Economic Analysis of Ohio's Renewable and Energy Efficiency Standards

Ohio State Researchers Find Ohio's Renewable and Energy Efficiency Standards Have Saved Ratepayers 1.4% Since Inception, and Weakening of the Standards Will Result in Higher Energy Bills, Fewer Jobs and Increased Emissions over the Coming Decade.

November 18, 2013

Ohio Senate Bill 221 (SB 221), which became law in 2008, includes provisions for renewable energy and efficiency improvements. To better understand the economic implications of these provisions, Advanced Energy Economy Ohio Institute[1] (AEEO) engaged The Center for Resilience[2] at The Ohio State University (OSU) to perform an energy-economic modeling study, resulting in estimates of the economic, environmental, and social benefits associated with this legislation.

OSU has analyzed the following two alternative scenarios, one retrospective and the other prospective:

- **Retrospective "fallback" scenario**: What if SB 221 had not been implemented in 2008?

  If SB 221 had not been implemented, we estimate that Ohio's statewide energy demand, electricity costs and carbon dioxide (CO_2) emissions would all have been about 2% higher by 2012. Despite a slight increase in generation costs, **SB 221 resulted in a 1.4% reduction in Ohio electricity bills.** In addition, increased investments in the energy sector stimulated GDP by $160 million in 2012, and created over 3,200 Ohio jobs in the period from 2008 to 2012.

- **Prospective "modified" scenario**: Looking ahead to 2025, how will the Ohio economy perform under SB 221? What if the SB 221 provisions were modified per Senate Bill 58?

  Projecting to 2025, we estimate that continuation of current SB 221 provisions will result in lower electricity demand, more jobs created, and less CO_2 emissions compared to the modifications proposed under SB 58. The net effect of these differences is an **electricity bill 3.7% higher under SB 58 than projected under maintaining the current SB 221 Actual Scenario (AS). This translates into increases of up to $3.94 billion between 2014 and 2025, with average annual increases of $302.8 million.** Further maintaining the current provisions in SB 221 will lead to increased investment within Ohio for renewable energy and energy efficiency projects, leading to higher employment and lower CO_2 emissions.

For purposes of this project, OSU utilized a state-of-the-art model called Dynamic Energy-Economic Policy Simulation (DEEPS).[3] DEEPS was developed by OSU for the State of Ohio, in collaboration with the Consortium for Energy, Economics and the Environment at Ohio University, with funding and guidance from the Ohio Department of Development, and in partnership with the Public Utilities Commission of Ohio and the Ohio Environmental Protection Agency. Further information about the DEEPS model is available at www.OhioEnergyResources.com.

Additional details are provided below for the two scenarios analyzed.

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[1] Advanced Energy Economy Ohio Institute (AEEO) seeks to foster a robust, advanced energy economy, drive technology innovation and implementation, and position Ohio as a global leader by enhancing and aligning existing business networks and assets. In particular, AEEO provides information to Ohio policy makers regarding potential pathways for a transition to a diverse, competitive Ohio economy that utilizes advanced energy technologies.

[2] The Center for Resilience is an interdisciplinary research center dedicated to improving the sustainability and resilience of industrial systems and the environments in which they operate. See www.resilience.osu.edu

[3]Using an integrated modeling approach called "system dynamics", coupled with data on historical trends, DEEPS is able to estimate the past and future economic, social, and environmental benefits associated with alternative energy policies. OSU retained the services of Dr. Andrea Bassi, an internationally-recognized expert in the field of energy policy modeling.

Retrospective scenario analysis (2008-2012)

To perform a retrospective analysis of SB 221, two scenarios were defined:

- **Actual Scenario** (AS):

  Represents actual Ohio history with the following SB 221 provisions in place.

  - Renewable Portfolio Standard (RPS): 12.5% of power generation to come from renewable sources by 2025.
  - Energy Efficiency Portfolio Standard: 22.2% cumulative electricity efficiency savings by 2025; and 7% peak demand reduction by 2017 for electric utilities.

- **Retrospective "Fallback" Scenario** (FS):

  Assumes SB 221 was never implemented.

The DEEPS simulation indicates that, from 2008 to 2012, the following benefits were realized:

- Overall, the SB 221 RPS and EE standards have led to a 1.4% reduction in Ohio electricity bills by 2012.
- RPS and EE standards reduced electricity use by 2.6% and overall energy demand by 2% (1.55% and 1.21% in 2012 alone, respectively).
- Improvements in energy efficiency reduced electricity generation by 2.4%, while the RPS increased power generation from renewables by 63.8% (40.75% in 2012 alone).
- Greenhouse gas emissions (carbon dioxide) declined by 1.9% due to the simultaneous effect of demand and supply interventions, as well as macroeconomic impacts.

As a result of increased power generation from renewables, electricity generation costs are estimated to have increased by 0.12% in 2011 and 0.30% in 2012, with no change observed in previous years. Nevertheless, the model indicates that improvements in energy efficiency have more than offset this increase in power generation costs, leading to a 1.9% reduction in electricity costs by 2012. For 2012, the effect of energy efficiency alone is estimated to reduce the electricity costs by 1.16%, equivalent to $190 million. For 2008 to 2012, ratepayer savings are estimated to be $230 million.[4]

With regard to macroeconomic impacts, the model indicates a cumulative increase in public and private investment of 8.5% and 0.94% by 2012 respectively (4.2% and 0.5% in 2012). This corresponds to direct and indirect investment of about $600 million and $60 million respectively in 2012 alone. The increased investment is estimated to have yielded the following benefits.

- Stimulated GDP by 0.04%, or $160 million in 2012
- Generated savings on the energy bill of up to $190 million in 2012
- Created over 3,200 Ohio jobs in the period from 2008 to 2012.

In summary, this retrospective analysis indicates that synergies due to the combination of energy efficiency and renewable energy, as well as the associated cost savings and employment generation, are encouraging, especially considering that these investments will have primarily medium to longer-term positive impacts. These findings are supported by the subsequent prospective analysis described in the next section.

The results of the DEEPS retrospective simulation are summarized in Table 1 and the graphs below.

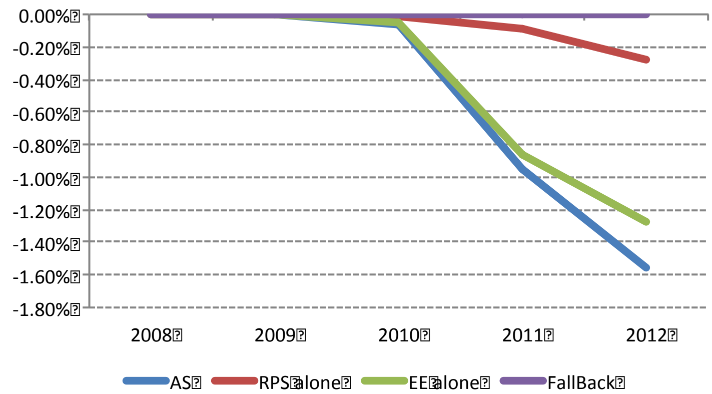
[4] Importantly, this study does not review the electricity bill savings associated with bidding energy efficiency resources into regional capacity markets; this is a practice that began in mid 2012 and is expected to produce considerable savings for customers in addition to the savings produced directly through energy efficiency programs and investments.

Table 1. Summary of DEEPS Retrospective Results (selected indicators)

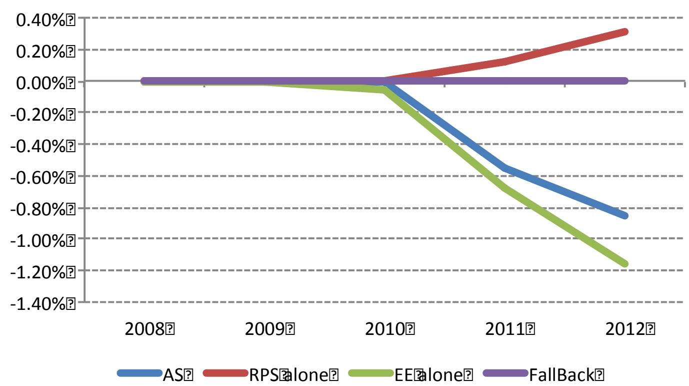
Cumulative (2008 to 2012) and annual (2012) percent change relative to the Fallback Scenario (no SB 221) for key selected energy and economic indicators, showing separate and combined impacts of Renewable Portfolio Standard (RPS) and Energy Efficiency (EE).

	% change 2012	% change 2008 - 2012		% change 2012	% change 2008 - 2012
Total Electricity Demand			**Electricity cost**		
AS (RPS + EE)	-1.55%	-2.57%	AS (RPS + EE)	-0.85%	-1.41%
RPS alone	-0.28%	-0.38%	RPS alone	0.30%	0.43%
EE alone	-1.27%	-2.20%	EE alone	-1.16%	-1.90%
Total renewable electricity generation			**Total power sector employment**		
AS (RPS + EE)	40.75%	63.76%	AS (RPS + EE)	3.93%	16.77%
RPS alone	41.22%	64.36%	RPS alone	4.07%	17.04%
EE alone	0.00%	0.00%	EE alone	0.00%	0.00%
Total CO_2 emissions			**Government investment**		
AS (RPS + EE)	-1.18%	-1.92%	AS (RPS + EE)	4.18%	8.46%
RPS alone	-0.35%	-0.50%	RPS alone	1.60%	3.34%
EE alone	-0.83%	-1.42%	EE alone	2.58%	5.12%

Annual percent change relative to the Fallback Scenario for **total electricity demand**, showing separate and combined effects of Renewable Portfolio Standard (RPS) and Energy Efficiency (EE).



Annual percent change relative to the Fallback Scenario for **total electricity cost**, showing separate and combined effects of Renewable Portfolio Standard (RPS) and Energy Efficiency (EE).



Prospective scenario analysis (2014 - 2025)

In order to enable future projection of the Ohio energy economy, OSU updated the DEEPS model to include shale gas production. Emphasis was put on the macroeconomic impacts of an expansion of the natural gas sector rather than on the production process. Several studies were reviewed in order to develop appropriate time series and multipliers for modeling (1) shale gas production, (2) value added (direct, indirect and induced), (3) employment (direct, indirect and induced) and (4) government revenues (federal, state and local taxes and federal royalty payments).[5]

Based on these sources, shale gas production is expected to reach 0.33 Tcf/year in 2025, with an average annual growth rate of 6%. This would increase the natural gas share of power generation to as much as 15% of the total, and reduce the share of coal-based generation to about 75%.

Apart from the extra investment allocated to the shale gas sector, and its impact on energy demand (estimated to be 4% higher by 2025), energy prices and expenditures are not projected to change significantly when substituting gas for coal. However, as discussed below, the shared savings mechanism could increase electricity prices if the cost were passed on to ratepayers.

To perform a prospective analysis of SB 221, two scenarios were defined:

- **Actual Scenario** (AS):

  Assumes continuation of current policies, with the following SB 221 provisions in place.

  - **Renewable Portfolio Standard (RPS)**: 12.5% of power generation to come from renewable sources by 2025. This includes a 50% REC requirement, with expansion of wind, hydro, and solar power. (Although biomass was included in the retrospective analysis above, this energy source was excluded here because its higher price will most likely make it less competitive in the future.)
  - **Energy Efficiency (EE) Portfolio Standard**: 22.2% cumulative electricity efficiency savings by 2025; and 7% peak demand reduction by 2017 for electric utilities.

- **Prospective "Modified" Scenario** (SB 58):

  Assumes modification of SB 221 as proposed in Substitute Senate Bill 58 (SB 58).
  The following potential modifications were analyzed:

  - **Energy Efficiency (EE) Portfolio Standard:**
    - **Industrial opt-out**: excludes all "reasonable arrangement" customers. Three scenarios are tested, corresponding to the exclusion of 25%, 30% and 35% of Ohio's statewide power consumption.
    - "**As found**" method rather than "standard of today". Assumes that Ohio's coal fleet could achieve a 2.5 % increase in efficiency (see WRI, p. 9), and also

[5] The main references used to create the shale gas module were the following:

- CARDI (2011), The Economic Consequences of Marcellus Shale Gas Extraction: Key Issues. Research Project sponsored by the Cornell University Department of City & Regional Planning;
- Continental Economics (2012), The Economic Impacts of U.S. Shale Gas Production on Ohio Consumers;
- EIA (2012), Effect of Increased Natural Gas Exports on Domestic Energy Markets;
- EIA (2013), Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States;
- IHS (2012), The Economic and Employment Contributions of Unconventional Gas Development in State Economies. Appendix C. Economic Contributions Excluding Cross-State Contributions by State and Year;
- Kleinhenz and Associated (2011), Ohio's Natural Gas and Crude Oil Exploration and Production Industry and the Emerging Utica Gas Formation;
- Weinstein A.L. and Partridge M.D. (2011), The Economic Value of Shale Natural Gas in Ohio, Ohio State University.

includes energy efficiency improvements from building codes and appliance standards that already occur as a result of federal policy (see ACEEE, p. 9).

    - **Expenditure cap**: Expenditures on energy efficiency by utilities are capped at 2013 levels ($233 million/yr). Two scenarios are tested, corresponding to average costs of 2c/kWh and 5c/kWh.
    - **Shared Savings Mechanism**: assumes that utilities are guaranteed a 33% financial incentive on all energy efficiency savings counted toward achieving the annual efficiency targets.

- **Renewable Portfolio Standard (RPS):**
    - Assumes elimination of the in-state requirement for RPS projects and includes only projects that are already operational, thus matching the AS until 2013 and then allowing the share of power generation from renewables installed in Ohio to reach only 1.24% by 2025.
    - Assumes that power could be imported from most of the US and parts of three Canadian provinces ("PJM, MISO, other RTOs"), primarily hydro.

Discussion of Results

The DEEPS projection indicates that, under the AS scenario, continuation of current SB 221 provisions will have the following estimated benefits in comparison to the proposed SB 58.

- Lower electricity demand (up to -4.7% lower by 2025 for all the opt-out scenarios), primarily due to improved energy efficiency. (The actual energy savings are listed in Table 2.) In fact, it appears that the "as found" method would largely eliminate energy efficiency standards established in SB 221 (see the explanation accompanying Table 3 below).
- Creation of more jobs by 2025. An estimated 3,258 (29% more) jobs would be due to the higher investment in renewables in Ohio, as well as the higher labor intensity of renewables relative to thermal power generation. In addition, 3,270 jobs would be created due to investment in energy efficiency improvements. (See Table 2.)

If SB 58 is enacted, the net effect of these differences is an **electricity bill 3.7% higher than projected under maintaining the current SB 221 AS. This translates into increases of up to $3.94 billion between 2014 and 2025, with average annual increases of $302.8 million.** Further maintaining the current provisions in SB 221 will lead to increased investment within Ohio for renewable energy and energy efficiency projects, leading to higher employment and lower CO_2 emissions. As an example, for energy efficiency alone, assuming an average cost of $5 c/kWh, the avoided investment would reach up to $167 million per year on average between 2014 and 2025 (against savings of $221 million/year).

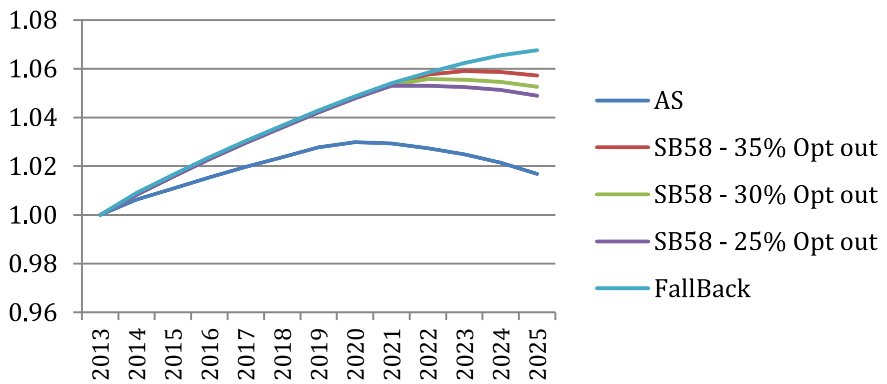
As a consequence of the "as found" provision in SB 58, the energy efficiency standards established in SB 221 would be largely eliminated. This is due to the fact that the Federal building codes and appliance standards exceed the energy efficiency improvement required under SB58. This analysis assumes that efficiency gains of 2,657 GWh/year would be generated by the Federal building codes and appliance standards (see ACEEE, p. 9). As shown in Table 3, without counting coal fleet energy efficiency the additional gains due to SB 58 would be modest, assuming that efficiency gains of 2,657 GWh/year would be generated by the Federal building codes and appliance standards (see ACEEE, p. 9). Moreover, including the additional 9,844 GWh/year of coal fleet energy efficiency improvements would eliminate need for further efficiency under SB 58.

Note that the actual savings would be 3,375 GWh/year (see WRI, p. 9), but since SB 58 dictates using the "Btu equivalent" of kWh instead of the actual heat rate of the grid, an extra 6,469 GWh/year must be included in the analysis (John Seryak, personal communication). Effectively, this formula ignores inefficiencies of the transmission and distribution lines, as well as the power plants.

Table 2. Highlights of DEEPS Prospective Results (selected indicators)

	Units	2014	2015	2020	2025
Electricity Savings (buildings and appliances)					
SB 58 (35% opt-out)	GWh/year	0	0	0	1,667
SB 58 (30% opt-out)	GWh/year	0	0	0	2,442
SB 58 (25% opt-out)	GWh/year	0	0	0	3,073
AS	GWh/year	339	849	3,113	8,606
Electricity bill savings (buildings and appliances)					
SB 58 (35% opt-out)	Million USD/year	242.1	242.6	242.6	390.9
SB 58 (30% opt-out)	Million USD/year	242.1	242.6	242.6	460.9
SB 58 (25% opt-out)	Million USD/year	242.1	242.6	242.6	518.0
AS	Million USD/year	272.9	320.1	525.1	1,011.4
Electricity bill differential (AS vs SB58 35%)	*%*	*-0.13%*	*-0.32%*	*-1.19%*	*-2.37%*
Electricity bill differential (AS vs SB58 25%)	*%*	*-0.13%*	*-0.32%*	*-1.19%*	*-2.97%*
Electricity Savings (buildings, appliances and coal efficiency)					
SB 58 (opt-out all cases)	GWh/year	0	0	0	0
AS	GWh/year	339	849	3,113	8,606
Electricity bill savings (buildings, appliances and coal efficiency)					
SB 58 (opt-out all cases)	Million USD/year	242.0	242.6	242.6	240.2
AS	Million USD/year	272.9	320.1	525.0	1,011.4
Electricity bill differential (AS vs SB58 35%)	*%*	*-0.13%*	*-0.32%*	*-1.19%*	*-3.69%*
Electricity bill differential (AS vs SB58 25%)	*%*	*-0.13%*	*-0.32%*	*-1.19%*	*-3.69%*
Total electricity generation from renewables					
SB 58	GWh/year	2,087	2,374	2,374	2,374
AS	GWh/year	2,087	2,689	5,907	10,089
Electricity generation differential	*%*	*0.0%*	*13.3%*	*148.8%*	*325.0%*
Total power generation employment					
SB 58	People	16,471	13,995	12,589	11,260
AS	People	16,471	16,341	16,676	14,518
Employment differential	*%*	*0.0%*	*16.8%*	*32.5%*	*28.9%*
Total energy efficiency employment					
SB 58 (35% opt-out)	People	0	0	0	633
SB 58 (30% opt-out)	People	0	0	0	928
SB 58 (25% opt-out)	People	0	0	0	1,168
AS	People	129	323	1,183	3,270

Projected electricity demand, indexed to 1 in 2013, showing lower demand in the AS



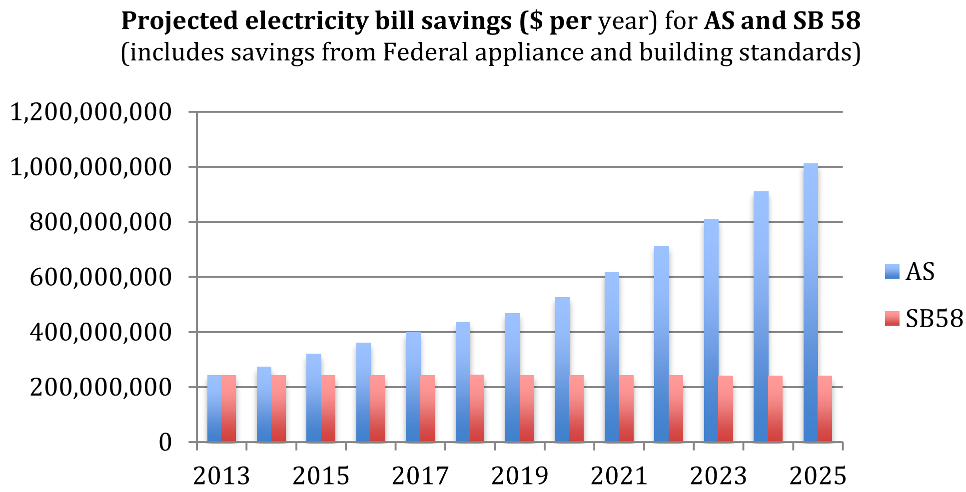


Table 3. Energy efficiency improvement (GWh/yr) required under SB 58 that would exceed efficiency gains from Federal building codes and appliance standards

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
AS	339.0	849.0	1,294.0	1,707.0	2,087.0	2,471.0	3,113.0	4,128.0	5,209.0	6,322.0	7,457.0	8,606.0
SB 58 (35% opt-out)	0	0	0	0	0	0	0	0	0	423.9	1,049.9	1,666.9
SB 58 (30% opt-out)	0	0	0	0	0	0	0	0	326.9	1,036.9	1,742.9	2,441.9
SB 58 (25% opt-out)	0	0	0	0	0	0	0	47.9	803.9	1,563.9	2,321.9	3,073.9

With regard to energy efficiency, the DEEPS projection indicates that:

- For buildings and appliances, the policy-induced savings could range between 3,370 GWh/yr (35% opt-out) and 2,980 GWh/yr (25%) in the AS scenario relative to the SB 58 case, possibly leading to a reduction in the expansion of power capacity of up to 500 MW.[6]
- A 2.5% improvement in efficiency for coal power generation would imply a reduction of about 3,375 GWh/yr (based on the current gross generation from coal of about 135,000 GWh/yr), equivalent to about 590 MW of capacity when considering the current load factor of coal power plants. The estimated cost of upgrading existing power plants to achieve this 2.5% target, based on a 5 c/kWh cost assumption, is approximately $170 million/yr, which is below the maximum amount (cap) of $233 million/yr.

Further, considering a cost of about $2.1 million per MW (International Energy Agency, 2012[7] cost estimate for the construction of supercritical coal power plants in the US), the reduced capacity requirement leads to a potential saving of $1.233 billion in capital costs. These savings could accrue to the shareholders of the generation company.

Finally, John Paul Jewell at the Environmental Law and Policy Center estimates that the difference in the gross shared savings payments under SB 58 (Shared Savings Mechanism) versus current law is approximately $1.15 billion (personal communication). The average annual value of gross savings is estimated to be $145 million/yr (using a discount rate of 8%). For the year 2013 this would correspond to a 0.9% increase in electricity rates.

[6] These savings are consistent with the ACEEE forecast (see p. 9), which indicates the potential to save up to 2,650 GWh/yr when comparing the AS case to the Fallback scenario.

[7] International Energy Agency (2012). Assumed investment costs, operation and maintenance costs and efficiencies for power generation in the New Policies and 450 Scenarios. Available at http://www.worldenergyoutlook.org/weomodel/investmentcosts/

As discussed in the section below (p. 9), this analysis is consistent with sectoral studies carried out by other organizations (i.e., PUCO on cost suppression, WRI on emission reduction, and ACEEE on energy efficiency savings and PUCO, Energy Velocity and R&M Analysis on Canadian hydropower capacity[8]) and confirms the results of our previous retrospective study. In summary, it indicates that the synergies created by the combination of energy efficiency and renewable energy, as well as the associated cost savings and employment generation, are having positive impacts on Ohio's economy and will continue to be beneficial in the medium to longer term.

Note

Models like DEEPS can be useful for exploring potential future scenarios and understanding the probable impacts of various assumptions and trends. DEEPS is based upon an existing model of the Ohio economy called T21-Ohio, one of a family of T21 models originating from the Threshold-21 model developed by the Millennium Institute for the World Bank. T21 models have a long history of successful application at a regional and national scale in the U.S. and around the world.

[8] Information available at: http://www.ohiogreenstrategies.com/documents/ericthummatestimonyattachment.pdf

Comparison with Similar Studies

For purposes of validation, the DEEPS analysis was compared against several recent studies of the Ohio energy economy, each with slightly different assumptions:

Public Utilities Commission of Ohio (PUCO)

PUCO conducted an analysis of anticipated price suppression due to adoption of renewable energy.[9] For this analysis, PUCO assumed that the lowest-cost renewable technologies would dominate, and therefore included only operational, pending and approved wind projects. In contrast, the original baseline scenario (AS) of DEEPS included solar, wind, hydro and biomass. To compare the results of the DEEPS simulation with the PUCO analysis, we removed solar and biomass and considered only wind and hydro. These two energy sources (wind and hydro) have similar costs, and are dispatched generally before fossil fuels.

In this case the DEEPS results indicated lower electricity prices due to the removal of the more expensive biomass (waste to energy) technology. The reduction in electricity prices by 2025 reaches 1.5% (for 2,703 MW), which should be compared to an extrapolation of the PUCO results, indicating a potential price reduction up to 1.96%. For reference, the reduction calculated by PUCO for 2014, considering existing and operational projects, is 0.15% (for 450 MW). This reduction increases to 0.67% when considering also the ones approved but not yet operational (for a total of 1,302 MW).

World Resources Institute (WRI)

WRI conducted a modeling study of the opportunities for reducing carbon dioxide emissions in Ohio. The study projects a 7% emission reduction by 2020 relative to 2011, and roughly (based on their graph) a 19% reduction by 2025 relative to 2010.[10] The results of this study are well aligned with the DEEPS results under the original AS scenario. However, with the adjusted AS scenario (no biomass), since electricity prices are lower, power demand is projected to be higher, and emissions decline only 13% by 2025. The WRI results may reflect an expectation of increasing wholesale prices in future years to come, but details are not provided in the report.

American Council for an Energy-Efficient Economy (ACEEE)

ACEEE analyzed the expected economic impacts of the energy efficiency standard in Ohio.[11] Their study projects a total \$5.57 billion savings through 2020, \$3.3 billion of which represent wholesale cost savings. The DEEPS analysis with the adjusted AS scenario estimates that wholesale cost savings will reach \$1.75 billion between 2010 and 2020 and \$4.4 billion by 2025.

Conclusions

The DEEPS model is able to generate results that are consistent with the more detailed and thematic studies available (e.g., energy supply vs. cost savings). It appears that the future energy mix will likely have noticeable impacts on electricity generation cost (and as a consequence on wholesale prices) as well as power demand. Therefore, the assumptions used in the various studies available should be carefully analyzed before a comparative assessment of their results is carried out. On the other hand, despite differences in baseline projections (i.e., absolute results), it is worth noting that the relative policy-induced impacts do not change considerably (e.g., percentage emission reductions).

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[9] The Public Utilities Commission of Ohio (2013). *Renewable Resources and Wholesale Price Suppression*. The Public Utilities Commission of Ohio (PUCO). Columbus, Ohio, USA.

[10] Obeiter, M., K. MeeK, and R. Gasper (2013). *Power Sector Opportunities for Reducing Carbon Dioxide Emissions: Ohio*. World Resources Institute. Washington DC, USA.

[11] Neubauer, M., B. Foster, R. N. Elliott, D. White, and R. Hornby (2013). *Ohio's Energy Efficiency Resource Standard: Impacts on the Ohio Wholesale Electricity Market and Benefits to the State*. American Council for an Energy-Efficient Economy. Washington DC, USA.