Natural gas and spillover from the Clean Power Plan into the Paris Agreement

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Major US CO$_2$ mitigation policy

2015 - Clean Power Plan (CPP)
- Target: 32% reduction of electricity sector CO$_2$ emissions from 2005 levels by 2030
- “Best system of emission reductions”

2016 - US Contribution to Paris Agreement (PA)
- Target: 28% reduction of nationwide GHG emissions from 2005 levels by 2025
- CPP cited as a key policy in meeting PA

Different policy scopes
- Sector bounds
- Emission bounds
Why is natural gas important for CPP?

![Graph showing U.S. Natural Gas Gross Withdrawals (MMcf) and U.S. Natural Gas Electric Power Price (Dollars per Thousand Cubic Feet)](EIA data)
Natural gas and decreasing emissions

Gas may help meet CPP, reducing electricity CO₂ emissions
Why is natural gas important for PA?

Gas may *compromise PA*, increasing fugitive CH$_4$ emissions

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John Bellamy, Stanford University
To what extent might gas spillover from the CPP to the PA?

- Gas may help meet CPP, reducing electricity CO₂ emissions,
- but may compromise PA, increasing fugitive GHG emissions

1. Introduce the scenario based analysis
2. How does gas price affect electricity generation?
3. What does increased gas production mean for fugitive emissions?
Scenario-based analysis
Sources of uncertainty: Gas price

“New normal” or “Future as Past”? 

Case for “New Normal”:
- Higher elasticity of supply with unconventional
- Still a lot of learning taking place
- Electricity demand has not yet caused rebound

Case for “Future as Past”:
- Uncertainty of reserves
- Rebound effects from electric power use and LNG exports
- Threat of regulations and/or moratoriums on fracking
We don’t really know...

On the very same day (Sept 8, 2016) in the Wall Street Journal:

**Natural Gas Falls on Demand Concerns**
Wall Street Journal - 2 hours ago

Demand for natural gas is expected to decline in the coming weeks as the weather cools. High temperatures increase demand for gas-powered electricity to run air-conditioning units. “Over the next few days, a weather system will sweep across the Plains, ...

**Natural Gas Rises After Smaller Inventory Build Than Expected**
Wall Street Journal - Sep 8, 2016

Natural gas prices posted their biggest daily increase since late July after government data showed a smaller than expected increase in the amount of natural gas in storage Thursday. Natural gas futures for October delivery jumped 13 cents, or 4.86% to ...

Make Natural Gas a (Shorter) Bridge to the Future
Bloomberg

Natural Gas Price Rises on Smaller-Than-Expected Inventory Build
24/7 Wall St.
We don’t really know… (part 2)

Again on October 12, 2016!
Sources of uncertainty: CPP implementation

Now add US Supreme Court
Scenario-based Analysis

Forecasting electricity generation to 2030

- “New Normal” or “Future as Past”
- CPP implementation or No CPP
  - Represented as the effective CO$_2$ tax on combustion required to meet the national 32% reduction target

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**Natural gas price and electricity generation**
The electricity sector model

**Shameless self-promotion:**


**Utilization, capacity, and their interdependence**

- Utilization - ability to adjust operations with existing capacity
  - Dispatchability - ability for technology to adjust operations
  - Technological substitution - ability for a technology to compete
- Expansion - retiring old and adding new capacity
- Interdependence - linked by returns
Confidence in projections: utilization

Control for capacity changes, focus on utilization

Peters and Hertel (2017)
Confidence in projections: expansion

Peters and Hertel (2017)
Confidence in projections: expansion

Peters and Hertel (2017)
Headed in right direction: Already a 14.2% reduction in electricity sector CO$_2$ from 2005 levels in 2014.
Electricity projections

New Normal: Low gas prices drives emissions close to CPP target with and without implementation.
Future as past: Coal retirements and renewable growth still drive emissions close to CPP target, but to lesser extent.
Electricity projections

**CPP Scenarios:** Low gas price leads to more gas, less coal. High gas leads to more coal and renewables, less gas.
Gas electricity generation and methane leakage
Sources of uncertainty: Fugitive emissions

**Fugitive emission leakage rate**
- EPA, 2016 - 1.1% of total production
- Horwath et al. 2011 - 5.6% of total production
- Brandt et al. 2014 - Most studies settle close to EPA value
Sources of uncertainty: Fugitive emissions

Fugitive emission leakage rate
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Policy effectiveness
- EPA - Oil and Natural Gas Sector: Emission Standards for New, Reconstructed, and Modified Sources
- Targets 40-45% reductions

Global Warming Potential
- 20-year: 86 CO$_2$e
- 100-year: 34 CO$_2$e
- Paris Agreement will use 100-year GWP
Scenario-based Analysis

Forecasting electricity generation
- “New Normal” or “Future as Past”
- CPP implementation or No CPP

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Fugitive emission accounting

Leakage rate: 1.1% or 5.6%
Policy effectiveness: 40% or 0%
GWP: 100-yr or 20-yr
Emission spillover

Bars: CO₂ emissions from combustion of fuel
Points: Total GWP adding assumption on fugitive emissions
Emission spillover: In business-as-usual shift to gas can cause spillover.
Emission spillover: In CPP scenario (-CPP), cheap gas (LG-CPP) creates spillovers.
Bridge to nowhere: Cheap gas offsets CPP benefits using high leakage and 20-yr GWP (HG-BAU > LG-BAU, LG-CPP).
Emission spillover

**Bridge fuel:** Cheap gas reduces GHG w/o CPP (LG-BAU > HG-BAU) and requires less stringent CPP ($6.50 < $24.75).
**Possible opportunity:** Using HG-CPP tax ($24.75) in cheap gas regime reduces total GHG emissions (LG-CPP+ $\succ$ HG-CPP).
Discussion
Where are we now? 2016 still has low gas, likely low-end of leakage, and 100-yr GWP. LG-BAU and LG-CPP • and x.
Under the “best guess” right now scenario:

- Meeting the CPP in 2030
  - LG-BAU CO₂ levels: -28.4% from 2005 levels
  - LG-CPP CO₂ levels: -32.0%
- Meeting the Paris Agreement in 2025
  - LG-CPP GHG levels (no spillover): -9.6% from 2005 levels
  - LG-CPP GHG levels (w/ spillover): -9.4% – -8.2%

Emission spillover

- “Best guess” scenario predicts spillover of 0.2% – 1.4%
- Worst case can be as high as 4.4%
  - High leakage
  - No or ineffective policy
  - 20-year GWP
Conclusions and future work

**Ensure the emission rates are low**
- Short-term warming can be important too. We should not dismiss 20-yr GWP spillover rates.
- Actual fugitive emission rates remain unknown.
- Fugitive emissions may come from a few super-emitters.
- Identification and mitigate may require only low-tech solutions.
  ⇒ Develop policy and technology to identify and mitigate fugitive emissions

**Enhance and/or expand the CPP**
- Enhance the CPP to treat cheap gas as a windfall and make policy more stringent
- Expand the CPP to include upstream GHG emissions in accounting
  - Electricity sector CO₂ emissions ⇒ Electricity sector life-cycle GHG emissions
Thank you for your attention
Questions?
Building the empirical model of the US electricity sector

- A partial equilibrium model of US electricity generation
  - Population, income, prices, and generation are shifted
  - Shifts preserve supply and demand responses
- Populate analytical framework with estimated parameters
  - Upward-sloping supply for foremost inputs ($\mu_i^s > 0$)
    - Coal - 1.86
    - Gas - 1.20
    - Oil - 0.51
    - O&M - 0.30
  - Downward-sloping demand for electricity - 0.20
- Focus on representations dispatchability, substitution, and expansion that better reflect the US electricity sector
Emission trend in US electricity sector

EIA: EIA projection of generation needs in 2030
A: CO₂ with intensity regressed on time from 1989–2013 (-8.2%)
B: CO₂ with intensity regressed on time from 2007–2013 (-44.5%)

A: CO₂ with intensity regressed on time from 1989–2013 (-8.2%)
B: CO₂ with intensity regressed on time from 2007–2013 (-44.5%)
A baseline projection of emissions to 2030

Without CPP implementation, “new normal” gas prices, same policies as today

Gas may help meet CPP, reducing electricity CO₂ emissions