The Marginal Effects of the Price for Carbon Dioxide: Quantifying the Effects on the Market for Electric Generation in Florida

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Research
Expanding the body of knowledge in public utility regulation, market reform, and infrastructure operations (e.g. benchmarking studies of Peru, Uganda, Brazil and Central America)

Education
Teaching the principles and practices that support effective utility policy and regulation (e.g. PURC/World Bank International Training Program on Utility Regulation and Strategy offered each January and June)

Service
Engaging in outreach activities that provide ongoing professional development and promote improved regulatory policy and infrastructure management (e.g. in-country training and university collaborations)
CEFA Mission
The FSU Center for Economic Forecasting and Analysis (CEFA) specializes in conducting economic research and performing economic analyses to examine public policy issues across a spectrum of research areas. CEFA provides advanced research and training in the areas of energy, aerospace, and environmental economics, and economic development, among other areas. FSU CEFA also serves as a foundation for training students on applied economics, using modeling software and other econometric and statistical tools.

Key Areas of Expertise:
- Sustainable Energy
- High Tech Economic Research
- Environmental/Natural Resources
- Economic Development
- Economics
- Economic Impact Analysis
- Econometrics
Acknowledgement

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Energy and Environmental Policy

• Policy goal to address the externalities associated with the emission of CO$_2$

• Two components of the policy
  – Energy component implemented primarily through energy portfolio standards
  – Emissions component implemented primarily through some kind of monetization of cost of emissions
Generation Portfolio Standards

• Renewable Portfolio Standard
  – Requires utilities to supply a portion of electricity from renewable sources
  – May also be met through implementation of energy efficiency measures
  – Often allows market participants to comply through monetary payments

• Clean Energy Standard
  – Expands the scope of the RPS to additional technologies
  – Often inconsistent with the classification of energy efficiency measures
Comparative RPS Policy

- Florida Draft RPS
- Waxman-Markey
- Bingaman

Renewable Portfolio Standards

www.dsireusa.org / September 2009

29 states & DC have an RPS
5 states have goals

State renewable portfolio standard
State renewable portfolio goal
Solar water heating eligible

Minimum solar or customer-sited requirement
Extra credit for solar or customer-sited renewables
Includes separate tier of non-renewable alternative resources

WA: 15% by 2020
MT: 15% by 2015
MN: 25% by 2025 (Xcel: 30% by 2020)
MI: 10% + 1,100 MW by 2015*
VA: 15% by 2025*
VT: (1) RE meets any increase in retail sales by 2012; (2) 20% RE & CHP by 2017
ME: 30% by 2000
New RE: 10% by 2017
NH: 23.8% by 2025
MA: 15% by 2020
RI: 16% by 2020
CT: 23% by 2020
PA: 18% by 2020†
NJ: 22.5% by 2021
MD: 20% by 2022
DE: 20% by 2019*
DC: 20% by 2020

OR: 25% by 2025 (large utilities)*
CO: 20% by 2020 (IOUs)
KS: 20% by 2020
IL: 25% by 2025
MI: 10% + 1,100 MW by 2015*
OH: 25% by 2025†
NY: 24% by 2013
OH: 25% by 2025†
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CA: 20% by 2010
UT: 20% by 2025*
AZ: 15% by 2025
NM: 20% by 2020 (IOUs)
10% by 2020 (co-ops & large munis)*
TX: 5,880 MW by 2015
HI: 40% by 2030
NH: 23.8% by 2025
MA: 15% by 2020
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Challenges of Implementation

• No global definition of alternative energy sources (e.g. waste coal in Pennsylvania)
• Whether to incorporate preferences for particular technologies (e.g. “carve outs” for solar or wind)
• Whether to limit credit for energy efficiency measures
• Price controls on RECs
Feed-in Tariffs

• Fixed price long term contract for gross generation
• Often confused with subsidies
• Implemented in Europe, China (wind), India (solar), and Gainesville, FL (solar)
• Greater implementation planned
  – Swiss program launched in January applies a system of feed-in tariffs to solar, wind, small hydro (up to 10MW), small geothermal (up to 20MW) and biogas for 20-25 years
  – Ontario and Vermont tariffs for multiple technologies recently passed into law, implementation currently under discussion
Market Solutions for Limiting CO$_2$

- Carbon Tax
  - Known and direct cost associated with emission
  - Entities balance cost of emission with cost of abatement

- Cap and Trade
  - Regulator sets emissions levels across scope of program
  - Tradable emissions allowances
  - Entities balance expected cost of emission with cost of abatement
Carbon Tax

• Regulator assigns a price for carbon emissions and collects from each entity

• Largely dismissed in the U.S.
  – Proposed by Clinton in 1993
  – Preference for the market to determine the price for carbon, but it already has

• Limited global implementation
  – British Columbia fuels tax through 2012
  – Finland and Sweden have had carbon taxes since early ‘90s
  – City of Boulder, Colorado
Cap and Trade Programs

- Regulator sets cap on emissions volume
- Tradable emissions allowances
- Implemented in EU ETS Phase II, New Zealand (forestry sector only)
  - EU plans Phase III for 2013
- Planned for Australia & Japan (voluntary trial program)
- New Zealand forestry sector participation began January 2008
  - Other sectors enter 2010-2013
Cap and Trade in the U.S.

- Governor Crist proposed reduction targets for Florida in 2007 Executive Order
- Chicago Climate Exchange is a voluntary GHG market with reduction standards and marketable credits
- Waxman-Markey Bill proposed the framework for a nationwide cap and trade program for CO₂
- Kerry-Boxer Bill refined the framework
## Cap and Trade Emissions Targets

<table>
<thead>
<tr>
<th>Florida Executive Order</th>
<th>ACESA</th>
<th>CEJAPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>Emissions Level</td>
<td>Year</td>
</tr>
<tr>
<td>2012</td>
<td>2005 (100% of 2005)</td>
<td>2012</td>
</tr>
<tr>
<td>2017</td>
<td>2000 (~95% of 2005)</td>
<td>2020</td>
</tr>
<tr>
<td>2025</td>
<td>1990 (~70% of 2005)</td>
<td>2030</td>
</tr>
<tr>
<td>2050</td>
<td>20% of 1990 (~14% of 2005)</td>
<td>2050</td>
</tr>
</tbody>
</table>
Cap and Trade vs. Carbon Tax

• Carbon tax is seen as easier to administer
  – No allocation issues
  – No secondary market for allowances

• Cap and Trade approach seen as more ‘market-based’
  – Market determines allowance price
  – Allocation of allowances can be political

• Economic impact of either program depends greatly on what the government does with the money
Cap and Trade in Florida

• FESC project for the Department of Environmental Protection
  – Julie Harrington, FSU
  – Ted Kury, UF

• Quantification of the impact of meeting emissions goals in Executive Order

• Provisions of state cap and trade program

• Initial impact on electric generation, with expansion of scope to other sectors
Economic Dispatch Model

• Transparent framework and logic
• Quantify the balance between level of the carbon cap and the shadow (or market) price of carbon
• Quantify the impact of RPS and generation additions
• Supply stack dispatch methodology
  – State-wide scope
  – Monthly resolution of hourly load
  – Individual generating units (over 500 in FL, AL, GA)
  – Key operating characteristics for each unit
  – Ability to shape load for growth or DSM
Marginal Effects of CO
CO$_2$ Price and Energy Costs
2009 Fuel Mix

[Graph showing fuel mix in millions of MMBtu across different CO2 price per ton levels, with PC, NG, and BIT categories indicated by different colors.]
2012 Fuel Mix

![Graph showing the 2012 Fuel Mix with CO2 Price per Ton on the x-axis and Millions of MMBtu on the y-axis. The graph compares PC, NG, and BIT fuel sources.]
Next Steps

• Scenarios for future policy and market uncertainties
  – Fuel prices
  – Load growth
  – Generation restrictions

• Statewide macro-economic modeling of scenario results and policy variables

• Report of results to state
Conclusions

• Still much uncertainty surrounding climate and energy legislation

• Marginal effects of CO$_2$ pricing are dynamic
  – Vary across years
  – Vary depending on price

• Modeling needs to address these marginal effects
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