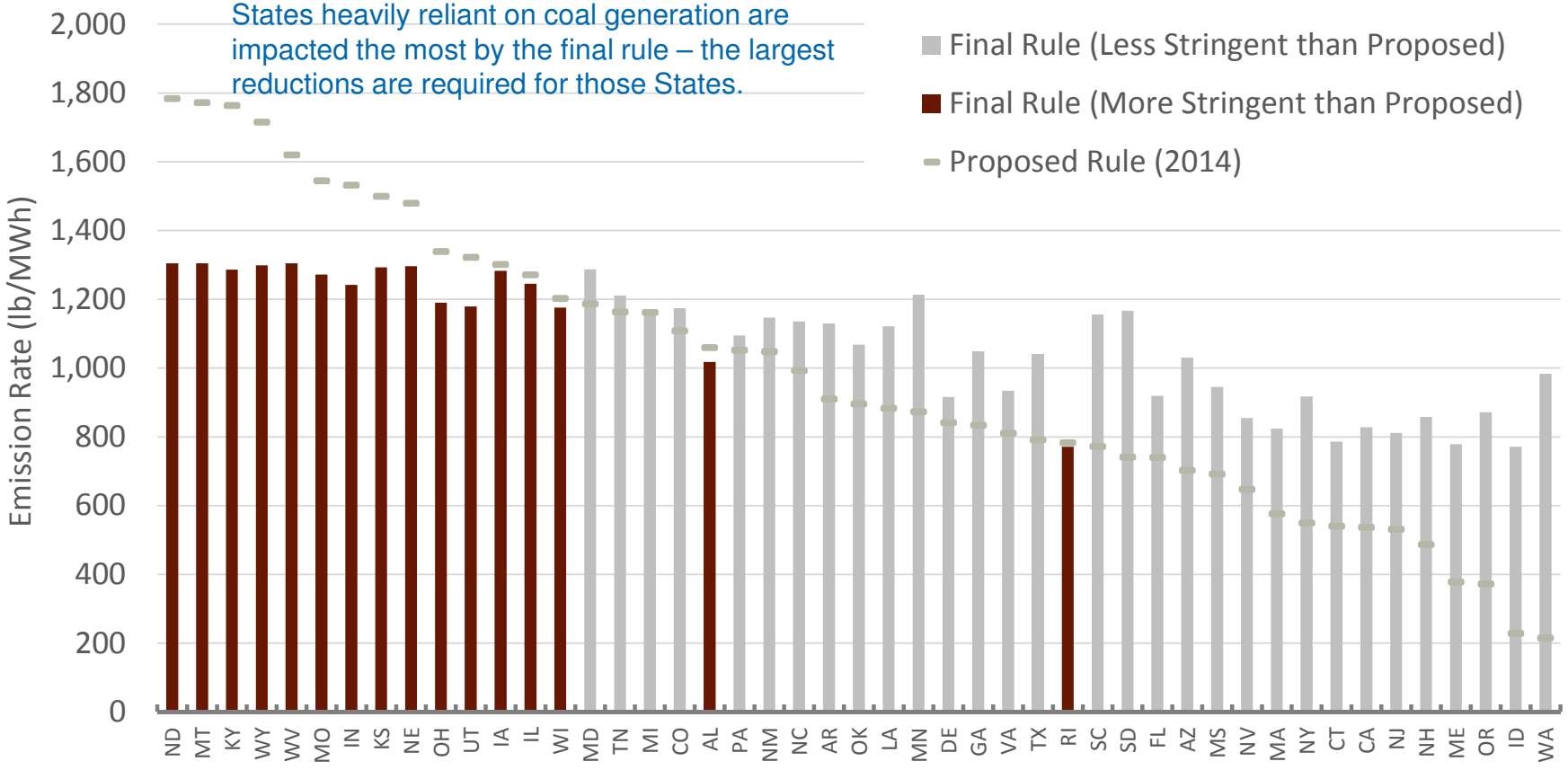


Legal Challenges

Source: Carbon Pollution Guidelines for Existing Power Plants, 79 Fed. Reg. 34829 (June 18, 2014)

Rate Standards in the Final CPP Rule

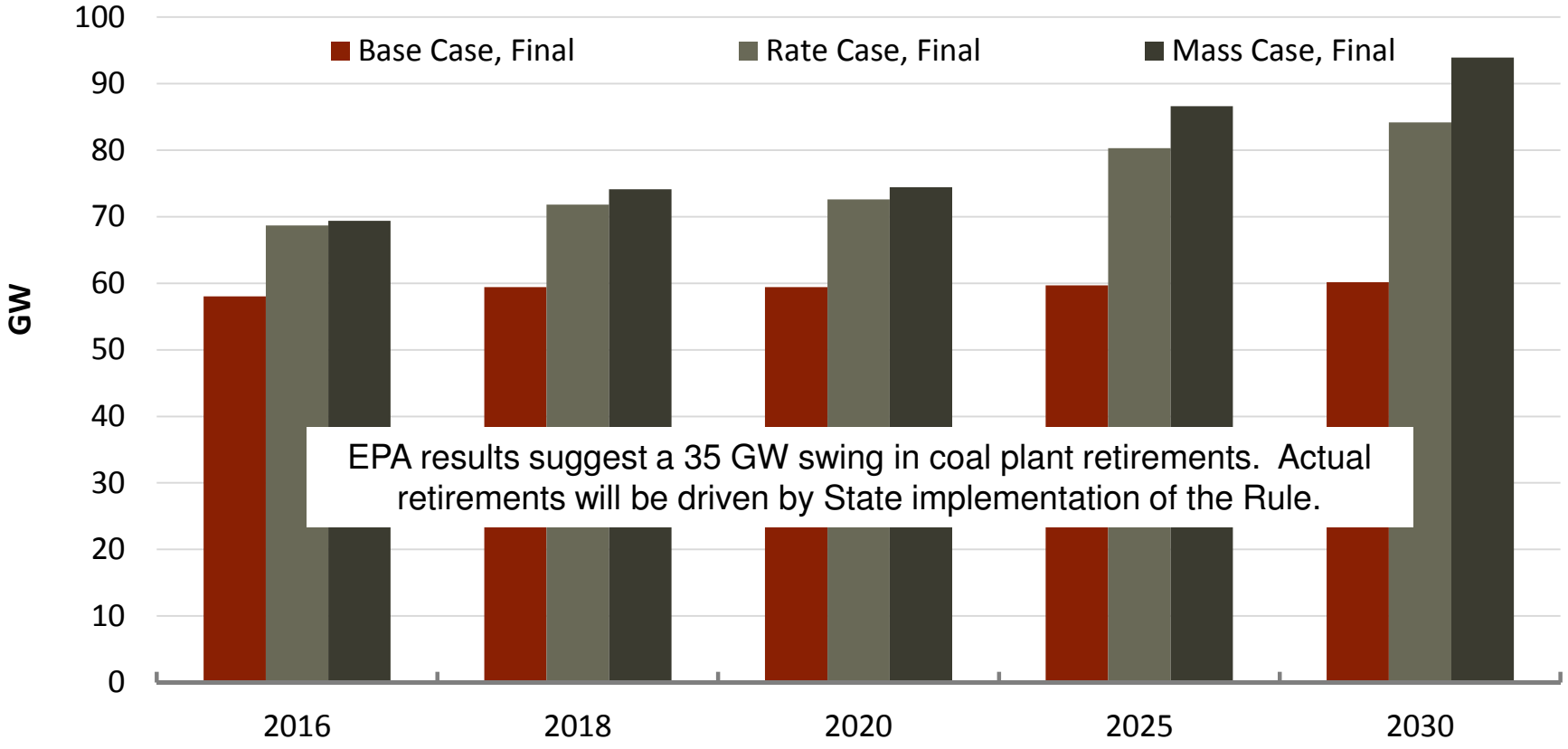
2030 Rate Standards by State under Final and Proposed Rules



Source: http://www.epa.gov/airquality/cpp/tsd-cpp-emission-performance-rate-goal-computation-appendix-1-5.xlsx

U.S. Coal Plant Retirements in EPA's Analysis

Cumulative EPA Projected Coal Unit Retirements, Final and Proposed Rules



Source: http://www.epa.gov/airmarkets/programs/ipm/cleanpowerplan.html

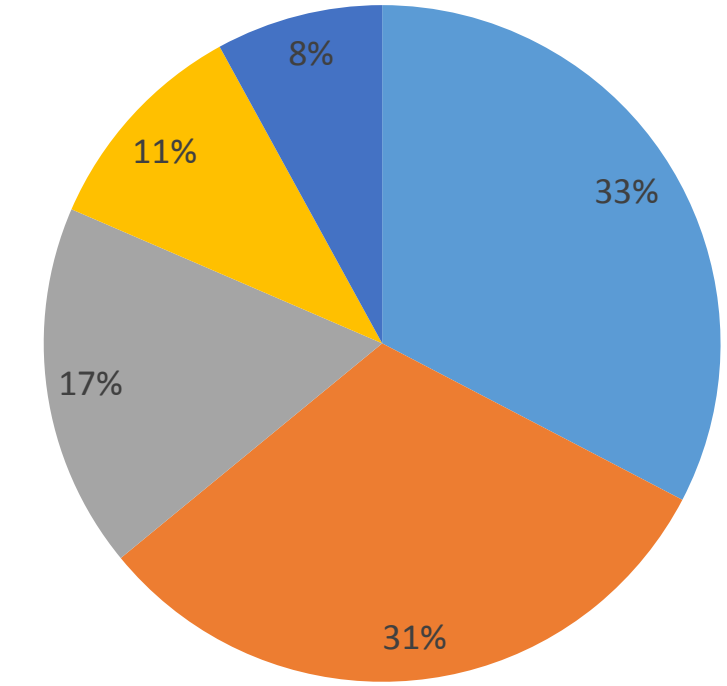
Cases Considered in this Presentation

- This presentation compares results from a number of cases to show potential impacts of the CPP. Results from ICF cases are ***illustrative***, subject to change – presented here ONLY to show potential impacts of program design on gas consumption with some key assumptions from EPA's analysis changed.
- Unless otherwise noted, assumptions are consistent with EPA IPM V5.15.

Source	Case Name	Affected Sources	Type of Standard	Trading of Allowances or Credits	Other
EPA	EPA Base Case	N/A	N/A	N/A	N/A
EPA	EPA Mass Case	Existing and New Fossil	Mass (tonnage)	In-state trading only; no multi-state	N/A
EPA	EPA Rate Case	Existing Fossil	State-level technology-specific Standards for Steam and NGCC	Interconnect-wide for credits for renewables; other credits within state boundaries	N/A
ICF	ICF No CO_2	N/A	N/A	N/A	No carbon control except for RGGI and CA AB32; ISO electricity demand forecasts applied in place of EPA demand; alternative costs assumed for new renewable capacity
ICF	ICF Mass Case	Existing and New Fossil	Mass (tonnage)	In-state trading only; no multi-state	ISO electricity demand forecasts applied in place of EPA demand; alternative costs assumed for new renewable capacity
ICF	ICF Rate Case	Existing Fossil	State-level technology-specific Standards for Steam and NGCC	Interconnect-wide for credits for renewables; other credits within state boundaries	ISO electricity demand forecasts applied in place of EPA demand; alternative costs assumed for new renewable capacity

EPA's Generation Mix for the U.S. in 2030 (including EE)

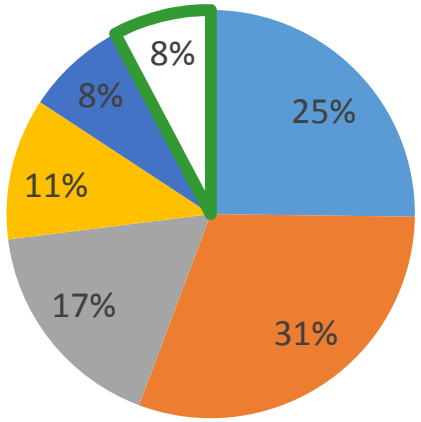
EPA Base Case Generation Mix (GWh)



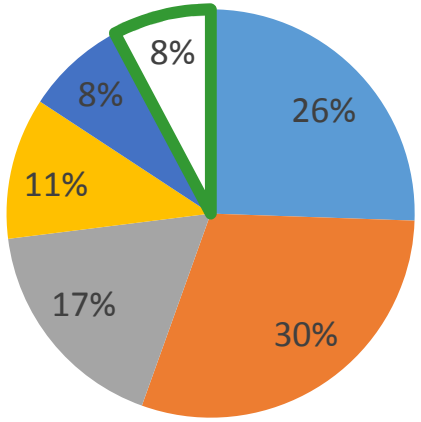
Coal Gas Nuclear RE Hydro/Other EE

Source: http://www.epa.gov/airmarkets/programs/ipm/cleanpowerplan.html

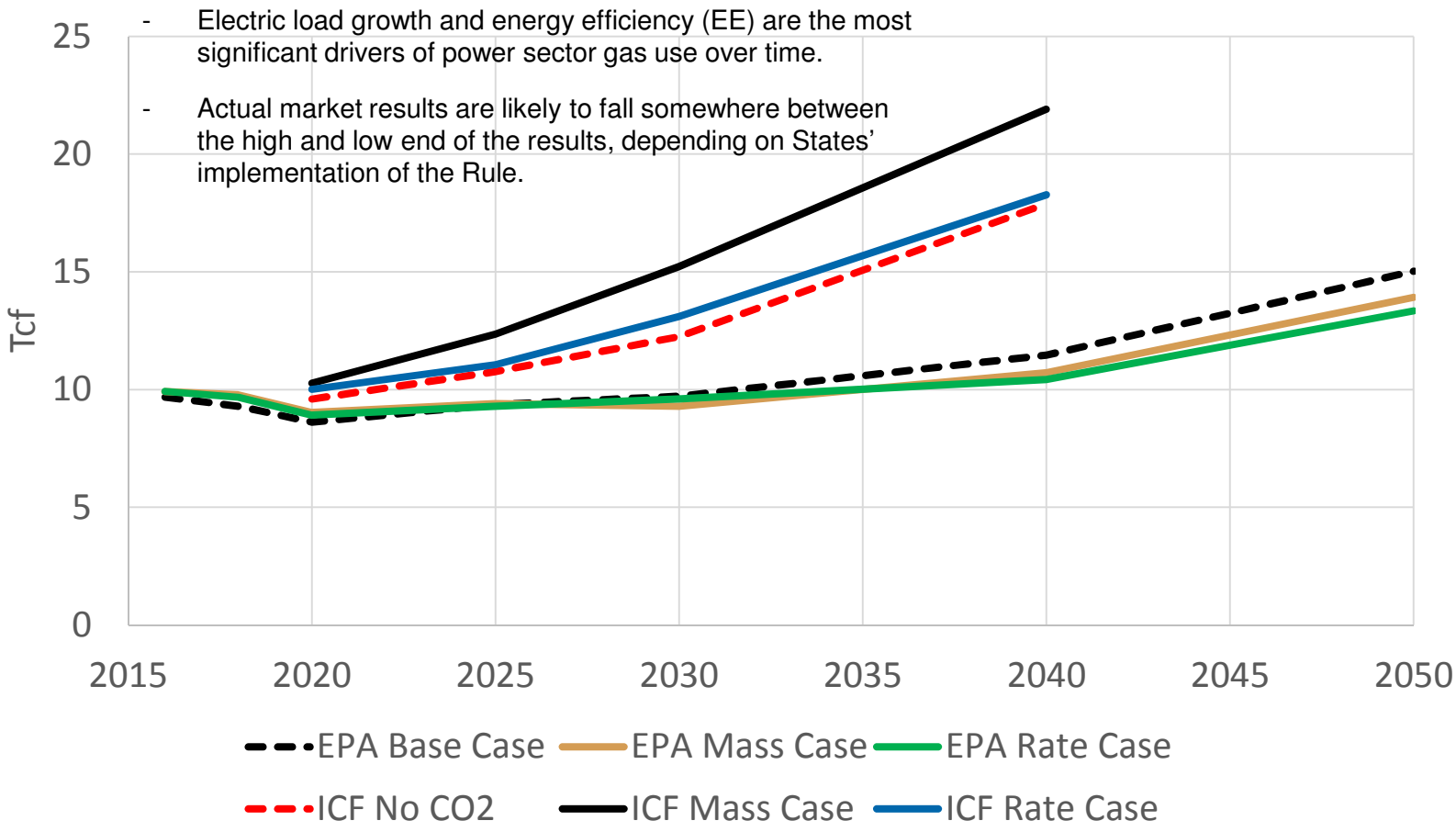
EPA Rate Case



EPA Mass Case



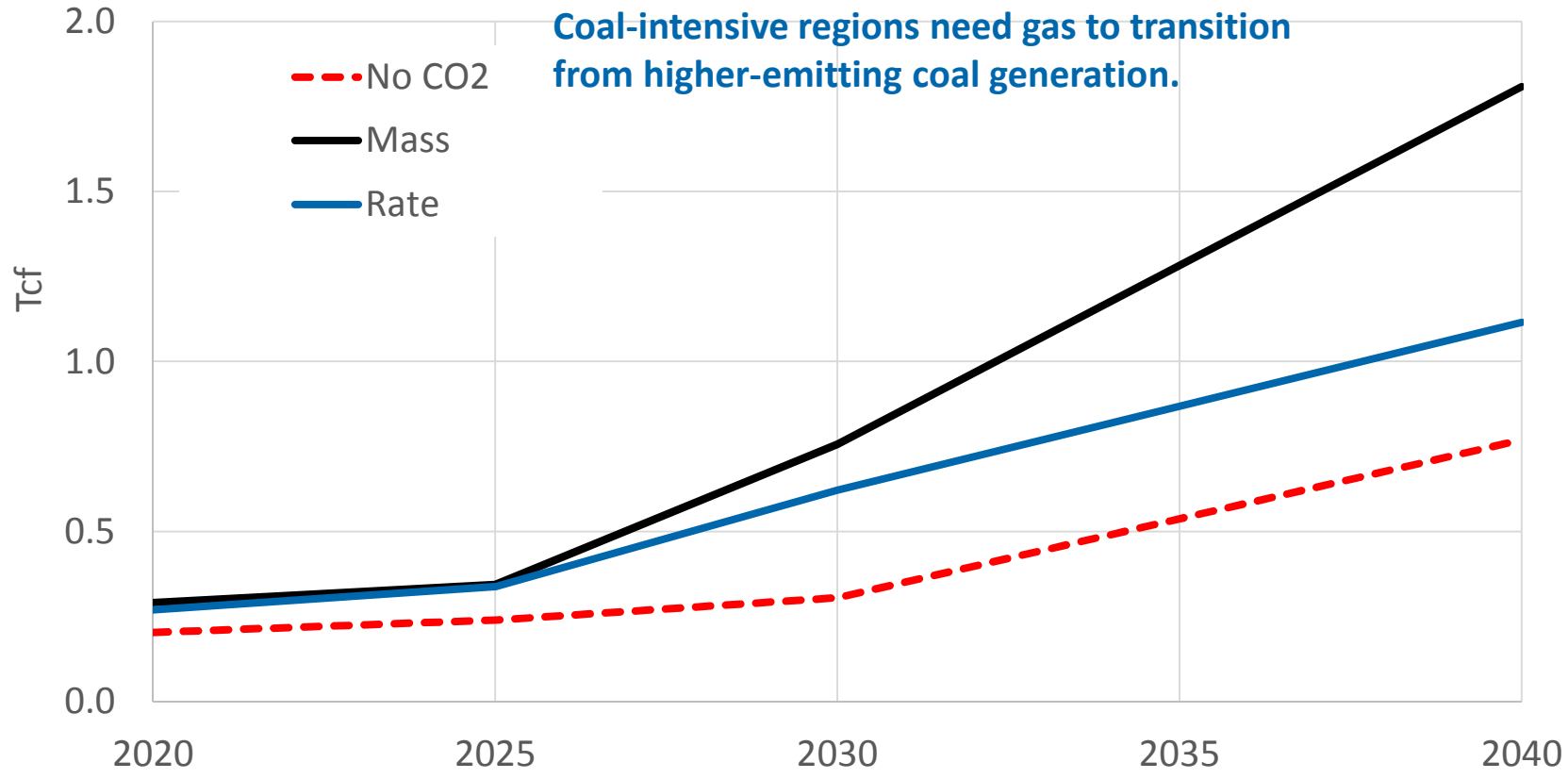
Comparison of Gas Consumption Across Cases



Source: For EPA cases, http://www.epa.gov/airmarkets/programs/ipm/cleanpowerplan.html. ICF results provided from internal modeling using ICF's Integrated Planning Model (IPM).

Regional Gas Consumption from ICF's Cases – MISO

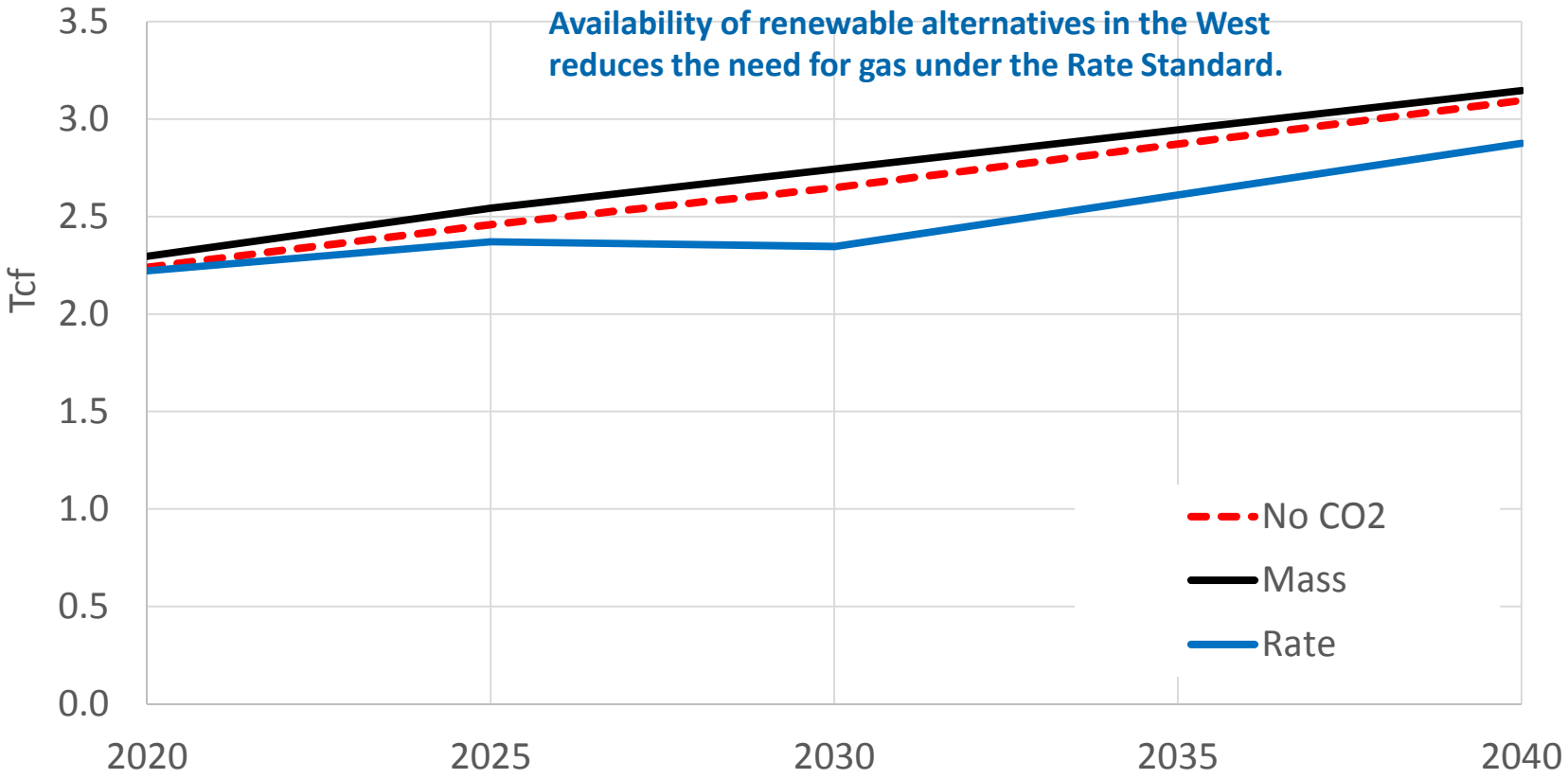
MISO Gas Consumption for Power Generation



Source: ICF results provided from internal modeling using ICF's Integrated Planning Model (IPM).

Regional Gas Consumption from ICF's Cases – WECC

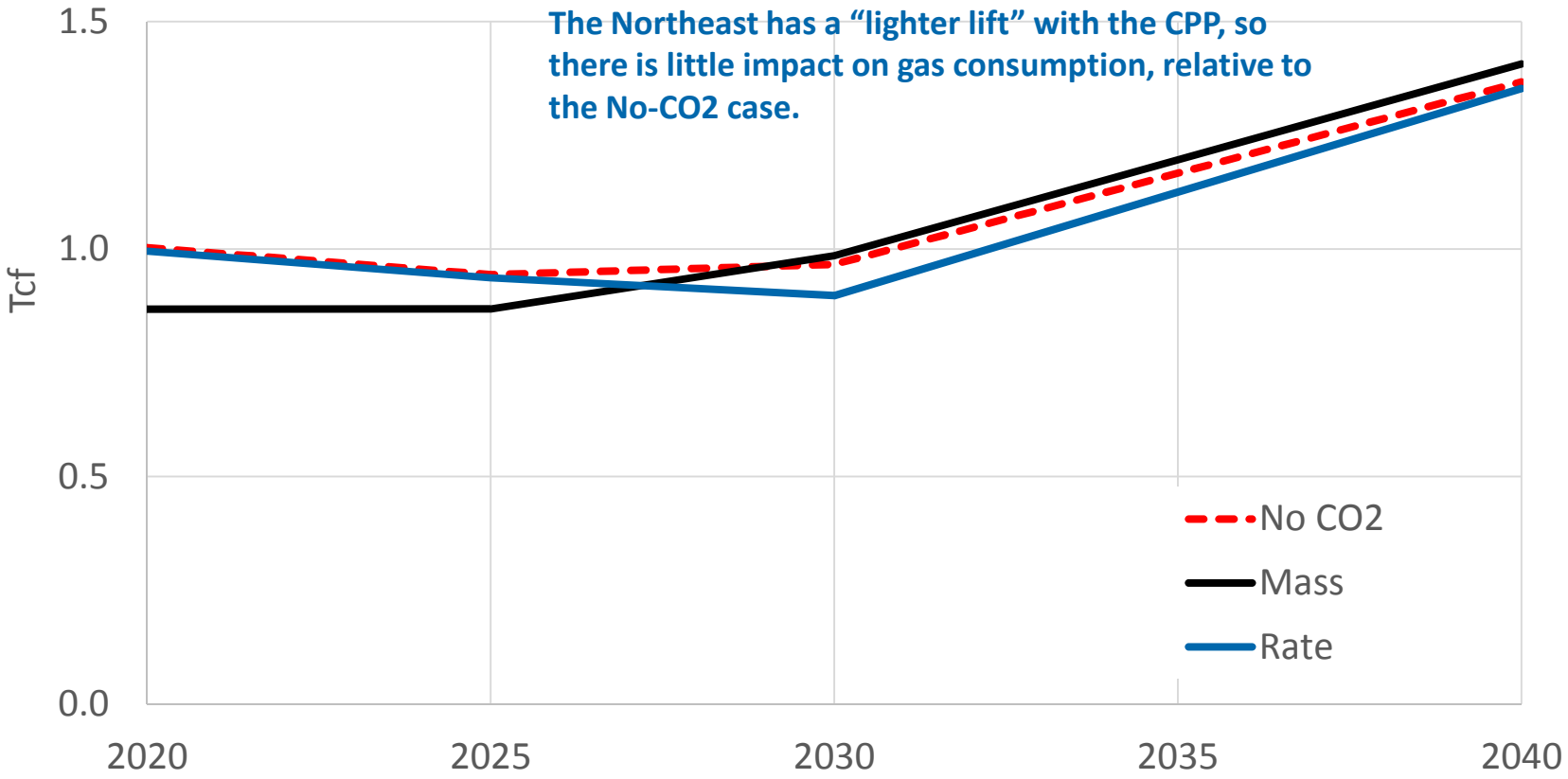
WECC Gas Consumption for Power Generation



Source: ICF results provided from internal modeling using ICF's Integrated Planning Model (IPM).

Regional Gas Consumption from ICF's Cases – Northeast

Northeast Gas Consumption for Power Generation



Source: ICF results provided from internal modeling using ICF's Integrated Planning Model (IPM).

CPP Under CHP

Applicability of CPP to CHP

- Regulatory applicability in previous programs was based on output and sales to grid. CHP facility excluded if:
  - Sells less than 1/3 of capacity/25 MW output to the grid
  - Amounts to < 219,000 MWh sales to grid
- This definition captured many large, industrial CHP facilities

- Final CPP rule uses a different approach. CHP facility excluded if:
  - Sells less than the greater of 219,000 MWh or the design efficiency * potential electric output to the grid
  - Potential electric output not specifically specified but in 111(b) = Heat input * overall efficiency * [conversion to MWh]
  - EPA has indicated that this definition applies to CPP as well
  - Excludes most industrial CHP facilities that have a significant thermal load

Implication of Revised CHP Applicability

- Industrial CHP facilities with significant thermal load will not be affected units even if large and selling most or all of their electric output to the grid.
- This will apply to new industrial CHP facilities as well.
- New non-affected facilities after 2012 are eligible to create tradeable Emission Rate Credits (ERCs) to affected facilities for compliance under rate-based programs starting in 2022.
  - Could be eligible to create allowances under mass-based programs depending on state implementation.
- Creates the opportunity for value creation from new CHP facilities.

Conclusions

Conclusions

- U.S. and Canada gas use is likely to grow robustly, from roughly 32 Tcf (90 Bcfd) in 2014 to nearly 49 Tcf (~130 Bcfd) in 2035.
  - Led by LNG exports that grow to over 14 Bcfd.
  - Mexican exports grow to nearly 7 Bcfd.
  - Petchem loads also contribute to total growth.
  - The rest of the increase is due to power demand and residential/commercial load growth.
- Growth in gas consumption from the power sector is dependent on the amount of coal plant retirements, which will be sensitive to environmental policies like the CPP and gas prices.
  - Assumptions on electric load growth and the level of energy efficiency (EE) penetration are key factors.
- Abundant gas supplies from shale resources will continue to be developed, with production from shale resources rising to over 80 Bcfd by 2035, accounting for over 70% of U.S. and Canada's gas supply at that time.
  - Marcellus/Utica production rises to over 40 Bcfd.
- The gas market is likely to remain in a lower price environment, with Henry Hub prices averaging under $5 per MMBtu in real terms through 2035.

Conclusions

- Growth in gas-fired power generation will be dependent on electric load growth, and thus energy efficiency (EE). **Penetration of energy efficiency and electric load growth** have been and are likely to remain the most significant drivers for gas-based electricity generation over time.
- Within the framework of the CPP, selection of either Rate or Mass-based standards by the States will have varying impacts on gas use. Results from the two approaches can look very different.
- States heavily reliant on coal generation (e.g., the Midwest States) will potentially experience much greater impacts from the CPP.
- While the CPP alters gas use in the power sector, these changes are very likely to be overwhelmed by other factors that impact North America's gas markets.
  - Evolution of global gas markets that drive LNG exports.
  - Oil prices
  - Exports of U.S. gas to Mexico
- Gas infrastructure (e.g., pipelines) development will be influenced by the CPP, among other factors, and detailed scenario analysis is required to evaluate impacts for planned pipeline projects.
  - Greater integration and coordination between the gas and electric sectors is still warranted.

Joel Bluestein
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