Economic Analysis of Maryland's Proposed 40% Renewable Portfolio Standard Legislation

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ABOUT THE AUTHOR

Jonathan Lesser is the President of Continental Economics, Inc., an economic and litigation consulting firm. Dr. Lesser has almost 30 years of experience in the energy industry working for electric utilities, state government agencies, and as an independent economic consultant. He testified before utility commissions in many U.S. states, before the Federal Energy Regulatory Commission (FERC), before international regulators in Latin America and the Caribbean; in commercial litigation cases; before the US Congress and numerous state legislative committees on regulatory and policy matters affecting the electric and natural gas industries. He has authored numerous academic and trade publications, as well as coauthored three textbooks, including *Environmental Economics and Policy*, *Fundamentals of Energy Regulation* and, most recently, *Principles of Utility Corporate Finance*. Dr. Lesser is also a contributing columnist and Editorial Board member for *Natural Gas & Electricity*.

Prepared on behalf of Maryland Energy Group

EXECUTIVE SUMMARY

Legislation has been introduced that will significantly increase costs for Maryland consumers and businesses by mandating a doubling of the current renewable portfolio standard (RPS) in Maryland. This will require 40% of retail electricity sales in Maryland to be supplied by renewable resources by the year 2025. Continental Economics has analyzed the costs and benefits of the proposed legislation, including the direct costs imposed upon Maryland consumers and businesses, and the potential impacts on the Maryland economy and jobs. The renewable energy targets contained in this legislation are double those of most surrounding states in the region. The increased costs associated with these targets will severely disadvantage Maryland consumers and businesses by having to pay the bill for these extreme mandates that are at levels not seen in neighboring States or in the broader PJM region.

Key findings on the impact of the proposed 40% RPS mandate:

- **Maryland consumers and businesses will pay an additional $4.1 to $6.5 billion by 2030; this represents an increase in compliance costs of 90% - 95% over the existing RPS;**

- **Residential compliance costs will increase from $4.64 in 2012 to between $106 (2,200% increase) and $145 (3,000% increase) by 2020, and between $130 (2,700% increase) and $215 (4,500% increase) by 2025;**

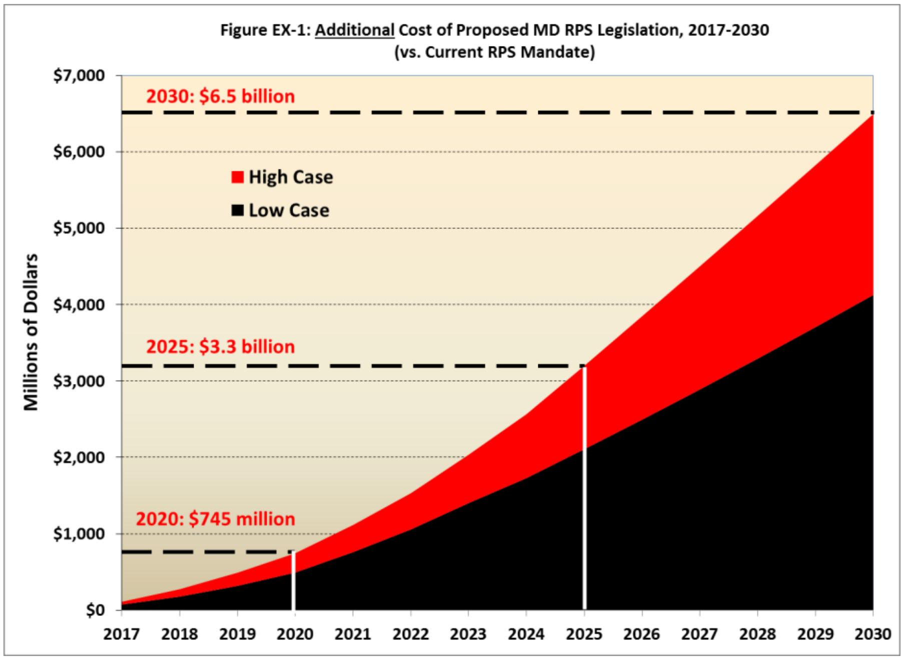
- **Commercial customers' annual electric bill will include between $1,000 (2,200% increase) and $1,500 (3,000% increase) in compliance costs in 2020, and between $1,300 (2,700% increase) and $2,100 (4,500% increase) in 2025;**

- **Industrial customer will see costs increase from an average $193 in 2012 to $4,900 in 2025;**

- **By 2020, the proposed 40% RPS mandate will eliminate between 3,000 and 4,000 jobs annually;**

- **The estimated cost to reduce a ton of carbon emissions under the proposed 40% RPS mandate is 12 to 20 times higher than the current price of CO^2 emissions in the most recent auction held by the Regional Greenhouse Gas Initiative (RGGI).**

We estimate that the proposed doubling of the RPS mandate to 40% of electricity sales will significantly impact Maryland consumers and businesses by forcing them to pay an **additional $4.1 to $6.5 billion** by 2030, double the cost of complying with the *existing* RPS mandate (Figure EX-1).



The proposed mandate will **increase** compliance costs by **90% - 95%**, limited only because the existing Alternative Compliance Penalty (ACP) imposes a price ceiling on what Maryland electricity suppliers can be forced to pay for required renewable energy certificates (RECs).

As a result of the proposed 40% RPS, all Maryland consumers will be forced to pay a significant premium over the costs imposed under the existing Maryland RPS program between 2017 and 2030 (Table EX-1).

Table EX-1: Total RPS Mandate Compliance Costs by Rate Class, 2017 to 2030 (Millions of Dollars)

Customer Class	Existing RPS Compliance Cost	Proposed 40% RPS Compliance Cost	Premium for 40% RPS	% Increase
Residential				
Low Case	$1,981	$3,763	$1,782	90%
High Case	$2,946	$5,751	$2,805	95%
Commercial				
Low Case	$2,235	$4,247	$2,011	90%
High Case	$3,325	$6,490	$3,166	95%
Industrial				
Low Case	$334	$635	$301	90%
High Case	$497	$970	$473	95%

In 2012, the average residential customer paid $4.64 to comply with the existing RPS mandate. Because of rapidly increasing REC prices and the increase in the overall REC requirement, we estimate the proposed 40% RPS mandate will increase the annual costs paid by a typical Maryland residential consumer by between **$106 (2,200% increase) and $145 (3,000% increase)** by 2020**,** and between **$130 (2,700% increase) and $215 (4,500% increase)** by 2025. The average commercial business' annual electric bill will include between **$1,000 (2,200%**

increase) and $1,500 (3,000% increase) in charges just to comply with the proposed mandate in the year 2020, and between **$1,300 (2,700% increase) and $2,100 (4,500% increase)** in the year 2025.

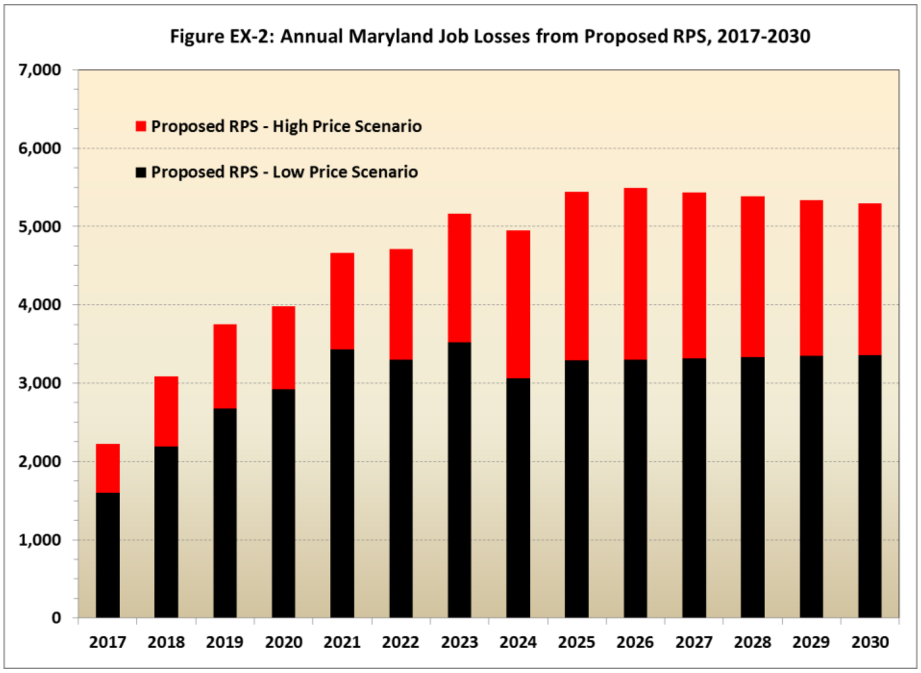


Figure EX-2: Annual Maryland Job Losses from Proposed RPS, 2017-2030

The huge increases in the cost of electricity that consumers and businesses will be forced to pay will reduce economic growth, incentivize businesses to leave Maryland, and damage the state economy. By 2020, the proposed 40% RPS mandate will eliminate between **3,000** and **4,000 jobs** annually (Figure EX-2). When the full 40% RPS requirement is reached in 2025, the proposed mandate will be eliminating between **3,300** and **5,500 jobs** annually.

Although Maryland consumers and businesses will be saddled with billions of dollars in additional compliance costs because of the proposed 40% RPS mandate, they will receive few benefits. First, to the extent that new renewable energy facilities are developed to meet the mandate, most of these facilities will be located outside the state. The most likely new sources of in-state, non-solar Tier 1 RECs are wind facilities. However, Maryland's wind resources, and the state's small size, will limit new in-state wind development. Thus, any offsetting economic development impacts of new in-state facilities will be small, and dwarfed by the adverse impacts to consumers and businesses caused by higher electricity costs.

Second, the potential environmental benefits, specifically reduction in carbon dioxide (CO^2) emissions will be negligible. Our analysis shows that the proposed 40% RPS mandate will reduce CO^2 emissions at a **minimum** cost of between $39/ton and $61/ton. This cost is **12 to 20 times larger than the current price of CO^2 emissions** in the most recent auction held by the Regional Greenhouse Gas Initiative (RGGI), a cap-and-trade arrangement for CO^2 emissions in which Maryland participates. Furthermore, over the 2014 – 2030 timeframe, the proposed 40% RPS mandate would only reduce US CO^2 emissions by two-tenths of one percent.

In Europe, politicians are rolling back ambitious – and unrealistic – RPS mandates. Not only are European policymakers realizing how these mandates have damaged their countries' economies, the mandates are jeopardizing the reliability of the electric system, and increasing the risk of cross-country blackouts. Skyrocketing electricity prices are not only impoverishing consumers, they are severely damaging economic competitiveness. European leaders have finally understood that a major factor behind their countries' economic woes is that electric power costs are two to three times higher than in the U.S.

Ultimately, the real beneficiaries of the proposed 40% RPS mandate will be out-of-state renewable energy suppliers and a select few renewable energy suppliers in Maryland, not Maryland consumers and businesses. They will benefit from increased costs paid by consumers as the demand for the energy they provide increases, along with the price. The few will benefit at the expense of millions of Maryland consumers and businesses. Maryland policymakers should reject this unnecessary, expensive and job-eliminating legislation.

I. Introduction and Summary

Maryland's Renewable Energy Portfolio Standard (RPS), enacted in May 2004 and revised numerous times, requires electricity suppliers to use renewable energy resources to generate a portion of their retail sales.[1] Beginning in 2006, electricity suppliers were required to provide 1% of retail electricity sales in the state from Tier 1 renewable resources and 2.5% from Tier 2 renewable resources.[2] Under current law, the RPS increases, ultimately reaching a level of 20% from Tier 1 resources in 2022, and 2.5% from Tier 2 resources from 2006 through 2018.[3] A solar carve-out was established in 2007, and requires 2% of retail electricity sales come from solar resources by 2020. In 2013 the state established an offshore wind carve-out of up to 2.5% beginning in 2017, with the actual annual requirements to be established by the Maryland Public Service Commission (PSC).

II. Increasing the Maryland RPS Will Increase Costs to Consumers and Businesses

Continental Economics estimates that the proposed doubling of the RPS mandate to 40% will force Maryland consumers and businesses to pay an *additional* $4.1 to $6.5 billion between 2017 and 2030 over the cost of complying with the existing RPS mandate.[4] The resulting increase in the cost of electricity will significantly damage the Maryland economy. We estimate

1 Electricity suppliers demonstrate compliance with the RPS by procuring renewable energy credits (RECs) equivalent to the required percentages. Most Tier I and all Tier II RECs can be provided from any qualified generation source throughout PJM. Solar, geothermal, poultry-litter-to-energy, waste-to-energy and refuse-derived fuel RECs must be provided by a qualified generation source connected to the Maryland distribution grid. Offshore wind RECs (ORECs) are geographically limited to a specific area near the Maryland coast.

2 Tier I sources include solar, wind, qualifying biomass, methane, geothermal, ocean, fuel cells, small hydro (less than 30MW), poultry-litter-to-energy, waste-to-energy, refuse-derived fuel, and thermal energy from a thermal biomass system. Tier II includes hydro other than pumped storage.

3 The Tier II requirement sunsets in 2018.

4 SB 733 has recently been introduced in the Maryland Legislature. As proposed, this bill would effectively raise the Tier I RPS requirement to 40% by 2025. This would constitute a near doubling of the current requirement in roughly the same time period. The proposed legislation also would double the solar requirement from the current 2% to 4%. All other aspects of the RPS would be left unchanged by this proposed legislation.

the proposed mandate will eliminate over 4,000 jobs annually by 2020, and 5,500 jobs annually by 2025 when the full 40% goal is reached.

Maryland consumers and businesses will be saddled with billions of dollars in additional compliance costs because of the proposed RPS mandate, but they will receive few, if any, benefits. First, to the extent that new renewable energy facilities are developed to meet the mandate, most of these facilities will be located outside the state. The most likely new sources of in-state, non-solar Tier 1 RECs are wind facilities. However, Maryland's wind resources, and the state's small size, will limit new in-state wind development. Thus, any offsetting economic development impacts of new in-state facilities will be small, and dwarfed by the adverse impacts caused by higher electricity costs.

Second, the potential environmental benefits, specifically reduction in carbon dioxide (CO^2) emissions will be negligible. Our analysis shows that the proposed 40% RPS will reduce CO^2 emissions at a minimum cost of between $39/ton and $61/ton. This cost is 12 to 20 times larger than the current price of CO^2 emissions in the most recent auction held by the Regional Greenhouse Gas Initiative (RGGI), a cap-and-trade arrangement for CO^2 emissions in which Maryland participates. Additionally, from 2014 through 2030, the proposed 40% RPS mandate will reduce US CO^2 emissions by only two-tenths of one percent.

The real beneficiaries of the proposed RPS mandate will be out-of-state renewable energy suppliers, who will see the demand for the energy they provide increase, along with the prices of that energy.

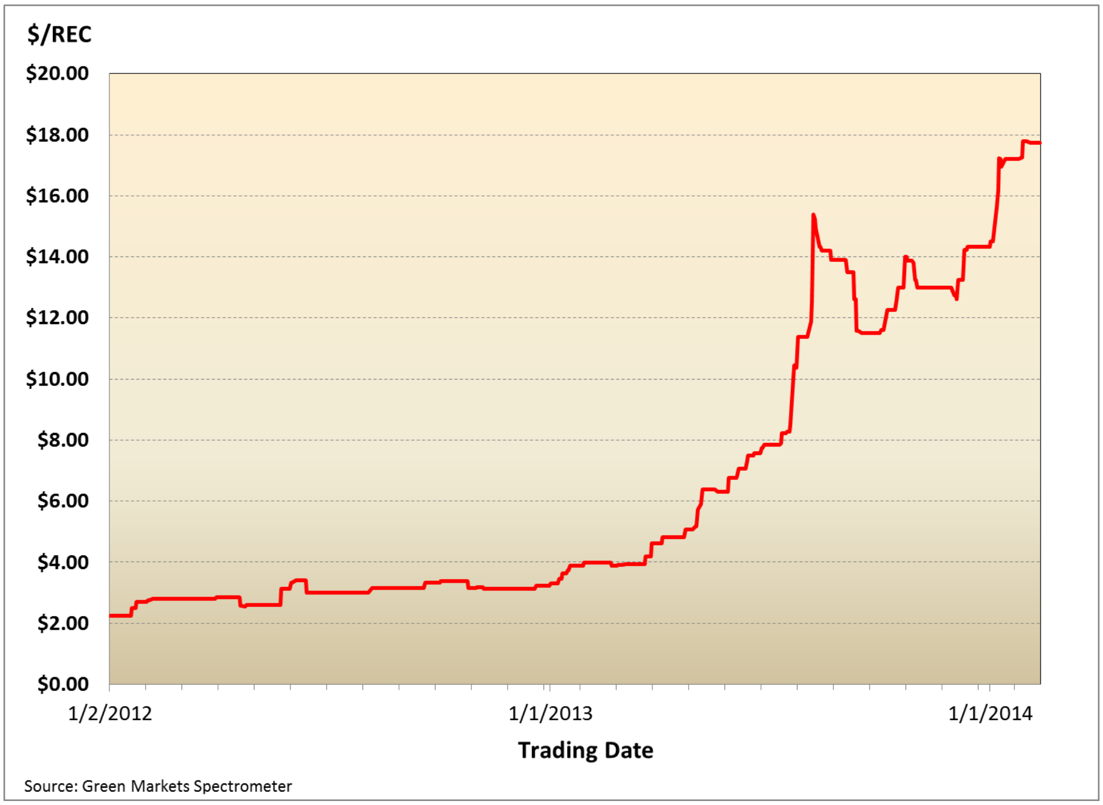
A. Estimating the Increase in Electric Costs of the Proposed 40% RPS Mandate

In any year, the cost of RPS compliance is determined by the specific non-solar Tier 1 RECs and solar RECs (SRECs) required times the respective market prices. Because the proposed mandate drastically increases the number of RECs that will be required starting in 2017 and doubles the existing REC requirement to 40% by 2025, the cost to consumers will increase. How much that increase will be depends on future REC and SREC market prices.

In its Annual Report for the year 2012, the Maryland Public Service Commission (MPSC) reported that the total cost of Tier 1 RECs (solar and non-solar) was $23.8 million. The reported average price of an SREC was $201.92, while the average price of a non-solar, Tier 1 REC was $3.19. Whereas the $23.8 million compliance cost in 2012 may seem small, the increase in the Tier 1 requirement, as well as increasing prices for RECs, will force Maryland consumers to pay hundreds of millions, if not billions, of dollars more each year for electricity.

Figure 1 provides a history of non-solar Tier1 REC prices in Maryland from January 2012 to the present. As this figure shows, although the market price was fairly flat in 2012 at around $3/REC, the market price has risen rapidly since the beginning of 2013. In early February, non-solar Tier 1 REC prices had increased almost six-fold, and are now about $18 per REC.

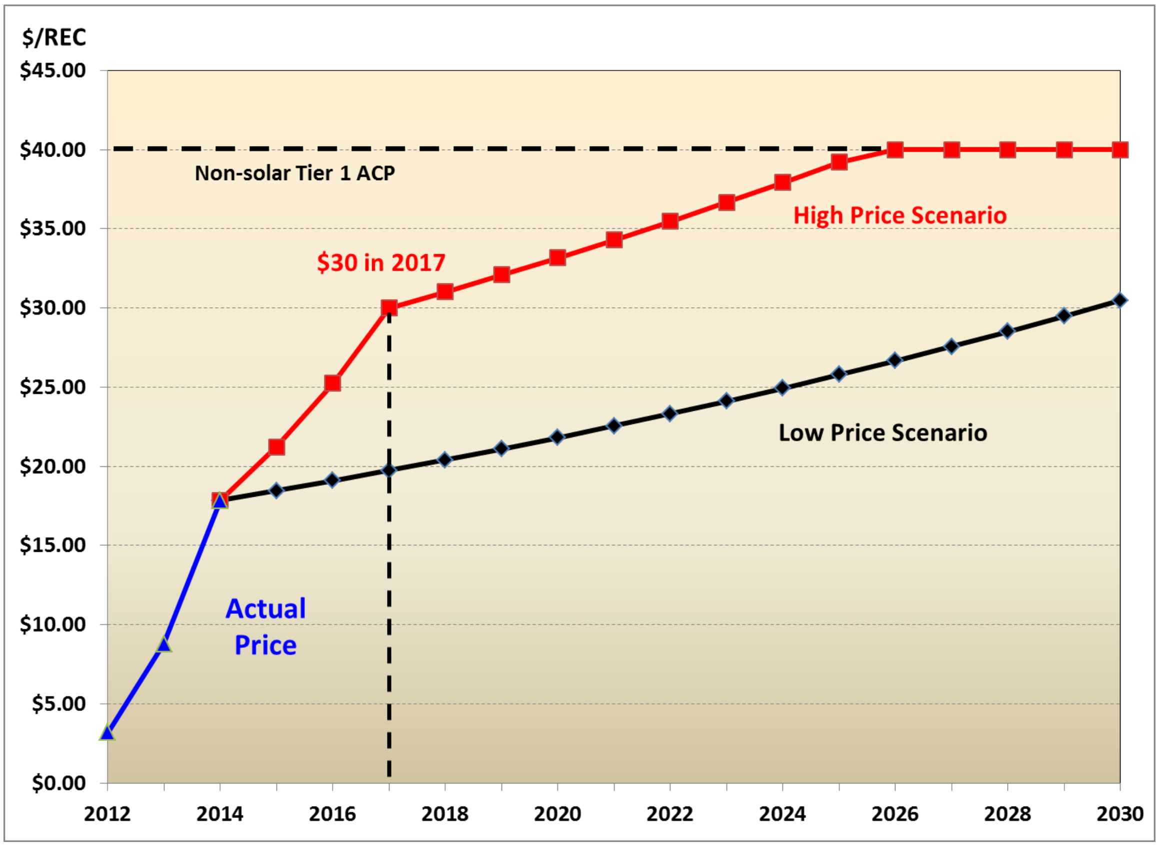
Figure 1: Maryland Tier 1 REC Historical Prices (Jan 2012 – Feb 2014)



While, there are no published long-term forecasts of REC prices, nor are there futures markets where Maryland non-solar Tier 1 RECs are traded actively, economic analysis can estimate potential future prices. First, because the increase in the RPS mandate will increase the demand Tier 1 RECs, those prices are unlikely to drop because of market forces. In other words, it is unlikely that renewable energy supplies will be able to increase commensurate with the increased demand.

For our analysis, we estimate the impacts of the proposed 40% RPS mandate under "Low" and "High" non-solar Tier 1 REC price forecasts. The "Low" case forecast assumes that the current price of non-solar Tier 1 RECs will increase at the forecast inflation rate. That is, despite the increase in demand for Tier 1 RECs, we assume prices will remain the same in real dollar terms. In its most recent, *Annual Energy Outlook 2014*, the US Energy Information Administration (EIA) projects an average rate of inflation of 1.7% for the years 2013 – 2025.[5] The "High" case forecast assumes that the rapid increase in mandated non-solar Tier 1 RECs starting in 2017 will cause the observed price increases to continue. We assume prices will escalate to $30 per REC in that year and thereafter, will increase at double the published rate of inflation until reaching the $40 ACP in 2027. These price forecasts, along with actual prices in 2012 – 2014, are shown in Figure 2.

Figure 2: Non-Solar Tier 1 Maryland REC Price Forecast Scenarios



The price of SRECs is more difficult to predict. After peaking at $375 in October 2010, Maryland SREC prices fell to $112.50 in early 2013. Prices then began increasing again, closing at $145 at the end of 2013. In early February 2014, prices had risen to $150. Under the

5 US Energy Information Administration (EIA), Annual Energy Outlook 2014, early release, Table A20. Available at: http://www.eia.gov/forecasts/aeo/er/pdf/tbla20.pdf

proposed RPS mandate, the mandated quantity of SRECs will double relative to the existing RPS mandate by 2022. The large increase in demand is likely to increase MD SREC prices. However, because the SREC ACP will drop from its current $400 to $150 by 2020, the same as today's SREC price, our analysis assumes the SREC price will increase at the rate of inflation until it reaches the ACP value in 2020. In 2022, the SREC ACP decreases to $100 and in 2024 decreases to $50, where it remains.

To calculate the cost of compliance with the proposed RPS increase, we also use the most recent load forecast prepared by PJM for the Baltimore Gas and Electric, and Delmarva Power & Light, load zones.[6] PJM projects average annual load growth of about 0.8% for these two load zones. Using this average annual growth rate, we estimate electricity usage in Maryland in each year through 2030 and, hence, the annual SREC and non-SREC Tier 1 REC requirements and costs under the "Low" and "High" non-solar Tier 1 REC price scenarios. The results are shown in Table 1.

Table 1: Annual MD RPS Compliance Costs, 2017-2030

Year	Proposed RPS Compliance Cost		Increase in Complance Cost Over Current RPS Mandate		Percent Increase	
	Low Case	High Case	Low Case	High Case	Low Case	High Case
	(Millions of Dollars)		(Millions of Dollars)		(Millions of Dollars)	
2017	$289.8	$403.4	$71.6	$108.8	33%	37%
2018	$404.6	$568.4	$104.5	$163.8	35%	40%
2019	$501.1	$704.2	$140.4	$216.4	39%	44%
2020	$557.0	$760.1	$174.8	$255.8	46%	51%
2021	$664.8	$904.2	$267.0	$369.4	67%	69%
2022	$651.7	$929.6	$297.9	$416.3	84%	81%
2023	$706.2	$1,035.2	$345.9	$505.0	96%	95%
2024	$624.0	$1,009.2	$326.7	$531.0	110%	111%
2025	$682.3	$1,129.3	$378.8	$633.3	125%	128%
2026	$696.9	$1,158.3	$387.0	$649.8	125%	128%
2027	$711.8	$1,167.3	$395.4	$654.8	125%	128%
2028	$727.1	$1,176.3	$404.1	$659.9	125%	128%
2029	$742.7	$1,185.4	$412.9	$665.0	125%	128%
2030	$758.7	$1,194.6	$421.9	$670.1	125%	128%
Total	**$8,719**	**$13,326**	**$4,129**	**$6,499**	**90%**	**95%**

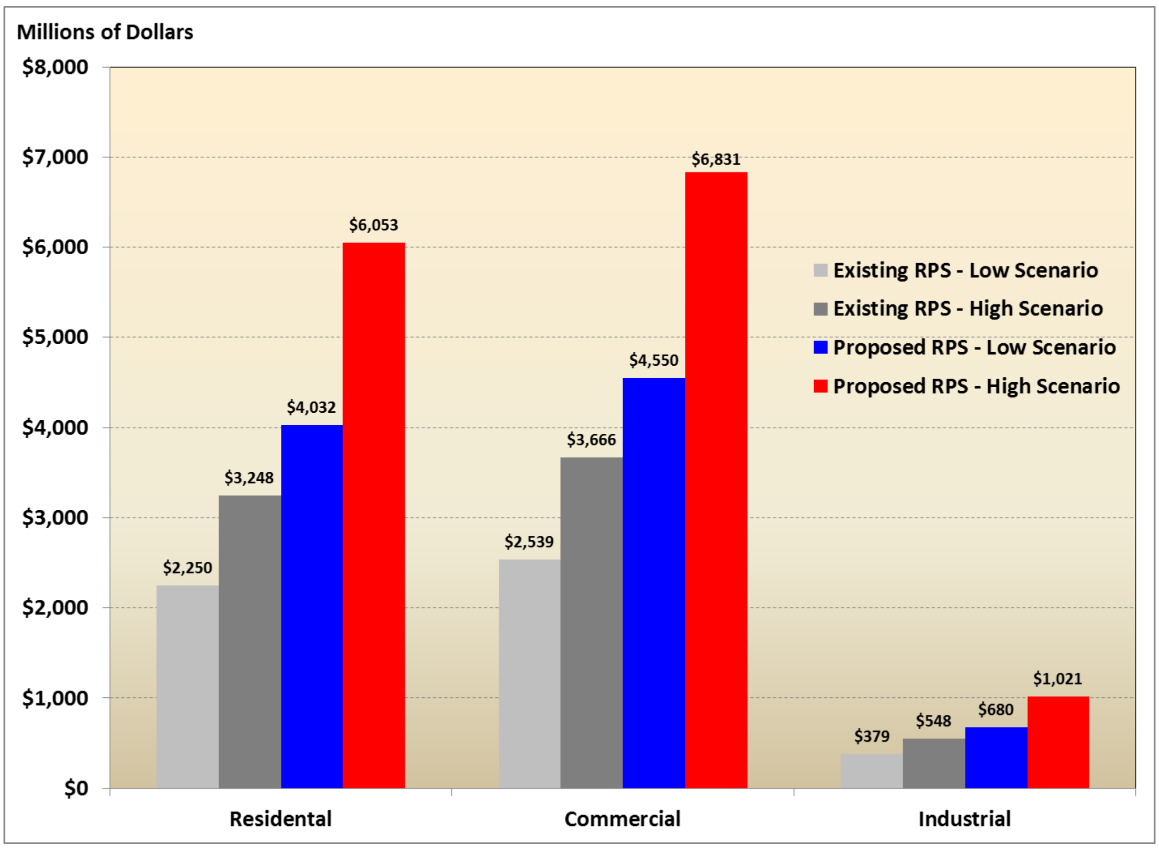
As Table 1 shows, under the "Low" REC price scenario, Maryland consumers and businesses will be forced to pay between **$8.7 billion** and **$13.3 billion** to comply with the proposed 40% RPS mandate by 2030. This represents an *additional* **$4.1 billion** to **$6.5 billion**

6 PJM, 2014 Load Forecast Report, January 2014, Table E-1, pp. 84-85. Available at: http://www.pjm.com/~/media/documents/reports/2014-load-forecast-report.ashx.

in RPS compliance costs, or a 90% to 95% increase, above what Marylanders will be required to pay under the *existing* RPS mandate. Under the "High" REC price scenario, Maryland consumers and businesses will be forced to pay over $14 billion to comply with the proposed mandate, $6.5 billion more than under the current mandate.

As shown in Figure 3, under the "Low" REC price scenario, Maryland residential customers will pay over $2.2 billion by 2030 under the existing RPS mandate. Under the proposed RPS mandate, that amount will increase to over $4 billion in the "Low" REC price scenario and over $6 billion with "High" REC prices. Thus, Maryland residential customers can expect to be forced to pay an additional $1.8 billion to $3.5 billion under the proposed mandate.

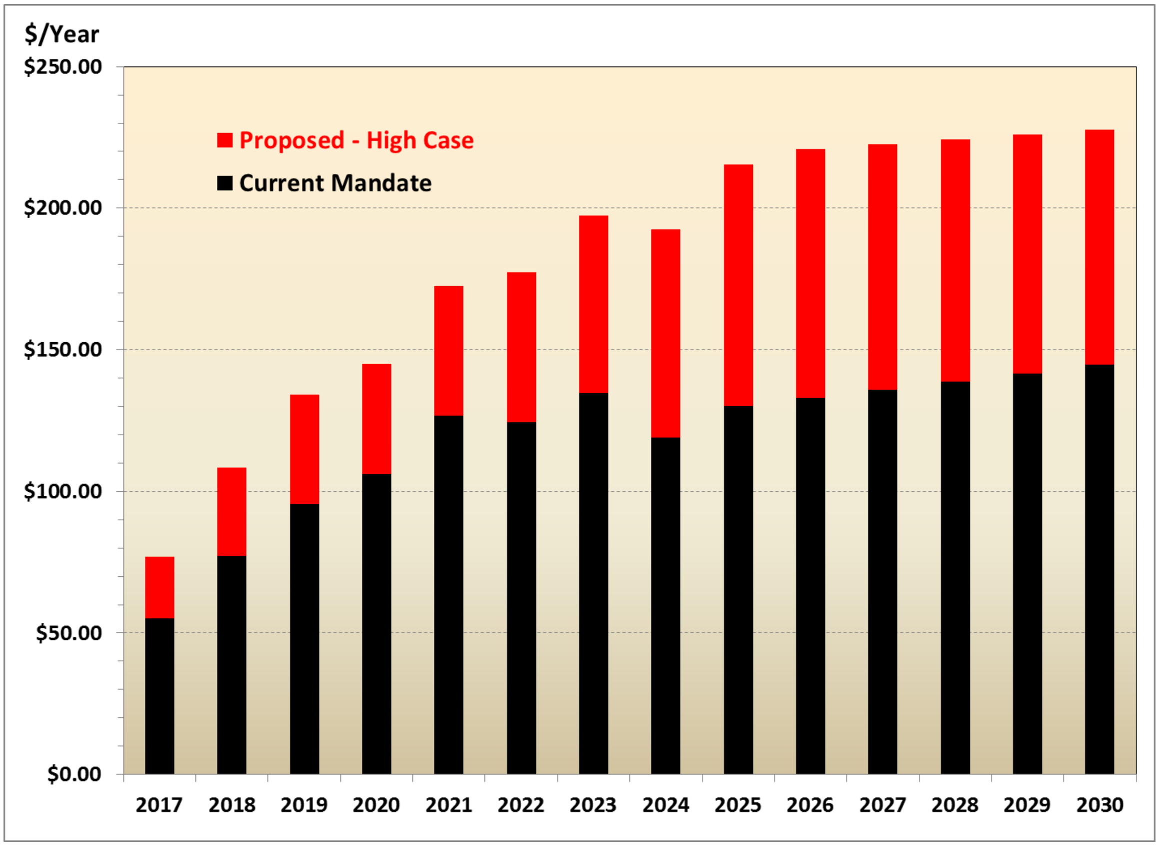
Figure 3: 40% RPS Mandate Expenditures by Customer Class, 2012- 2030



For the average Maryland residential customer, the proposed RPS mandate will mean a huge increase in annual electric bills, as shown in Figure 4. In 2012, the average residential customer paid a total of $4.64 under the existing RPS mandate. Under the proposed RPS mandate, by 2020, the average residential customer will pay as much as $145 per year, a **3,000%**

increase.[7] By 2025, a typical residential customer will be paying almost $220 per year for RPS compliance, an almost **5,000%** increase over 2012 REC expenditures.

Figure 4: Estimated Residential Customer 40% RPS Compliance Cost, per Year, 2017 – 2030



Similarly, the cost to comply with the proposed mandate will increase for the typical commercial customer from $47 in 2012 to almost $1,500 in 2020 and over $2,200 by the year 2025. A typical industrial customer will see costs increase from an average $193 in 2012 to $4,900 in 2025. These cost increases are summarized in Table 2.

[7] This estimate only takes into account the RPS compliance costs and not the additional generation, transmission, and distribution costs required to continue operating the system in a safe and reliable manner.

Table 2: Proposed 40% RPS Mandate, Annual Compliance Costs by Customer Class

Year	Customer Class		
	Residental	Commercial	Industrial
2017	$76.92	$777.88	$3,210.04
2020	$144.93	$1,465.74	$6,048.63
2025	$215.32	$2,177.63	$8,986.35
2030	$227.78	$2,303.58	$9,506.10

B. The Proposed Increase in the MD RPS Mandate Will Damage the State's Economy

The billions more in electricity costs that Maryland consumers and businesses will be forced to pay under the proposed RPS mandate will damage the entire Maryland economy, for several reasons. First, households will be paying far higher electric bills. That will reduce the amount of money spent on other goods and services, which will harm local Maryland businesses. Second, higher electric costs will harm those businesses, and many others, by making it more costly to provide goods and services. As their costs increase, Maryland businesses will become less competitive, especially those who must compete with other firms across the US and worldwide.

As they are put at an increasing competitive disadvantage because of escalating electric costs stemming from the proposed RPS, Maryland businesses will be reticent to expand their operations in Maryland. Instead, higher electric costs will provide an incentive for some Maryland businesses to relocate to states where electric costs are lower, taking with them Maryland jobs and further harming the state's economy.

A 40% RPS results in Significant Job Losses

We can estimate the job losses likely to be caused by higher electric prices under the proposed RPS mandate using an input-output (I/O) framework. I/O analysis traces the interdependencies of an economy, specifically the sales and purchases of goods among all of the sectors of an economy.

Ultimately, the more energy intensive a state economy, the larger the economic impact of higher electric prices on job losses. Research by Continental Economics has shown that these job losses range from 6 to 13 full-time equivalent (FTE) jobs per million (2012) dollars of additional electric expenditures per year.[8] Using the *lowest* value of that range, the loss of 6 FTE per million dollars of additional electricity costs means that a 40% RPS mandate will increase job losses from 1,600 to 2,200 in 2017, to between 3,300 and 5,500 by 2025, as shown in Table 3.

Table 3: Estimated Annual Job Losses Caused by Higher RPS Compliance Costs

Year	Annual Jobs Lost Current RPS Mandate		Annual Jobs Lost Proposed RPS Mandate		Percent Increase in Jobs Lost	
	Low Case	High Case	Low Case	High Case	Low Case	High Case
2017	1,203	1,625	1,598	2,225	33%	37%
2018	1,627	2,194	2,194	3,082	35%	40%
2019	1,923	2,601	2,672	3,755	39%	44%
2020	2,004	2,644	2,920	3,985	46%	51%
2021	2,050	2,757	3,427	4,662	67%	69%
2022	1,794	2,603	3,304	4,713	84%	81%
2023	1,796	2,643	3,520	5,160	96%	95%
2024	1,457	2,344	3,058	4,946	110%	111%
2025	1,463	2,390	3,288	5,442	125%	128%
2026	1,468	2,410	3,302	5,489	125%	128%
2027	1,474	2,388	3,317	5,439	125%	128%
2028	1,480	2,366	3,331	5,389	125%	128%
2029	1,486	2,345	3,346	5,340	125%	128%
2030	1,492	2,323	3,361	5,292	125%	128%

III. Benefits of the Proposed 40% RPS Mandate are Minimal

There are only two possible categories of benefits from the proposed RPS mandate. The first is the potential for the proposed RPS mandate to spur development of new, in-state renewable generating facilities. The second is improved environmental quality because of reduced air pollution emissions. In this section, we evaluate these potential benefits.

A. In-State Renewable Energy Development and Economic Growth

To evaluate the potential for development of in-state renewable generation facilities stemming from the proposed mandate, we begin by evaluating the existing in-state facilities that provide Tier 1 RECS.

[8] Appendix A-2 contains a detailed technical discussion of the input-output framework and how job losses from higher electric prices are estimated

According to data published by the Maryland PSC, in 2012, Maryland facilities provided 23% of all Tier 1 RECs, including SRECs. Table 4 provides a list of the non-solar Tier 1 facilities and the type of renewable energy they provide.

Table 4: Maryland In-State Non-Solar Tier 1 Facilities

Facility Name	Type	Tier 1 RECs
Criterion	Wind	129,409
Klondike Rd	Wind	108
Luke Mill	Black Liquor	106,251
Deep Creek	Hydro	11,512
Montgomery County	Muni Solid Waste	269,126
Wheelabrator	Muni Solid Waste	212,738
Sparrows Point	Blast Furnace Gas	90,587
BWWTP	Landfill Gas	8,738
DPL NWLND	Landfill Gas	894
PEP Ritchie Brown	Landfill Gas	2,845
PEP Ritchie PG	Landfill Gas	6,149
Worcester County	Landfill Gas	1,774
Total non-solar Tier 1 RECs		**840,131**
MD SRECs		**56,207**
Total in-state Tier 1 RECs		**896,338**
Total Tier 1 RECs		**3,963,343**
In-state Percent		**23%**

Source: MD PSC, Renewable Energy Portfolio Standard Report for 2012, January 2014, Appendix A.

Table 5 provides the percentage breakdown of all in-state Tier 1 REC facilities by fuel type. As this table shows, the largest source of existing, in-state Tier 1 RECs are municipal solid waste facilities which provided over half of all Tier 1 RECs from Maryland facilities.

Table 5: Maryland In-State REC Facilities by Fuel Type, 2012

Fuel Type	RECs	Percentage
Wind	129,517	14.4%
Black Liquor	106,251	11.9%
Hydro	11,512	1.3%
Muni Solid Waste	481,864	53.8%
Blast Furnace Gas	90,587	10.1%
Landfill Gas	20,400	2.3%
Solar	56,207	6.3%
Total	**896,338**	**100.0%**

Another 10% of Tier 1 RECs were supplied by the Sparrows Point Steel Mill, which is now closed. Another 12% was supplied by the New Page Paper Mill located in Luke, Maryland. Just over 14% was sourced from in-state wind generators, with another 6% from in-state solar facilities.

There is little likelihood of significant additional REC supplies from either municipal waste streams or paper mills. Nor are there likely to be new Tier 1 hydroelectric plants constructed. Thus, the most likely sources of future renewable energy growth in Maryland will be wind generation. However, because Maryland's wind generation is limited, it is reasonable to conclude that the majority of the additional renewable energy that will be required under the proposed RPS mandate will be purchased from out-of-state suppliers. As such, in-state economic development impacts from construction of renewable generating facilities will be small, and temporary. (Moreover, very few employees are needed to operate wind and solar generating facilities.) We conclude that the in-state economic development benefits from the proposed RPS mandate will be negligible and dwarfed by the job losses caused by the higher electric prices Maryland consumers and businesses will be required to pay.

B. Environmental Benefits of the Proposed RPS Mandate are Miniscule and Expensive

If few economic benefits can be expected from increasing the RPS to 40%, then the only other benefit will be potential reductions in air pollution, especially reductions in greenhouse gas emissions, specifically carbon dioxide emissions.[9] We can estimate the potential environmental benefits from reduced carbon dioxide (CO^2) emissions by considering the fossil generation that additional renewable resources would likely displace.

In 2012, coal-fired power plants provided 42.1% of all PJM generation. An additional 18.8% was generated by natural gas, while another 34.6% was generated by nuclear power plants.[10] The remainder is assumed to be wind, solar, and hydroelectric generation, none of which has CO^2 emissions.

The percentage of electricity in PJM generated by coal-fired power plants is decreasing due to a combination of lower natural gas prices and additional environmental regulations,

[9] Under the US Clean Air Act, emissions of the major "criteria" pollutants, SO2 and NOx, are capped already and a system of emissions allowances is used to allocate allowable emissions.

[10] PJM Market Monitor, *2012 State of the Market Report*, p. 51.

including the Mercury Air Toxics (MATS) rule and CO^2 emissions limits imposed by the US Environmental Protection Agency (EPA).

Nevertheless, we assume the 2012 generation mix continues unchanged in order to estimate a "best case" emissions reduction benefit from the proposed RPS mandate. According to emissions data published by EPA, in 2012 the average coal plant emits 2,093 pounds of CO^2 per MWh (lbs/MWh) of generation.[11] In 2012, EIA reported that the average CO^2 emissions-rate from natural gas-fired generators was 1,220 lbs/MWh. Using these emissions rates, and because nuclear power is emissions-free, the weighted average CO^2 emission rate from all PJM generating plants in 2012 can be estimated as 1,110 lbs/MWh.

Over the 14-year period, 2017 -2030, the proposed 40% RPS mandate will require an additional 153 million MWh of renewable generation. Using the 1,110 lbs/MWh average from 2012, this implies the new renewable generation will avoid an additional 85 million tons of CO^2 emissions. As discussed previously, the proposed RPS mandate will increase the costs paid by Maryland consumers between \$4.1 billion and \$6.5 billion over the 2017 – 2030 time period, or between \$3.3 billion and \$5.2 billion in inflation-adjusted 2012 dollars. Thus, the proposed RPS will cost Maryland consumers between \$39 and \$61 (2012\$) per ton of CO^2 reduced, assuming there is no reduction in coal-fired generation in PJM, and ignoring the additional CO^2 emissions that will result from additional cycling of back-up generators.

We can compare this estimated range of CO^2 reductions with current CO^2 prices. Maryland is one of nine states that participate in the Regional Greenhouse Gas Initiative (RGGI), which holds periodic CO^2 allowance auctions. The most recent auction was held on December 4, 2013 and had a clearing price of \$3/ton.[12] In 2012, the average CO^2 allowance price was just over \$2/ton, which was also the average price of the auctions since they began in 2008.[13] Thus, **under the proposed RPS mandate, Maryland consumers will be forced to pay between 12 and 20 times more to reduce CO^2 than the current \$3/ton RGGI auction clearing price**.

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[11] US EPA, National Electric Energy Data System, 2013. Average emissions calculated for 1,260 generating units. The spreadsheet data can be downloaded at: http://www.epa.gov/airmarket/images/CoalUnitCharacteristics2012.xls.

[12] RGGI, Results of Auction 22. http://www.rggi.org/market/co2_auctions/results/auction-22

[13] RGGI, 2012 Annual Market Monitor Report, p. 5. Available at: http://www.rggi.org/docs/Market/MM_2012_Annual_Report.pdf

Moreover, the estimated emissions reductions of at most 153 million tons of CO^2 between 2017 and 2030 will have no measurable impact on world climate. In 2012, for example, total US CO^2 emissions were over 7 billion tons. At that emissions level, between 2017 and 2030 a 40% RPS in Maryland will reduce US CO^2 emissions by less than two-tenths of one percent.

IV. The European Mandate Experience: A Cautionary Tale[14]

Because of decreased emphasis on nuclear power (except in France, which derives 80% of its electricity from nuclear plants) and concerns about climate change, western European countries embraced expansive policies to promote renewable energy and reduce greenhouse gas emissions. Germany was one of the leaders in this effort, called *Energiewende*, or "energy transformation." The result of these policies has been unaffordable electricity, an unstable electric grid highly susceptible to blackouts, loss of economic competitiveness and, ironically, little reduction in greenhouse gas emissions.

In 2000, for example, Germany enacted a law setting a renewable target of 80% by the year 2050, together with an 80% - 95% reduction in CO^2 emissions. Germany's law provided wind and solar developers with 20-year fixed price contracts at levels far greater than the market, as well as preferred access to the transmission grid. As a result, today Germany has over 35,000 MW of solar photovoltaic capacity and another 30,000 MW of wind, equal to 25% of the country's total generating capacity.

However, in their zeal to "transform" the energy industry, German – and other European – policy makers ignored basic economic and engineering principles. As a recent article in *The Economist* stated,

> This subsidy is costly. The difference between the market price for electricity and the higher fixed price for renewables is passed on to consumers, whose bills have been rising for years. *An average household now pays an extra €260 ($355) a year to subsidise renewables: the total cost of renewable subsidies in 2013 was €16 billion.* Costs are also going up for companies, making them less competitive than rivals from America, where energy prices are falling thanks to the fracking boom.
>
> …

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[14] Appendix A-3 includes copies of a number of recent news articles discussing the European experience.

> The Energiewende has, in effect, upset the economics of building new conventional power plants, especially those fired by gas, which is cleaner but more expensive than coal. So existing coal plants are doing more duty. Last year electricity production from brown coal (lignite), the least efficient and dirtiest sort, reached its highest level since 1990. … *In effect, the Energiewende has so far increased, not decreased, emissions of greenhouse gases*.[15]

Other European countries have experienced similar rate shocks. Electricity prices average 3 – 4 times higher than in the US. Table 6 shows the average electric prices for residential and industrial consumers in European countries that imposed stringent renewable generation mandates, along with average US prices.

Table 6: Average Residential and Industrial Electric Prices, Jan 2013 – July 2013

	Customer Class		Difference from US	
Country	Residential (cents/kWh)	Industrial (cents/kWh)	Residential (percent)	Industrial (percent)
US	12.03	6.76	-	-
France	20.17	13.12	68%	94%
Great Britain	23.85	16.18	98%	139%
Spain	30.52	16.77	154%	148%
Germany	39.99	19.52	232%	189%
Denmark	41.10	14.32	242%	112%

Source: Eurostat, US EIA

Note: European prices based on Feb 13, 2014 exchange rate of $1.37 per €.

As Table 6 shows, average prices for electricity in these five European countries, all of which offer heavy subsidies to renewable generation, are far higher than average US prices. Even France, with its preponderance of nuclear power, provides large subsidies for renewable generators. With industrial electric prices so much higher than in the US, it is little wonder that European firms are struggling to compete in the global marketplace.

Moreover, not only are high electric prices damaging European economics, renewable subsidies and preferential access to the electric grid has increased the likelihood of major blackouts. An October 2013 report by European consulting firm Capgemini concludes that Europe faces significant instability in its electric grid because of heavy penetration of

15 "Sunny, windy, costly and dirty," *The Economist*, January 18, 2014 (emphasis added). Available at: http://www.economist.com/news/europe/21594336-germanys-new-super-minister-energy-and-economy-has-his-work-cut-out-sunny-windy-costly.

intermittent wind and solar generation.[16] Subsidized renewable generation has driven wholesale prices lower, making it unprofitable to build new fossil-fuel or nuclear generation needed to ensure the lights stay on, especially on cold, cloudy, and windless days. This is one reason why generation from coal-fired power plants has increased in Germany, causing CO^2 emissions to *increase*.

As Maryland legislators debate the proposed doubling of the RPS mandate, they may wish to heed the experience in Europe. A recent article in the British newspaper *The Telegraph* states:

> Germany has become a cautionary tale for Europe, an example of where the wrong energy policies are damaging, perhaps mortally wounding, its economy, punishing consumers and the poor while undermining the green objectives, of reduced CO2 emissions, it set out to achieve.[17]

V. Conclusion

The costs of imposing a 40% RPS in Maryland will far exceed any benefits. As the analysis shows, the proposed doubling of Maryland's RPS will force Maryland consumers and businesses to pay up to $6.5 billion more for electricity while receiving very little real benefits and as a result, will significantly harm Maryland's economic viability. If enacted there will be thousands of job losses, massive decreases in consumer spending throughout the local economy, and very little environmental benefits. Maryland policymakers should reject this unnecessary, expensive and job-eliminating legislation.

[16] Capgemini, European Energy Markets Observatory, 15th ed., October 2013. Available at: http://www.capgemini.com/resources/european-energy-markets-observatory-2013-full-study

[17] Bruno Waterfield, "Germany is a cautionary tale of how energy polices can harm the economy," The (UK) *Telegraph*, January 16, 2014. Available at: http://www.telegraph.co.uk/finance/newsbysector/energy/10577513/Germany-is-a-cautionary-tale-of-how-energy-polices-can-harm-the-economy.html

Appendix 1: Maryland Renewable Portfolio Standard Background & Summary

Maryland's Renewable Energy Portfolio Standard (RPS), enacted in May 2004 and revised numerous times since, requires electricity suppliers to use renewable energy resources to generate a portion of their retail sales. Beginning in 2006, electricity suppliers were required to provide 1% of retail electricity sales in the state from Tier 1 renewable resources and 2.5% from Tier 2 renewable resources.[18] The RPS increases, ultimately reaching a level of 20% from Tier 1 resources in 2022, and 2.5% from Tier 2 resources from 2006 through 2018.[19] A solar carve-out was established in 2007, and requires that a total of 2% of retail electricity sales come from solar resources by 2020. In 2013 the state established an offshore wind carve-out of up to 2.5% beginning in 2017, with the actual annual requirements to be established by the Maryland Public Service Commission (PSC) subject to the 2.5% limitation.

Electricity suppliers demonstrate compliance with the RPS by procuring renewable energy credits (RECs) equivalent to the required percentages in table A1-1.[20] Most Tier I and all Tier II RECs can be provided from any qualified generation source throughout PJM. Solar, geothermal, poultry-litter-to-energy, waste-to-energy and refuse-derived fuel RECs must be provided by a qualified generation source connected to the Maryland distribution grid. Offshore wind RECs (ORECs) are geographically limited to a specific area near the Maryland coast.

Maryland law currently contains two forms of cost containment with respect to the RPS – an alternative compliance penalty (ACP) and customer rate impact restrictions. The customer rate impact restriction for solar permits an electricity supplier to request from the Maryland Public Service Commission (MPSC) a one year delay for the percentage increase of the solar target if actual or projected costs to be incurred for SRECs are greater than or equal to 1% of the electricity supplier's total annual electricity sales revenues in MD. The customer rate impact restriction for Tier I other than solar permits an electricity supplier to request from the MPSC a one year delay of the percentage increase of the Tier I target if actual or projected costs to be incurred for RECs are greater than or equal to the **greater of** the Tier I percentage or 10% of the electricity supplier's total annual electricity sales revenues in MD. The customer rate impact restriction for offshore wind is a projected customer rate impact limitation for offshore wind projects of $1.50 per month (in 2012 dollars).

[18] Tier I sources include solar, wind, qualifying biomass, methane, geothermal, ocean, fuel cells, small hydro (less than 30MW), poultry-litter-to-energy, waste-to-energy, refuse-derived fuel and thermal energy from a thermal biomass system. Tier II includes hydro other than pumped storage.

[19] The Tier II requirement sunsets in 2018.

[20] A REC has a three-year life during which it may be transferred, sold, or otherwise redeemed.

Table A1-1: Current RPS Targets as a Percentage of Retail Sales and Corresponding ACPs by Year

YEAR	Tier I % (ACP)	Tier II % (ACP)	Solar carve out % (ACP)	Offshore wind carve out % (OREC price limit)
2014	10.3 (.04/kWh) 9.95 + solar	2.5 (.015/kWh)	0.35 (.40/kWh)	0
2015	10.5 (.04/kWh) 10 + solar	2.5 (.015/kWh)	0.5 (.35/kWh)	0
2016	12.7 (.04/kWh) 12 + solar	2.5 (.015/kWh)	0.7 (.35/kWh)	0
2017	13.1 (.04/kWh) 12.15* + solar	2.5 (.015/kWh)	0.95 (.20/kWh)	Up to 2.5 (.19/kWh)
2018	15.8 (.04/kWh) 14.4* + solar	2.5 (.015/kWh)	1.4 (.20/kWh)	Up to 2.5 (.19/kWh)
2019	17.4 (.04/kWh) 15.65* + solar	0	1.75 (.15/kWh)	Up to 2.5 (.19/kWh
2020	18 (.04/kWh) 16* + solar	0	2 (.15/kWh)	Up to 2.5 (.19/kWh)
2021	18.7 (.04/kWh) 16.7* + solar	0	2 (.10/kWh)	Up to 2.5 (.19/kWh)
2022+	20 (.04/kWh) 18* + solar	0	2 (.10/kWh)	Up to 2.5 (.19/kWh)

*will decrease depending upon OREC%

Economic Analysis of Maryland's Proposed Renewable Portfolio Standard Legislation

Appendix 2:
Input-Output Framework

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Appendix 2: Input-Output Framework

Mathematics of the Input-Output Framework[1]

An input-output framework begins with observed transaction data for a particular region. For example, the IMPLAN model is constructed from data at the national, state, and county levels. The transactions are typically converted into dollar amounts, as that makes tracing economic flows much easier, since dollars are a uniform measure.

We assume that the economy is made of up of numerous sectors, e.g., manufacturing, mining, agriculture, services, government, and foreign trade. To construct an input-output table, we record how the output produced (supplied) by a given sector, such as steel, is purchased by (demanded) the other industry sectors (who then use those purchased inputs to manufacture other goods), plus external sales to government and consumers. Thus, if there the economy consists of N industries, the total output produced by an individual industry, X_k, will be purchased by the other N–1 industries, used by itself, and sold to final consumers. Thus,

$$X_k = z_{k,1} + z_{k,2} + z_{k,3} + \ldots + z_{k,N} + Y_k \qquad (1)$$

where the $z_{i,n}$ are sales to each industry *n*, and Y_k equals sales for final demand (i.e., to consumers, the government, and for export). Since we have N industries, we can write the entire set of flows as

$$\begin{bmatrix} X_1 = z_{1,1} + z_{1,2} + \ldots + z_{1,k} + \ldots + z_{1,N} + Y_1 \\ X_2 = z_{2,1} + z_{2,2} + \ldots + z_{2,k} + \ldots + z_{2,N} + Y_2 \\ \vdots \\ X_k = z_{k,1} + z_{k,2} + \ldots + z_{k,k} + \ldots + z_{k,N} + Y_k \\ \vdots \\ X_N = z_{N,1} + z_{N,2} + \ldots + z_{N,k} + \ldots + z_{N,N} + Y_N \\ \end{bmatrix} \qquad (2)$$

Each column of coefficients on the right-hand side of equation (2), *i.e.*,

[1] For a far more detailed discussion, see Leontief, *op. cit.* See also, R. Miller and P. Blair, *Input-Output Analysis: Foundations and Extensions*, (Englewood Cliffs, NJ: Prentice-Hall 1985), Chp. 2.

$$\begin{bmatrix} z_{1,k} \\ z_{2,k} \\ \vdots \\ z_{k,k} \\ \vdots \\ z_{N,k} \end{bmatrix}$$

represents the purchases from industry sector k to the N–1 other industry sectors, and to itself ($z_{k,k}$). In other words, industry k purchases inputs from all of the other industries to produce output X_k. When all of the N different columns are combined, they create an *input-output table*, with each selling sector a different row, and each purchasing sector a different column, as shown in Table A2-1.

Table A2-1: An Input-Output Table

Purchasing industry sector

		1	**2**	**...**	**K**	**...**	**N**
	1	$Z_{1,1}$	$Z_{1,2}$	...	$Z_{1,k}$		$Z_{1,N}$
Selling	**2**	$Z_{2,1}$	$Z_{2,2}$	...	$Z_{2,k}$		$Z_{2,N}$
Industry	⋮	⋮	⋮		⋮		⋮
Sector	**k**	$Z_{k,1}$	$Z_{2,k}$	...	$Z_{k,k}$		$Z_{N,k}$
	⋮	⋮	⋮		⋮		⋮
	N	$Z_{N,1}$	$Z_{N,2}$	...	$Z_{N,k}$		$Z_{N,N}$

Although the input-output table above incorporates all of the inter-industry sales and purchases, it does not account for the remainder of the economy. For example, final demand includes sales to consumers, state, local, and the federal government, investment, and exports. Moreover, in addition to buying outputs from other industries, each industry pays wages to its employees (W), pays for government services (in the form of taxes), pays for capital (in the form of interest payments, I), and profits. Together, these components are called *value-added*. On top of that, each sector imports goods and services from outside the economy. For example, if building a new high-voltage transmission line requires buying substation equipment from Germany, then the input-output model for the U.S. would consider that an import.

The input-output framework assumes that production coefficients are fixed. This means that there are specific quantities of inputs required to produce a given output. Thus, building a car—any car—is assumed to take (say) 2000 pounds of steel, 100 pounds of rubber, 200 pounds of glass, and so forth. Obviously, this assumption of fixed production coefficients does not hold true entirely—the amount of materials needed to build a large pick-up truck is greater than that needed to built a subcompact car—but for estimating short-run impacts, the overall assumption is reasonable: building more cars and trucks will clearly require more steel, producing more steel will require more iron ore, and so forth.

Because the input-output framework assumes fixed production coefficients (called a "Leontief production function"), the necessary inputs needed to produce a unit of output are all constant. If we divide the purchases made by industry k from every industry, *i.e.*, the $z_{i,k}$, to produce output X_k, we derive the *technical coefficients, $a_{i,k}$*, for industry k. In other words,

$$a_{i,k} = \frac{Z_{i,k}}{X_k} \tag{3}$$

If we substitute equation (3) into equation (2), we obain:

$$\begin{bmatrix} X_1 = a_{1,1}X_1 + a_{1,2}X_2 + \ldots + a_{1,k}X_k + \ldots + a_{1,N}X_N + Y_1 \\ X_2 = a_{2,1}X_1 + a_{2,2}X_2 + \ldots + a_{2,k}X_k + \ldots + a_{2,N}X_N + Y_2 \\ \vdots \\ X_k = a_{k,1}X_1 + a_{k,2}X_2 + \ldots + a_{k,k}X_k + \ldots + a_{k,N}X_N + Y_n \\ \vdots \\ X_N = a_{N,1}X_1 + a_{N,2} + \ldots + a_{N,k}X_k + \ldots + a_{N,N}X_N + Y_N \end{bmatrix} \tag{4}$$

What equation (4) tells us is that some of the output produced by an industry is sold to all other industries and used in fixed quantities to produce those industries' outputs, and the remainder is sold as final demand to consumers, government, and as exports. As a final step, we isolate the final demands for the output from each industry, Y_k. Thus,

$$\begin{bmatrix} X_1 - a_{1,1}X_1 + a_{1,2}X_2 + \ldots + a_{1,k}X_k + \ldots + a_{1,N}X_N = Y_1 \\ X_2 - a_{2,1}X_1 + a_{2,2}X_2 + \ldots + a_{2,k}X_k + \ldots + a_{2,N}X_N = Y_2 \\ \vdots \\ X_k - a_{k,1}X_1 + a_{k,2}X_2 + \ldots + a_{k,k}X_k + \ldots + a_{k,N}X_N = Y_n \\ \vdots \\ X_N - a_{N,1}X_1 + a_{N,2} + \ldots + a_{N,k}X_k + \ldots + a_{N,N}X_N = Y_N \end{bmatrix} \tag{5}$$

Equation (5) lies at the heart of the economic impact analysis, because it allows us to answer the question, "If the demand for the output of industry k changes, by how much would the output of all of the other industries change?" For example, building a new high-voltage transmission line would increase the demand for concrete, steel, and so forth. How will these changes in demand ripple through a state's economy and what will be the final changes in output levels in all other industries, as well as the change in total labor (i.e., jobs) and income?

To answer this sort of question, we solve equation (5) for each of the X_i. This requires a bit of matrix algebra. It turns out that the solution can be written as

$$\mathbf{X} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{Y} \tag{6}$$

where

$$\mathbf{A} = \begin{bmatrix} a_{1,1} \cdots a_{1,N} \\ a_{2,1} \cdots a_{2,N} \\ \vdots \\ a_{k,1} \cdots a_{k,N} \\ \vdots \\ a_{N,1} \cdots a_{N,N} \end{bmatrix}, \qquad \mathbf{X} = \begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_k \\ \vdots \\ X_N \end{bmatrix}, \qquad \mathbf{Y} = \begin{bmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_k \\ \vdots \\ Y_N \end{bmatrix}$$

The matrix $(\mathbf{I} - \mathbf{A})^{-1}$ is called the *Leontief inverse*. By changing the level of final demand in the output vector **Y** and knowing the technical coefficients $a_{i,k}$, we can determine the flows through the economy.

There are three types of economic impacts typically evaluated in an input-output study: *direct*, *indirect*, and *induced*. Direct effects are those that are a direct result of an increase in demand for good k. For example, building a new high-voltage transmission line will require concrete for the tower foundations. Thus, the demand for concrete will increase. That is a *direct* impact. Increasing the demand for concrete, however, will require concrete manufacturers to increased their purchases of all of the inputs used to manufacture concrete, including sand, gravel, electricity, and so forth, thus increasing the demand for all of those inputs. Thus, the *direct* increase in the demand for concrete *indirectly* increases the demand for all of these other products. Finally, all of these manufacturers pay wages to employees. Those employees, in turn spend a portion of their wages on food, electricity, new cars, and so forth. As a result, we say the resulting consumer spending from households *induces* further increases in demand, and thus additional economic impacts.

Because of the interconnections among industries and between industries and households, an increased demand for just one good or service is said to cause *ripple effects* throughout the economy. These ripple effects lead to additional jobs and increases disposable income as workers are hired, equipment and supplies are purchased from other local businesses, wages are paid to employees, and taxes are paid to government entities. These impacts are called *multiplier effects* or *multipliers*. For example, if the demand for concrete increases by $1 million and the overall impact on a state's economy is $2 million, then the output multiplier equals $2million/$1 million = 2.0. We can also calculate jobs and income multipliers. For example, if 100 workers are hired to construct a transmission line, and the overall ripple effects lead to 50 new jobs created as a result, the employment multiplier will equal 150/100 = 1.5.

Estimating economic impacts

Ripple effects act like waves bouncing off walls. Eventually, each subsequent round of impacts decreases in magnitude, just like a wave bouncing off walls eventually subsides. The speed at which these ripple effects diminish, and the overall magnitude of multipliers, depends on what are called *leakages* out of an economy. For example, not all of the materials needed to build the transmission line will be purchased from in-state companies. Moreover, some of the workers hired to construct the project may be from outside the state. Furthermore, in-state workers who are hired will not spend all of their wages within the state, but will instead buy goods and services from neighboring states, too. As we discuss in the sections that follow, assumptions about *leakage rates*, i.e., what fraction of spending occurs outside the state, are crucial in estimating the overall economic impacts to the state.

Calculating multipliers[2]

Multipliers are calculated from the Leontief inverse matrix defined previously. For example, suppose we have an economy with just two industries, industry **X** and industry **Y**, with the following technical coefficients matrix.

$$\mathbf{A} = \begin{bmatrix} 0.15 & 0.25 \\ 0.20 & 0.05 \end{bmatrix} \qquad (7)$$

What this means is that to produce $1 of additional output, industry **X** purchases $0.15 from itself and $0.20 from industry **Y**. The remaining $0.65 is accounted for through valued added – wages and salaries paid to employees, taxes paid to federal, state, and local governments, and profits. Similarly, to produce $1 of additional output, industry **Y** purchases $0.25 from industry **X**, $0.05 from itself, and the remaining $0.70 is value added. It turns out the Leontief inverse matrix (ignoring the value added impacts) is

$$(\mathbf{I} - \mathbf{A})^{-1} = \begin{bmatrix} 1.254 & 0.33 \\ 0.264 & 1.122 \end{bmatrix} \qquad (8)$$

The values in the Leontief inverse provide the output multipliers, by adding up each column. Specifically, if there is a $1 increase in final demand for the output of industry **X**, then the total increase in demand for output of industry **X** is $1.254 - $1 for the increase in final demand, and $0.254 for inter-industry and intra-industry use. There is also an *indirect* increase in demand of $0.264 of industry **Y** for inter-industry and intra-industry use. Thus, if we sum

2 For a much more detailed discussion, see Miller and Blair, fn. 1, from which these examples are drawn.

down the first column, a $1 increase in demand for industry **X** leads to a total increase in output of $1.254 + $0.264 = $1.518. The output multiplier for industry **X** is thus $1.518/$1 = 1.518. Because we are not considering households in this example, this output multiplier is called a *Type I* multiplier.

Next, we consider household impacts, such as from wages paid to households. Suppose that industry **X** pays $0.30 in wages per dollar of output and that industry **Y** pays $0.25 in wages per dollar of output. By incorporating these payments into the technical coefficients matrix, we can determine the direct, indirect, and *induced* impacts from increased output. So, we rewrite the technical coefficients matrix as follows:

$$\mathbf{A}=\begin{bmatrix}0.15 & 0.25 & 0.05\\ 0.20 & 0.05 & 0.40\\ 0.30 & 0.25 & 0.05\end{bmatrix} \qquad (\mathbf{I}-\mathbf{A})^{-1}=\begin{bmatrix}1.365 & 0.425 & 0.251\\ 0.527 & 1.348 & 0.595\\ 0.570 & 0.489 & 1.289\end{bmatrix} \tag{9}$$

The new technical coefficients matrix **A** now contains 3 rows and 3 columns. The 2x2 matrix of values in the top left hand corner is the original matrix shown in equation (7). The third column represents households. So, in the example, households spend $0.05 per dollar buying items from industry **X**, $0.40 per dollar buying items from industry **Y**, and $0.05 buying items from within the household sector. (The remainder is spent paying taxes and for investment.). The third row shows that industry **X** spends $0.30 per dollar on wages, while industry **Y** spends $0.25 per dollar on wages.

When we calculate the new Leontief inverse $(\mathbf{I}-\mathbf{A})^{-1}$, the first thing to notice is that the previous coefficients (the top-left 2x2 matrix) are all larger than they were in equation (8). This is because we are now including household demand impacts. Now, the output multiplier for industry **X** is the sum of the first column [1.365, 0.527, 0.570], or 2.462. Thus, for every $1 increase in demand in industry **X**, total output in the local economy increases by $2.462. The output multiplier for industry **X** is therefore 2.4262. In matrix notation, the output multiplier for industry *i* in our N-industry economy is:

$$M_{output,i}=\mathbf{i}_i \bullet (\mathbf{I}-\mathbf{A})^{-1} \bullet \mathbf{i}_i', \tag{10}$$

where $\mathbf{i}_i=\begin{bmatrix}0 & \cdots & 1_j & \cdots & 0\end{bmatrix}$.[3]

In our 2-industry example, we can calculate the household income multiplier for industry **X** in several ways. The first is to treat household spending as outside our model and estimate impacts using the Type 1 multipliers. To do that, we go back to the initial Leontief inverse in

[3] In other words, $\mathbf{i}_j$ is a 1*x*N unit vector having value 1 for industry j. The term $\mathbf{i}_j'$is called the *transpose* of $\mathbf{i}_i$, and is a N*x*1 column vector.

equation (8) and multiply the household income coefficients in **A** for our two industries (the third row) by the first column in the Leontief inverse, and add the results, i.e.,

$$H_X = (0.30)(1.254) + (0.25)(0.264) = 0.442$$

What this means is that, for every $1 increase in demand for the output of industry **X**, total household income increase by $0.442 because of the direct and indirect economic impacts on output. Thus, the *Type 1 multiplier* is $0.442/$0.30 = 1.47.

If we include the economic impact caused by households also spending money in the economy, the result is called a *Type II multiplier*. To do this, we use the new **A** and $(\mathbf{I}-\mathbf{A})^{-1}$ matrices shown above. For industry **X**, we calculate the total household income change, including the within-household sector impacts and divide by $0.30 that industry 1 pays directly to households in the form of wages. Thus, we have

$$H'_X = (0.30)(1.365) + (0.25)(0.527) + (0.05)(0.57) = 0.570$$

and the multiplier is H'_X/0.30 = $0.57/$0.30 = 1.9. Note also that the overall household impact, $0.57 is just the value in the last row of the Leontief inverse matrix for industry **X**.

Finally, we estimate *employment multipliers*, following the same approaches previously outlined. Only this time, the multipliers do not reflect dollar changes, but changes in employment. To do this, one determines the number of employees (in full-time equivalents) per dollar of output in each industry. For example, suppose for each million dollars of output produced in industry **X**, 300 employees are required, and that in industry 2, 400 employees are used per million dollars of output. This translates to values of 0.003 and 0.004 employees per dollar in industries **X** and **Y**, respectively. Similarly, assume the household sector requires 100 employees per million dollars of output, or 0.001 employees per dollar. Then, using the Leontief inverse matrix in equation (9), we calculate the total employment impact for industry **X** as

$$E'_X = (0.003)(1.365) + (0.004)(0.527) + (0.001)(0.570) = 0.000572$$

Then, using the same approach as for calculating the Type II income multipliers, we can calculate the Type II employment multiplier for industry 1 as E'_X/0.0003 = 1.907. Thus, for every job added in industry **X**, a total of 1.907 jobs are added in the entire economy.

The IMPLAN Model

IMPLAN was first developed in the 1970s by the U.S. Forest service to analyze the economic impacts of different forestry policies. The current version of IMPLAN is maintained by the University of Minnesota IMPLAN group. IMPLAN provides a detailed breakdown of the U.S. economy, with over 500 separate economic sectors. IMPLAN is widely used by numerous government agencies, including at the federal and state levels.

The IMPLAN model begins with the most current national transactions matrix developed by the current National Bureau of Economic Analysis Benchmark Input-Output Model. Next, the model creates state and county-level values by adjusting the national level data, such as removing industries that are not present in a particular state or economy. The model also estimates imports using what are called *regional purchase coefficients* (RPCs). RPCs measure the proportion of the total supply of a good or service required to meet a particular industry's intermediate demands and final demands that are produced locally. The larger the RPC value, the greater the percentage of total regional demand that is met through local supplies.

In addition to calculating standard Type I and Type II multipliers, IMPLAN can also calculate what are called "SAM multipliers." SAM stands for "Social Accounts Matrix," and is a more detailed breakdown of transactions within an economy. Specifically, whereas the typical input-output framework captures production and consumption, it leaves out some income transactions, such as taxes, savings, and transfer payments. IMPLAN allows users to capture these components as well, and thus derive what are called SAM multipliers.[4] SAM multipliers are a form of Type II multiplier. Thus, SAM multipliers incorporate direct, indirect, and induced impacts, while accounting for the effects of savings, taxes, and transfer payments.

Estimating the economic impacts of higher electric prices

To estimate the overall economic impacts of the higher wholesale electric prices and higher capacity market costs, we assumed a short-run elasticity of zero. That is, we assumed consumers would not, initially, reduce their electric consumption in response to the slightly higher electric prices they faced. Since consumer income is assumed to be fixed in the short run, this implies consumers must reduce their expenditures on all other goods and services (including savings and investment) by an equivalent amount.

Similarly, we assumed that in-state businesses would react to the increased price of electricity by reducing their total output such that their aggregate production expenses remained unchanged. This assumption is consistent with the assumption of fixed production coefficients in the Leontief model. It also assumes that businesses would not be able to pass on the increased production costs to consumers.

Estimating the total impacts on individual state output

With these assumptions, we estimate the overall change in output as follows. First, we calculate a weighted-average *regional purchase coefficient* for output in a state's economy, excluding electric power. A regional purchase coefficient (RPC) equals the fraction of local demand for a good or service that is satisfied from local production. For example, in Ohio, about 47% of all ready-mix concrete was purchased from in-state manufacturers, based on 2008 data. Thus, the weighted RPC, RPC_W, equals the sales-weighted average of the individual sector RPCs, excluding the electric generation sector (assumed to be sector k). Thus,

4 For complete discussion of how SAM multipliers are derived, see G. Alward, "Deriving SAM multipliers using IMPLAN," paper presented at the 1996 National IMPLAN Users Conference, Minneapolis, MN, August 15–17, 1996, 1996. Available at: http://implan.com/v3/index.php?option=com_docman&task=doc_download&Itemid=138&gid=127.

$$RPC_W = \frac{\sum_{i=1,i\neq k}^{N} Q_i \cdot RPC_i}{\sum_{i=1,i\neq k}^{N} Q_i} \tag{11}$$

Similarly, we calculate the weighted-average state SAM output multiplier, $\bar{M}_{State}^{output}$, using the output from each industry as the individual industry weights. Thus, using equation (10) for the output multiplier for industry i, we have

$$\bar{M}_{State}^{output} = \sum_{i=1,j\neq k}^{N} Q_i \cdot \{\mathbf{i_i} \bullet (\mathbf{I}-\mathbf{A})^{-1} \bullet \mathbf{i_i'}\} / \Delta Q_{State}^{TOT} = \sum_{i=1,j\neq k}^{N} Q_i \cdot M_{output,i} / \Delta Q_{State}^{TOT}, \tag{12}$$

The total impact on output in the state, ΔQ_{State}^{TOT}, will equal the weighted RPC times the weighted output multiplier, times the estimated increase in total electric expenditures. Thus, if the total change in electric expenditures is ΔQ_{ELEC}, we have:

$$\Delta Q_{State}^{TOT} = \Delta Q_{ELEC} \cdot RPC_{State} \cdot \bar{M}_{State}^{output} \tag{13}$$

Estimating the total impact on state employment

We can follow a similar procedure to estimate the total impacts on state employment arising from the higher electric expenditures, with the additional step of estimating the weighted average employment per million dollars of output, using the employment multipliers calculated by IMPLAN. Thus, the weighted jobs per million dollars of output can be written as:

$$\bar{J}_{State} = \sum_{i=1,i\neq k}^{N} Q_i \cdot J_i / \Delta Q_{State}^{TOT}, \tag{14}$$

where J_i is jobs per million dollars of output in industry *i*. Therefore, the overall weighted jobs multiplier is:[5]

$$\bar{M}_{State}^{jobs} = \sum_{i=1,i\neq k}^{N} Q_i \cdot J_i \{\mathbf{i_i} \bullet (\mathbf{I}-\mathbf{A})^{-1} \bullet \mathbf{i_i'}\}, \tag{15}$$

And so, the total impact on jobs in the state from the increased expenditures on electricity will equal:

$$\Delta J_{State}^{TOT} = (\Delta Q_{ELEC} \cdot RPC_{State}) \cdot (\bar{J}_{State} \cdot \bar{M}_{State}^{jobs}) \tag{16}$$

[5] The jobs multiplier is just the output multiplier weighted by jobs per million dollars of output.

Economic Analysis of Maryland's Proposed Renewable Portfolio Standard Legislation

Appendix 3:
Selected News Articles on European Experience with Renewable Mandates

Jonathan A. Lesser, PhD
President, Continental Economics

February 24, 2014

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The Telegraph: Germany is a cautionary tale of how energy polices can harm the economy

Despite Germany's shift to renewable solar and wind energies, and amid a recession, its carbon emissions rose by 1.8pc last year

Germany is trying to meet a target of producing 80pc of the country's electricity from renewable, wind and solar power by 2050 Photo: EPA

By Bruno Waterfield

Germanys shift to renewable energy was once Angela Merkel's flagship policy - now it has become her biggest headache.

"For me, the most urgent problem is the design of the energy revolution," said the German Chancellor in her first television interview after being re-elected last month. "We are under a lot of pressure. The future of jobs and the future of Germany as a business location depend on it."

She is not wrong: Europe's largest country and economy faces a crisis. Such is the mess over energy that the future of Germany's much-vaunted economic competitiveness is now seriously threatened.

Ms Merkel is currently Europe's most popular leader but there is a growing backlash against her ill-thought-out energy policies.

And, to cap it all, policies hailed as saving the world from climate change have, in fact, increased CO2 emissions.

The plan was called energiewende, which can be translated as energy transition or even revolution. But despite Germany's shift to renewable solar and wind energies, and amid a recession, its carbon emissions rose by 1.8pc last year.

In the European Union, as a whole, emissions fell by 1.3pc, mainly due to recession, according to the Centre for International Climate and Environmental Research in Oslo.

Ms Merkel has no one to blame but herself. Germany's shift to renewables was very much along the norms of the European model, with the aim of going beyond EU targets. Then along came Fukushima and the wave of anti-nuclear hysteria that followed the 2011 Tohoku earthquake and tsunami in Japan.

The once-in-a-millennium event at the Fukushima reactor killed nobody, although the tsunami claimed 16,000 lives. However, it was enough to panic Germany's green middle class.

Ms Merkel caved in to shrill demands for the country's atomic reactors to be closed. This decision, from a former chemist, who is personally pro-nuclear, is perhaps the most important economic call she has made. It is a disaster.

In March 2011, at the height of the eurozone recession, Germany switched off eight of its 17 nuclear reactors, cutting 7pc of electricity generation, with another 18pc to go over the next decade. The other nine reactors will be phased out from 2015 to 2022, bringing forward a previous 2036 deadline by 14 years.

Germany has also stepped up energiewende, as it switches to meet a target of producing 80pc of the country's electricity from renewable, wind and solar power by 2050. The fields carpeted with solar panels and the North Sea wind farms may have gratified the green conceits of Germany's middle class but they have come at a terrible economic and social cost. According to Nature, the international science magazine, this year German consumers will be forced to pay €20bn (£17bn) to subsidise electricity from solar, wind and bio-gas plants, power with a real market price of €3bn.

To pay for this green adventure, surcharges on electricity for households have increased by 47pc, or €15bn, in the past year alone. German consumers already pay the highest electricity prices in Europe; before long, the average three-person household will spend around €90 a month for electricity, almost twice as much as in 2000. Currently, more than 300,000 German households a year are seeing their power shut off because of unpaid bills.

Two-thirds of the electricity price increase is due to new government surcharges and taxes to subsidise renewable energy. While electricity prices have rocketed and the middle classes receive handouts to put solar panels on their houses, pensions and wages have not kept up, hitting Germany’s poorest hardest.

There are some serious practical problems emerging. Solar and wind power is erratic, which means that Germany will require storage capacity for 20bn to 30bn kilowatt-hours by 2050. So far, the storage capacity has grown by little more than 70m kilowatt-hours.

Compounding problems, when the wind stops blowing or the sun disappears, the electricity supply needed to power the national grid becomes scarce. This has pushed Germany into increased use of heavy oil and coal power plants, which is why the country released more carbon dioxide into the atmosphere in 2012 than in 2011.

Its decision to phase out nuclear power also led to a rise in coal prices, as traders realised that it was likely to keep more coal for domestic consumption.

Germany has got used to delivering economic homilies on competitiveness to the rest of Europe. But a new picture is emerging: German industry is in trouble. Energy prices are 40pc more expensive than in France and the Netherlands, and the bills are 15pc higher than the EU average. Even though Germany’s energy-intensive manufacturing sector is given a break with reduced levies, industries such as chemicals and steel are among the hardest hit, with energiewende costs of up to €740m a year. The burden could get even worse after the European Commission (EC) launched an investigation into the reduced levies.

The Verband der Industriellen Energie- und Kraftwirtschaft, which represents high-energy manufacturing, is alarmed that the commission could be about to rule that the levies are in breach of EU competition rules on state aid to industry. It is concerned that the EC will levy full charges on companies with immediate effect, and maybe even retroactively, a move it says could “destroy Germany’s industrial core”.

Germany has become a cautionary tale for Europe, an example of where the wrong energy policies are damaging, perhaps mortally wounding, its economy, punishing consumers and the poor while undermining the green objectives, of reduced CO_2 emissions, it set out to achieve.

WSJ Opinion Europe

Europe's Stark Renewables Lesson
Like Frankenstein, the EU has created a renewable-energy monster it does not know how to tame.

By
Rupert Darwall
Jan. 28, 2014 4:05 p.m. ET

"We can avoid what could well be a human calamity," German Chancellor Angela Merkel said in 2007 after EU leaders decided to cut greenhouse gas emissions by 20% and to generate 20% of the EU's energy from renewable sources by 2020. While these policies might have no discernible effect on the climate, they are a calamity for the EU. Like Frankenstein, the EU has created a renewable-energy monster it does not know how to tame.

In a clear-eyed analysis last week, the European Commission published its proposals for the follow-up period from 2020. The Commission notes that since 2005, the U.S. cut its CO_2 emissions by more than 12% (a little less than the EU, which cut emissions by just under 14%), thanks largely to shale gas. EU firms and households, the commission says, are increasingly concerned by rising energy prices and widening cost differentials with the U.S. Between 2008 and 2012, the average electricity price paid by European industrial firms rose by 16.7% while American firms are paying 2.3% less, so prices paid by American firms are 45% lower than EU firms.

As the U.S. powers into an era of cheap, abundant energy, across the Atlantic the European Commission reckons electricity prices will rise 31% before inflation by 2030 from 2011, and will consume an increasing share of European GDP. Widening energy-price disparities may reduce production and investment and shift global trade patterns, the commission concedes. However, it adds, if other countries outside Europe agreed to cap their greenhouse-gas emissions, they would help Europe's energy-intensive industries—hardly an inducement for them to do so.

Having driven much of the way to its 2020 vision, the EU has a big problem. Institutionally, it has no reverse gear. So for the post-2020 period, the commission proposes pushing on in the same direction, but with considerably less determination. It wants to nix some of the most egregious policies. First-generation biofuels have a limited role in decarbonizing the transport sector, so should not receive public support after 2020. The commission also puts a black mark over biomass policies (chopping down trees to burn in power stations), questioning their ability to reduce greenhouse emissions and highlighting their effects on other timber-consuming sectors.

Enlarge Image

Europe's Energy Calamity

Average cost of energy by price per kilowatt hour in 2012 (U.S. cents)

	United States	European Union	European Union cost disadvantage
Industrial Firms	6.67	12.25	+5.58
Households	11.88	19.75	+7.78

Source: Eurostat, US Energy Information Administration

Europe's Energy Calamity

Average cost of energy by price per kilowatt hour in 2012 (U.S. cents)

	United States	European Union	European Union cost disadvantage
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Source: Eurostat, US Energy Information Administration

But the EU's biggest energy problem lies at the dead center of its 2020 vision. By the end of 2012, the EU had installed around 44% of the world's renewable capacity. The commission acknowledges that, because member states over-incentivized investment in renewables, they compounded the challenges posed by weather-dependent electricity generation. Renewable energy needs conventional back-up, but the subsidies needed to make wind power profitable upend generators' cost structures, imperiling investment in conventional capacity.

The variable costs of wind and solar electricity are virtually zero. Subsidizing their fixed costs increases the risks and displaces the returns from investing in conventional power stations. When the wind blows, wind power delivers the lowest-cost electricity to the grid, bumping off conventional generators. Ironically, when wind becomes a sizeable component of a nation's electricity mix, profits from a gas-fired power station are more at risk from wind conditions than investments in wind-farms.

According to John Constable of the Renewable Energy Foundation, wind investors receive subsidies that give them satisfactory returns even in a low-wind year. A high-wind year is a bonus. The unsubsidized conventional generator is in a more awkward position. Its fixed costs are only recovered from the electricity it sells. With a large wind fleet in a high-wind year, the load factor for conventional generators could drop very low indeed, making it almost impossible to recover their fixed costs. The squeeze is being felt by gas-fired power stations. Last month, gas-fired power stations contributed 29% to the U.K.'s net supply of electricity compared to 50% four years earlier. As a result, there is a dearth of investment in such capacity.

The commission does not have an answer to Europe's looming energy crunch other than to propose that any post-2020 target for renewables should not be binding on member states. It also argues for "more market oriented approaches," including phasing out subsidies for mature energy technologies.

At Davos last week, U.K. Prime Minister David Cameron talked up the huge opportunity represented by shale gas. Having lots of shale gas won't be much use without gas-fired power stations. At the same time, the prime minister boasted that Britain is one of the best places for green investment, with the world's largest offshore wind market, seemingly oblivious to its effect on killing investment in new gas-fired power stations.

For the rest of the world, Europe offers a stark lesson. When it comes to unilateral cuts in greenhouse emissions and aggressive incentives for renewables, this is a global race you don't want to win. As Europe shows, the winner loses—big.

Mr. Darwall is the author of "The Age of Global Warming—A History," (Quartet Books, 2013).

European Economic Stability Threatened By Renewable Energy Subsidies

3.6 MW wind turbines stand at the nearly completed Riffgat offshore wind farm in the North Sea on June 23, 2013 near Borkum, Germany. Germany is pursuing the construction of offshore wind farms in the North Sea, made profitable only by extensive subsidies that appear to be wreaking havoc on European energy markets. (Image credit: Getty Images via @daylife)

The stability of Europe's electricity generation is at risk from the warped market structure caused by skyrocketing renewable energy subsidies that have swarmed across the continent over the last decade.

This sentiment was echoed a week ago by the CEOs of Europe's largest energy companies, who produce almost half of Europe's electricity. This group joined voices calling for an end to subsidies for wind and solar power, saying the subsidies have led to unacceptably high utility bills for residences and businesses, and even risk causing continent-wide blackouts (**Géraldine Amiel WSJ**).

The group includes Germany's E.ON AG, France's GDF Suez SA and Italy's Eni SpA, and they unanimously pointed the finger at European governments' poorly thought-out decision at the turn of the millennium to promote renewable energy by any means.

The plan seemed like a good one in the late 1990s as a way to reverse Europe's reliance on imported fossil fuels, particularly from Russia and the Middle East. But it seems the execution hasn't matched the good intentions, and the authors of the legislations didn't understand the markets.

"The importance of renewables has become a threat to the continent's supply safety," warned senior global energy analyst, Colette Lewiner, referring to a recent report by a Europe energy firm, *Capgemini*.

"We've failed on all accounts: Europe is threatened by a blackout like in New York a few years ago, prices are shooting up higher, and our carbon emissions keep increasing," said GDF Suez CEO Gérard Mestrallet ahead of the news conference.

Under these subsidy programs, wind and solar power producers get priority access to the grid and are guaranteed high prices. In France, nuclear power wholesales for about €40/MWhr ($54/MWhr), but electricity generated from wind turbines is guaranteed at €83/MWhr ($112/MWhr), regardless of demand. Customers have to pick up the difference.

The subsidies enticed enough investors into wind and solar that Germany now has almost 60,000 MWs of wind and solar capacity, or about 25% of that nation's total capacity. Sounds good for the Planet.

The problems began when the global economic meltdown occurred in 2008. Demand for electricity fell throughout Europe, as it did in America, which deflated wholesale electricity prices. However, investors kept plowing money into new wind and solar power because of the guaranteed prices for renewable energy.

Meanwhile, electricity prices have been rising in Europe since 2008, just under 20% for households and just over 20% for businesses, according to *Eurostat*.

Since renewable capacity kept rising and was forced to be taken, utilities across Europe began closing fossil-fuel power plants that were now less profitable because of the subsidies, including over 50 GWs of gas-fired plants, Mr. Mestrallet said.

I'm a little confused, isn't gas supposed to be the savior along with renewables? You can't have a lot of renewables without back-up gas to buffer the intermittency of renewables since gas is the only one you can turn on and off like a light switch.

I understand that Germany is building new coal plants that can ramp up and down faster than ever before, but the replacement of so much gas with renewables means Europe may not be able to respond to dramatic weather effects, like an unusually cold winter when wind and solar can't produce much.

Exhaust plumes rise from the new Neurath lignit coal-fired power station at Grevenbroich near Aachen, southern Germany. RWE, one of Germany's major energy provider, invested in new coal conducted power plants that will buffer wind energy as well as replace reliable base-load nuclear. The wisdom of this decision remains to be seen. (Image credit: AFP/Getty Images via @daylife)

In a warped parody of free market economics, some countries are building gas-fired plants along their borders to fill this void in rapid-ramping capacity, and that scares the markets even more, since gas is so expensive in Europe, that the price for electricity will climb even higher (EDEM/ESGM).

As the European Commission meets this week to discuss the issue, a parallel threat looms in America as a result of a similarly well-intentioned maze of mandates and subsidies over the last decade. It has been kept at bay only by our much larger energy production and our newly abundant cheap natural gas.

Americans may not be aware that natural gas is not cheap in Europe like it is in America. America's gas boom has occurred in the absence of a natural gas liquefying infrastructure, which is needed for import/export of natural gas to the world markets. Thus, the more expensive global prices do not affect the price in the U.S.

Yet.

But that will change. We're building LNG infrastructure at an amazing pace to exploit the huge gas reserves laid bare by advances in fracking technologies. Within five years, the U.S. will be the major player in the world gas market. Of course, gas prices will double or triple in the U.S. because, like oil, the price will now be set by the global market, not by the U.S. market. And like oil, it doesn't matter how much you produce in your own country, you pay the global price. Period. Just ask Norway.

So when natural gas prices double, what happens to the price of electricity since gas is so intimately married to renewables? State mandates and renewable production tax credits will still require us to buy renewable energy, even if it's double the price. We've already seen this occur here in the Pacific Northwest in battle between expensive wind and inexpensive hydro (Hydro Takes A Dive For Wind). Hydro lost.

That's fine when gas is cheap. It won't be fine when gas is expensive.

Europe Starts To Run, Not Walk, Away From Green Economics
Investor's Business Daily

Posted 02/05/2014 07:07 PM ET

Energy Policy: The media aren't paying much attention, but in recent weeks Europe has decided to run, not walk, as fast as it can away from the economic menace of green energy.

That's right, the same Europeans who used to chastise us for not signing the Kyoto climate change treaty, not passing a carbon tax and dooming the planet to catastrophic global warming.

In Brussels last month, European leaders agreed to scrap per-nation caps on carbon emissions. The EU countries — France, Germany, Italy and Spain — had promised a 40% reduction in emissions by 2030 (and 80% by 2050!). Now those caps won't apply to individual nations.

Brussels calls this new policy "flexibility." Right. More like "never mind," and here's why: The new German economic minister, Sigmar Gabriel, says green energy mandates have become such an albatross around the neck of industry that they could lead to a "deindustrialization" of Germany.

Chancellor Angela Merkel said earlier this year that overreliance on renewable energy could cause "a problem in terms of energy supply" — and she's always described herself as a green politician and a champion of these programs.

But green dreams have collided with cold economic reality. Green programs aren't creating green jobs but green unemployment at intolerable double-digit rates. The quip in economically exhausted Europe these days is that before we save the planet, we have to save ourselves.

Now European leaders are admitting quietly that they want to get into the game of fracking and other new drilling technologies that have caused an explosion of oil and gas production in the U.S.

According to energy expert Daniel Yergin, if Europe wants to remain competitive, these nations must tap the fountain of abundant and cheap shale gas and oil. He recently wrote that European leaders now realize a major factor behind the economic woes in euroland is that electric power costs are "two to three times more expensive" than in the U.S.

Consider the price of natural gas in the U.S. vs. other nations in the chart below. U.S. prices are about three to four times lower, and in states like Ohio, Michigan and Pennsylvania this is causing a renaissance in manufacturing. German engineering and manufacturing firms are looking to relocate to the U.S. where power costs are lower.

What's amazing about this story is that so few American politicians get it. President Obama talked in his State of the Union speech about doubling renewable energy output over the coming years. Mr. President, these are exactly the goals the Europeans are abandoning. Why chase the losers?

Why not try a different approach to energy policy? Get rid of all taxpayer subsidies for energy — oil, gas, wind and solar power, biofuels, electric-battery-operated cars and others — and create a true level playing field where every energy source competes on efficiency and cost rather than political/corporate favoritism?

The answer is that the green lobby knows it can't possibly compete on a level playing field. Not with natural gas at $4 and 150 years' worth of this power source in Appalachia's Marcellus shale basin and more out West.

The Europeans made nearly a $100 billion wrong bet on renewable energy, and their economies and citizens have taken a big hit. Now they've awakened to their mistakes. The shame is Washington is still slumbering.

German Energy Official Sounds a Warning

NY Times

By MELISSA EDDYJAN. 21, 2014

BERLIN — Germany's new energy minister on Tuesday struck a sobering tone about the country's ambitious goals for making its energy sector more reliant on renewable sources, saying that rising costs risked losing public support and jeopardizing the powerful German industrial base.

The minister, Sigmar Gabriel, in his first major policy speech, said at an annual energy conference organized by the publication Handelsblatt in Berlin that annual consumer costs for renewables of about 24 billion euros, or about $32.5 billion, were already pushing the limits of what the German economy, Europe's most powerful, could handle.

"We need to keep in mind that the whole economic future of our country is riding on this," said Mr. Gabriel, who is responsible for the Energiewende, or energy transformation. "The energy transformation has the potential to be an economic success, but it can also cause a dramatic de-industrialization of our country."

Mr. Gabriel's proposals for overhauling the energy law will be presented to Chancellor Angela Merkel's new cabinet on Wednesday. He is chairman of the Social Democratic Party, which formed a coalition government in December with Ms. Merkel's Christian Democrats. The country has been awaiting his plans for overhauling the Energiewende, which was put in place in 2011 by the chancellor's previous government in response to the nuclear disaster in Japan.

The German proposals are being discussed even as the European Union on Wednesday planned to announce its climate and energy goals for 2030. Officials are trying to balance the interests of business with the imperative to reduce emissions of the gases that cause global warming.

Germany sees itself as an exemplar of the way to adopt cleaner energy sources. Berlin now wants to ensure that its own energy transformation does not jeopardize its progress on emissions reductions.

Getting German energy on the right path is so important to the new coalition government that Mr. Gabriel has been put in charge of two previously separate portfolios in a sort of super ministry that combines energy and the economy.

His proposals would curb some of the subsidies paid to producers of electricity generated by solar and wind production, cutting them by about a third by 2015, while setting limits to improve control of the expansion of onshore wind and solar farms, according to documents, versions of which have been widely reported in the German news media.

“We need to control the expansion of renewable energy, and not have the anarchy that we have seen previously,” Mr. Gabriel said. “We need to reduce costs so that it remains affordable.”

At the same time, Mr. Gabriel has sought to dampen expectations that he can bring about radical changes. He has repeatedly emphasized that he is not promising to bring down electricity prices, which are already among the highest in Europe.

Germany faces a delicate balance. It wants to keep momentum for renewable energy, while ensuring that it remains affordable. The country seeks to phase out its nuclear reactors by 2022, while increasing the share of power generated by renewable sources to 40 percent or 45 percent by 2025.

Last year, 23.4 percent of all energy produced in Germany came from renewable sources.

Ms. Merkel’s government wants to push the revamped laws through Parliament by midyear in an effort to stem the rising costs. Adding to the pressure is an investigation by the European Union into exemptions for energy-intensive operations in Germany, which Brussels says might violate trade laws but that Berlin argues are necessary to maintaining the country’s competitive edge.

Mr. Gabriel said that he would push back against Brussels, arguing that Germany was conducting an experiment from which the entire 28-nation bloc could benefit.

“We are trying to ease burdens that don’t exist elsewhere in Europe,” Mr. Gabriel said. “Germany is paying for the learning curve that others don’t need to pay for, that we need to keep this affordable for the German industry.”

Germany also faces the challenge of ensuring stability in the energy market. Conventional energy providers have suffered devastating losses because of imbalances in the energy market caused by the heavily subsidized renewables. Several have demanded that the government compensate them for keeping unprofitable plants active in order to ensure stability on the market.

Peter Terium, the head of the German power company RWE, said at the conference that nuclear energy might be phased out even earlier than the government has planned, given that it is no longer profitable. “It would not be responsible to allow a reactor to continue to run when it is losing money every day,” Mr. Terium said.

Mr. Gabriel has rejected subsidies for conventional plants but said he would hold talks with industry leaders over how best to address the problem.

An adverse effect of Germany’s energy transformation has been an increased use of brown coal, or lignite, one of the cheapest and dirtiest sources of energy. Germany is already the world’s largest miner of brown coal, and last year it produced more electricity from brown coal than any time since 1990.

Germany Promises Energy Shake Up

Energy Minister Vows to Address Disruption to Electricity Market Caused by Renewable Subsidies

By
Jan Hromadko
Jan. 21, 2014 11:48 a.m. ET

BERLIN—Germany's new energy minister Tuesday promised power companies to address disruptions in the country's electricity market caused by subsidies for renewable energy sources.

Sigmar Gabriel, energy minister in Chancellor Angela Merkel's government, made the announcement after months of lobbying by German and European utilities, whose profits have plunged because subsidized renewables are displacing their conventional power plants.

Mr. Gabriel's reassessment shows the challenges Germany faces in attempting a radical and expensive shift from fossil fuels and nuclear power to such green energy sources as wind and solar. Many other countries are watching how Germany, one of the world's richest countries, handles the transition.

The government will this year start discussions with energy companies on possible financial support for fossil-fuel powered plants to balance subsidies for renewables, Mr. Gabriel told an energy conference.

"We will have to provide an answer to this problem, or at least guidance, by the end of the year," Mr. Gabriel said.

At stake is more than corporate profits. Renewables aren't yet sufficiently developed to provide reliable and constant electricity flows, so power grids still depend on backup supplies from traditional sources, such as coal and gas.

But because power providers face eroding demand for wattage from these massive fossil-fuel generators, which are designed for efficiency at high output, the companies are mothballing or closing unprofitable power plants. This threatens to remove the necessary backup supply.

Leonhard Birnbaum, executive board member at German power company E.ON SE, welcomed the government's pledge to address power-market woes. "This is absolutely inevitable, because earnings in conventional power generation are deteriorating to such an extent that many utilities will not survive for much longer," he told a press conference.

Mr. Birnbaum singled out gas-fired power plants as particularly hard hit. "There is no gas-fired power plant on the European continent that generates profits at present," he said.

Europe imports most of its natural gas and prices remain high. This has put Europe at a competitive disadvantage against the U.S., where natural gas prices have plunged thanks to new domestic sources.

Germany's gas-fired power plants are greatly affected by renewables because they are designed to meet daytime peak demand—the same hours when renewables are generally available.

Utilities, including E.ON and RWE have dominated Germany's power market for decades. But the growth of subsidized renewables has undermined the companies' long-standing business model.

Compounding the problem is Europe's economic weakness, which has cut industrial demand for power and added to the growing capacity glut.

"The situation of the power industry in Germany and all of Europe is miserable," said RWE Chief Executive Peter Terium at the Berlin conference. "We're in the deepest structural crisis this industry has ever seen."

In November, RWE said it swung to a net loss for 2013's third quarter, blaming poor performance of its power generation business due to low power prices and reduced utilization rates.

Mr. Gabriel said that coal- and gas-fired plants will remain essential for many years as backup, and the surge of plant closures raises concerns about the stability of future electricity supplies despite the glut.

"Until around 2016, there's sufficient capacity, in fact, power plant operators are complaining about overcapacities," he said.

To ensure constant supply, other European countries, including France and the U.K., have established systems that will compensate operators for providing backup capacity, even when it sits idle. Utilities are urging Germany to set up a similar system.

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Germany’s energy transition
Sunny, windy, costly and dirty

Germany’s new “super minister” for energy and the economy has his work cut out

The Economist

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SIGMAR GABRIEL has been on a roll. The boss of Germany’s centre-left Social Democrats (SPD) has herded his party into a coalition with Chancellor Angela Merkel and become vice-chancellor. He is jovial, convivial and aligned with the *Zeitgeist*. Demonstrating the SPD’s vision of work-life balance, he plans to take Wednesday afternoons off to pick up his two-year-old daughter from her crèche.

But Mr Gabriel, who is mulling a run for chancellor in 2017, will by then be judged on a more daring project. As part of his coalition deal with Mrs Merkel, he is now a “super minister” combining two portfolios, energy and the economy. He is thus in charge of rescuing Germany’s most ambitious and risky domestic reform: the simultaneous exits from nuclear and fossil-fuel energy, collectively known as the *Energiewende*, a term that means energy “turn” or “revolution”.

More a marketing slogan than a coherent policy, the *Energiewende* is mainly a set of timetables for different goals. Germany’s last nuclear plant is to be switched off in 2022. The share of renewable energy from sun, wind and biomass is meant to rise to 80% of electricity production, and 60% of overall energy use, by 2050. And emissions of greenhouse gases are supposed to fall, relative to those in 1990, by 70% in 2040 and 80-95% by 2050.

German consumers and voters like these targets. But they increasingly dislike their side-effects. First, there is the rising cost of electricity. This is a consequence of a renewable-energy law passed in 2000 which guarantees not only 20 years of fixed high prices for solar and wind producers but also preferred access to the electricity grid. As a result, Bavarian roofs now gleam with solar panels and windmills dominate entire landscapes. Last year, the share of renewables in electricity production hit a record 23.4%.

This subsidy is costly. The difference between the market price for electricity and the higher fixed price for renewables is passed on to consumers, whose bills have been rising for years. An average household now pays an extra €260 ($355) a year to subsidise renewables: the total cost of renewable subsidies in 2013 was €16 billion. Costs are also going up for companies, making them less competitive than rivals from America, where energy prices are falling thanks to the fracking boom.

To forestall job losses, Germany therefore exempts companies who depend on electricity and compete globally from paying the subsidy. But the European Union’s competition commissioner, Joaquín Almunia, has been investigating whether the entire package of subsidies and exemptions violates European law. Only concerted German lobbying in Brussels just before Christmas has held him back from seeking repayments for now.

So Mr Gabriel is in a bind. New estimates by McKinsey, a consultancy, suggest that there is almost nothing he can do to reduce the costs of the subsidy. Germany's constitution forbids retroactively reneging on promises already made. Cutting subsidies for, say, new windmills by 15% in the next two years would reduce an average household's annual electricity bill by only a cent. Even if Mr Gabriel decided to stop supporting renewable energy completely (which is unimaginable), the surcharge on consumers' monthly bills would hardly decrease. And if he hypothetically scrapped all industrial exemptions (also unimaginable), the average bill would still fall only a little.

Cost is not the only problem with the *Energiewende*. It has in effect turned the entire German energy industry into a quasi-planned economy with perverse outcomes. At certain times on some days, sun and wind power may provide almost all German electricity. But the sun does not always shine, especially in winter, and the wind is unpredictable. And "batteries"—storage technologies that, for example, convert power to gas and back again to electricity—on a scale sufficient to supply a city are years away. Nuclear-power plants are being phased out (this week's court decision that the closure of a plant in Hesse was illegal will raise costs even more, as it may entitle the operator to more compensation). So conventional power plants have to stay online in order to assure continuous supply.

The *Energiewende* has, in effect, upset the economics of building new conventional power plants, especially those fired by gas, which is cleaner but more expensive than coal. So existing coal plants are doing more duty. Last year electricity production from brown coal (lignite), the least efficient and dirtiest sort, reached its highest level since 1990. Gas-fired power production, by contrast, has been declining (see chart). In effect, the *Energiewende* has so far increased, not decreased, emissions of greenhouse gases.

This puts the SPD and Mr Gabriel in a particularly awkward spot. Germany is the world's largest miner of brown coal, and mining belts such as the one in North-Rhine Westphalia are traditional strongholds for the party. Mr Gabriel cannot therefore be seen to be "anti-coal". But that is exactly what the ecologically minded Greens in the opposition are. They want Mr Gabriel to lean on Brussels to reform the EU's emissions-trading regime, making certificates for carbon-dioxide emissions more expensive and thus coal-fired plants less attractive than gas-powered ones. Ideological allies before last September's election, the Greens and the Social Democrats could now become increasingly shrill opponents.

As Mr Gabriel plans his rescue, he enjoys just one advantage over his predecessors: as super minister, he has all the relevant bureaucracies under his control. The accompanying disadvantage is that, come the next election, voters will know exactly whom to blame if the*Energiewende* is still a failure. If that happens, Mr Gabriel may find that he can pick up his daughter from school a lot more often.

Energy Bosses Call for End to Subsidies for Wind, Solar Power

Group Includes CEOs From Eni, GDF Suez and E.ON

By
Géraldine Amiel
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BRUSSELS—The chief executives of 10 energy companies accounting for half of Europe's electricity production capacity issued a joint call Friday to end subsidies to wind and solar power, saying the mechanisms have led to whopping bills for households and businesses and could cause continentwide blackouts.

Speaking at a news conference in Brussels, the CEOs also urged European Union authorities to set up a system that would compensate electricity companies that agree to maintain spare capacity on standby—a practice that helps increase the security of Europe's highly interconnected power grid.

The informal group, which includes utilities such as Germany's E.ON AG, France's GDF Suez SA, and Italy's Eni SpA, blamed the trend on policies introduced at the turn of the century, when most European governments sought to promote renewable energy

The criticism from Europe's commercial power producers isn't new. The industry has long been critical of the continent's shift to renewable energy because it threatens their core nuclear and coal-based power production. Europe's economic woes, however, have sharpened the debate, as companies and private citizens alike complain about the rising cost of power.

In the late 1990s and early 2000s, Germany, France, Italy and some other EU countries subsidized solar and wind power in an effort to minimize the bloc's reliance on imported fossil fuels and reduce power prices.

"We've failed on all accounts: Europe is threatened by a blackout like in New York few years ago, prices are shooting up higher, and our carbon emissions keep increasing," said GDF Suez CEO Gérard Mestrallet ahead of the news conference.

The European Commission, the bloc's executive body, is scheduled to discuss the issue next week.

Under the subsidy mechanisms, wind and solar power producers benefit from priority access to the grid and enjoy guaranteed prices. In France, for instance, even as wholesale prices hover around €40 ($54) a megawatt, windmill electricity goes at a minimum of €83 a megawatt, regardless of demand. The difference is charged to customers.

The system certainly lured investors into wind and solar power projects. Germany now has 60 gigawatts of wind and solar capacity—about 25% of the country's total power-generation capacity.

Members of the CEO group said the subsidy mechanisms became deeply flawed in 2008, when the financial crisis hit and many European countries descended into economic recession. Although demand for electricity stalled or fell in some countries, pushing down wholesale electricity prices, investors kept plowing money into new wind and solar power capacity thanks to the guaranteed tariffs for renewables.

Meanwhile, electricity prices continued rising. On average, after-tax power prices rose 17% for households and 21% for businesses in Europe over the past four years, according to Eurostat data.

To cope with overcapacity, utilities decommissioned or mothballed some of their fossil-fuel power plants that had become unprofitable to operate. Over the past four years, 51 GW of gas-fired capacities have been idled across Europe, Mr. Mestrallet said.

"That's like wiping out half of France's power-generation capacity, or those of Belgium, the Czech Republic and Portugal combined," he said.

Analysts say the trend is dangerous because, unlike renewable wind and solar sources, which are intermittent, gas-fired plants are a key element to improving the reliability of the grid because they can be turned on or off at short notice. Some fear that Europe is now ill-equipped to weather a cold spell.

"The importance of renewables has become a threat to the continent's supply safety," Colette Lewiner , an energy analyst at Capgemini consultancy, warned in a report released this week. "There could indeed be a blackout."

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