Nevada Policy Research Institute

analysis

RPS: A Recipe for Economic Decline

Scheme to cost Nevadans $2.275 billion over 12 years

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Executive Summary

In 1997, Nevada policymakers amended state law regulating public utilities — NRS Chapter 704 — to implement a Renewable Portfolio Standard (RPS). Under that standard, NV Energy (formerly Nevada Power and Sierra Pacific Power) must use eligible renewable energy resources to supply 25 percent of the total retail electricity it sells by 2025, of which 6 percent must be met with solar energy. Subsequent legislation allows energy-efficiency measures to satisfy 25 percent of the RPS mandate.

To estimate the economic effects of these RPS mandates, the Beacon Hill Institute was asked to employ STAMP®, the Institute's State Tax Analysis Modeling Program. Conservatively, this study utilizes the optimistic estimates of renewable electricity costs and capacity factors provided by the U.S. Energy Information Administration (EIA), a division of the Department of Energy.

It also, however, provides three estimates of the cost of Nevada's RPS mandates — low, medium and high — by employing different cost and capacity factor estimates for electricity-generating technologies derived from the academic literature and from compliance reports from the Public Utilities Commission of Nevada (PUC).

Our major findings show:

- The current RPS law will raise the cost of electricity by $174 million for the state's electricity consumers in 2025, within a range of $45 million and $310 million.
- Nevada's electricity prices will rise by 6 percent by 2025, due to the current RPS law, within a range of 1.6 percent and 10.8 percent.

These increased energy prices will hurt Nevada's households and businesses and, in turn, inflict significant harm on the state economy. In 2025, the RPS would:

- lower employment by an expected 1,930 jobs, within a range of 590 jobs and 3,070 jobs;
- reduce real disposable income by $233 million, within a range of $72 million and $373 million;
- decrease investment by $29 million, within a range of $9 million and $47 million; and
- increase the average household electricity bill by $70 per year; commercial businesses by an expected $400 per year; and industrial businesses by an expected $26,220 per year.

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Introduction

In 1997, Nevada lawmakers enacted the state Renewable Portfolio Standard (RPS). Since then the law has been revised significantly. The law set the RPS mandate at 6 percent in 2005 with scheduled increases of 3 percent every two years. Upon full implementation the law requires that NV Energy (the state's public utility) use eligible renewable energy resources to supply 25 percent of the total electricity it sells by 2025. The RPS also mandates the utility to meet 6 percent of the requirement through solar energy beginning in calendar year 2016, up from 5 percent through 2015. The law defines qualifying renewable energy resources as solar, biomass, geothermal energy, wind, oil and gas from microwave reduction process to recycle tires and certain hydroelectric (less than 30 megawatts of capacity).[1]

In addition, the law allows energy-efficiency measures to satisfy 25 percent of the RPS mandate. To qualify, energy-efficiency measures would have to be installed after January 1, 2005; sited or implemented at a retail customer's location; and be partially or fully subsidized by an electric utility. Also, energy-efficiency measures must reduce customers' demand as opposed to shifting demand to off-peak hours. Fifty percent of the energy-efficiency measures must be installed for residential customers.[2]

The Public Utilities Commission of Nevada (PUC) set up a market for Portfolio Energy Credits (PECs) to comply with the RPS mandate. Utilities must hold enough PECs to satisfy their RPS mandate each year. One kilowatt-hour (kWh) of electricity generated by a renewable-energy system earns one PEC, except solar photovoltaic systems (PV) earn 2.4 PECs per actual kWh of energy produced. Another 0.05 is added to the solar multiplier for systems that are customer-sited, bring the total multiplier to 2.45. Energy-efficiency measures earn 1.05 PECs for each kWh of electricity saved and 2.0 PECs for electricity saved during peak periods. If a utility exceeds its requirement for a given year, the PECs are valid for a period of four years.[3]

The law requires public utilities to issue an annual compliance report. The report must detail the amount of electricity which the provider generated, acquired or saved from portfolio energy systems or efficiency measures during the reporting period and, if applicable, the amount of PECs that the provider acquired, sold or traded during the reporting period to comply with its portfolio standard. The utility must also report the capacity of renewable energy production it owned or operated, and additions to its renewable generation capacity and new energy-efficiency measures made to it during the reporting period.[4]

The law requires the PUC to establish the Temporary Renewable Energy Development (TRED) Program. The program establishes a TRED charge, allowing investor-owned utilities to collect revenue from electricity customers to pay for renewable energy separate from other wholesale power purchased by the electric utilities. The program operates as an independent TRED trust to receive the proceeds

[1] Ibid, 704:7811.
[2] Ibid, 704:7819.
[3] Ibid, 704:78215 and 22.
[4] Ibid, 704:7825.

from the TRED charge and remit payment to renewable energy projects that deliver renewable energy to purchasing electric utilities.[5]

Finally, the law charges the PUC with the power to enforce the RPS. If a public utility is short of the RPS requirement, the shortage is tacked onto the requirement for the next year. The PUC may also issue a fine to any public utility in violation of the RPS.[6]

The "NV Energy Portfolio Standard Annual Report, Compliance Year 2011" estimated the compliance costs under the RPS mandate. NV Energy estimated compliance costs of $384 million for the renewable energy portion of the RPS in 2011, or $102 per megawatt hour (MWh) of energy produced. The report also estimated that the RPS energy-efficiency measures cost $152.481 million, or $137 per MWh, in 2011, bringing the total gross cost to comply with the RPS to $537 million.[7]

To put this number into perspective, the company reported revenues of $2.943 billion in 2011, making the RPS account for 18.2 percent of total revenues. Based on sales of 28.117 billion kilowatt-hours (KWhs), RPS compliance raised electricity prices by 1.86 cents per kilowatt hour, or 15 percent for a residential customer. However, these figures did not subtract the displacement of conventional energy production and its associated cost.[8]

Since renewable energy generally costs more than conventional energy, Nevadans may worry about higher electric rates. A wide variety of cost estimates have been made for renewable electricity sources. The U.S. Department of Energy's Energy Information Administration (EIA) provides estimates for the cost of conventional and renewable electricity-generating technologies. A literature review (see appendix) shows that in most cases the EIA's projected costs can be found at the low end of the range of estimates, while the EIA's capacity factor for wind to be at the high end of the range. The EIA does not take into account the actual experience of existing renewable electricity power plants.

One could justify the higher electricity costs if the environmental benefits — in terms of reduced greenhouse gases (GHGs) and other emissions — outweighed the costs. However, it is unclear that the use of renewable energy resources — especially wind and solar — significantly reduces GHG emissions. Due to their intermittency, wind and solar require significant conventional backup power sources that are cycled up and down to accommodate the variability in the production of wind and solar power. A 2010 study found that wind power actually increases pollution and greenhouse gas emissions.[9] Thus, there appear to be few, if any, benefits to implementing RPS policies based on heavy uses of wind.

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[5] Ibid, 704:7827.

[6] Ibid, 704:7828.

[7] NV Energy Portfolio Standard Annual Report, Compliance Year 2011, https://www.nvenergy.com/renewablesenvironment/renewables/images/2011_Compliance_Report.pdf.

[8] Connecting Today with Tomorrow, NV Energy 2011 Annual Report http://www.annualreports.com/HostedData/AnnualReports/PDF/nve2011.pdf.,

[9] See , Bentek Energy, LLC , "How Less Became More: Wind, Power and Unintended Consequences in the Colorado Energy Market," http://goo.gl/kr6qN, (May 2010).

Governments enact RPS policies because most sources of renewable electricity generation are less efficient and thus more costly than conventional sources of generation. The RPS policy forces utilities to buy electricity from renewable sources and thus guarantees a market for them. However, there is no free lunch. The higher costs are passed on to electricity consumers, including residential, commercial and industrial customers.

Increases in electricity costs are known to have a profound negative effect on the economy — not unlike taxes — as prosperity and economic growth are dependent upon access to reliable and affordable energy. Since electricity is an essential commodity, consumers and producers of goods will have limited opportunity to avoid the costs added by the renewable standards. For the poorest members of society, these energy taxes will compete directly with essential purchases in the household budget, such as food, transportation and shelter.

The Beacon Hill Institute at Suffolk University (BHI) estimates the costs of the Nevada RPS law and its impact on the state's economy. To that end, BHI applied its STAMP® (State Tax Analysis Modeling Program) to estimate the economic effects of the state RPS mandate.[10]

Estimates and Results

In light of the wide divergence in the costs and capacity factor estimates available for the different electricity generation technologies, we provide three estimates of the effects of Nevada's RPS mandate using low, medium and high cost valuations for both renewable and conventional generation technologies. Each estimate represents the change that will take place in the indicated variable against the counterfactual assumption that the RPS mandate would not be implemented. The Appendix below explains our methodology. Table 1 displays the cost estimates and economic impact of the current 25 percent RPS mandate in 2025, compared to a baseline of no RPS policy.

Table 1: The Cost of the 25 Percent RPS Mandate on Nevada (2010 $)

Costs Estimates	**Low**	**Medium**	**High**
Total Net Cost in 2025 ($million)	45	174	310
Total Net Cost 2013-2025 ($million)	993	2,275	3,581
Electricity Price Increase in 2025 (cents per kWh)	0.16	0.60	1.08
Percentage Increase	1.6	6.0	10.8
Economic Indicators			
Total Employment (jobs)	(590)	(1,930)	(3,070)
Investment ($ m)	(9)	(29)	(47)
Real Disposable Income ($m)	(72)	(233)	(373)

[10] Detailed information about the STAMP® model can be found at http://www.beaconhill.org/STAMP_Web_Brochure/STAMP_HowSTAMPworks.html.

The current RPS will impose annual costs of $174 million by 2025, within a range of $45 million and $310 million. As a result, the RPS mandate would increase electricity prices by 0.60 cents per kilowatt hour (kWh) or by 6.0 percent, within a range of 0.16 cents per kWh, or by 1.6 percent, and 1.08 cents per kWh, or by 10.8 percent.

The rather modest price increases reflect the unique geothermal resources available to Nevada. Nevada utilities use geothermal electricity production to satisfy 56 percent of the RPS mandate, a resource that is competitive with coal and nuclear production. The use of geothermal resources has allowed the Nevada utility to minimize the RPS rate impact on its electricity consumers.

The STAMP model simulation indicates that, upon full implementation, the RPS law will hurt Nevada's economy. The state's ratepayers will face higher electricity prices that will increase their cost of living, which will in turn put downward pressure on households' disposable income. Over the 12-year period from 2013 to 2025, the cumulative cost to Nevadans of the RPS will be *$2.275 billion*, within a range of $993 million and $3.581 billion. By 2025, the RPS will cause Nevada's economy to shed 1,930 jobs, within a range of 590 and 3,070 jobs.

The job losses and price increases will reduce real incomes as firms, households and governments spend more of their budgets on electricity and less on other items, such as home goods and services. In 2025 real disposable income will fall by an expected $233 million, between $72 million and $373 million under the low and high cost scenarios respectively. Furthermore, net investment will fall by $29 million, within a range of $9 million and $47 million.

Table 2 shows how the RPS mandates affect the annual electricity bills of households and businesses in Nevada. In 2025, the RPS will cost families an average of $70 per year; commercial businesses $400 per year; and industrial businesses $26,220 per year. Over the entire period from 2013 to 2025, the RPS will cost families an average of $940; commercial businesses $5,050 per year; and industrial businesses $334,080.

Table 2: Annual Effects of RPS on Electricity Ratepayers (2010 $)

	Low	Medium	High
Cost in 2025			
Residential Ratepayer ($)	20	70	130
Commercial Ratepayer ($)	100	400	720
Industrial Ratepayer ($)	6,870	26,220	47,690
Cost over period (2013-2025)			
Commercial Ratepayer ($)	410	940	1,480
Industrial Ratepayer ($)	2,190	5,050	7,980
Industrial Ratepayer ($)	145,030	334,080	527,440

Emissions: Life Cycle Analysis

One could justify the higher electricity costs if the environmental benefits – in terms of reduced GHGs and other emissions – outweighed the costs. Up to this point we calculated the costs and economic effects of requiring more renewable energy in the state of Nevada. The following section conducts a Life Cycle Analysis (LCA) of renewable energy and the total effect that the state RPS law is likely to have on Nevada's emissions.

The burning of fossil fuels to generate electricity produces emissions as waste, such as carbon dioxide (CO_2), sulfur oxides (SO_x) and nitrogen oxides (NO_x). These emissions are found to negatively affect human respiratory health and the environment (SO_x and NO_x), or are said to contribute to global warming.

Many proponents of renewable energy (such as wind power, solar power and municipal solid waste) justify the higher electricity prices, and the negative economic effects that follow, based on the claim that these sources produce no emissions (see examples below). But this is misleading. The fuel that powers these services, such as the sun and wind, create no emissions. However, the process of construction, operation and decommissioning of renewable power plants does create emissions. This raises the question:

Is renewable energy production as environmentally friendly as some proponents claim?

> "Harnessing the wind is one of the cleanest, most sustainable ways to generate electricity. Wind power produces no toxic emissions and none of the heat trapping emissions that contribute to global warming."[11]
>
> "Wind turbines harness air currents and convert them to emissions-free power."[12]
>
> ~Union of Concerned Scientists
>
> "As far as pollution…Zip, Zilch, Nada… etc. Carbon dioxide pollution isn't in the vocabulary of solar energy. No emissions, greenhouse gases, etc."[13]
>
> ~Let's Be Grid Free. Solar Energy Facts

The affirmative argument is usually based on the environmental effects of the operational phase of the renewable source (that will produce electricity with no consumption of fossil fuel and no emissions) excluding the whole manufacturing phase (from the extraction to the erection of the turbine or solar panel, including the production processes and all the transportation needs) and the decommission phase. LCA provides a framework to provide a more complete answer to the question.

LCA is a "cradle-to-grave" approach for assessing industrial systems. LCA begins with the gathering of raw materials from the earth to create the product and ends at the point when all materials are returned to

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[11] How Wind Energy Works, Union of Concerned Scientists, http://www.ucsusa.org/clean_energy/our-energy-choices/renewable-energy/how-wind-energy-works.html.
[12] Union of Concerned Scientists , "Our Energy Choices: Renewable Energy," http://www.ucsusa.org/clean_energy/our-energy-choices/renewable-energy/ (March 2012).
[13] Solar Energy Facts. Let's Be Grid Free. http://www.letsbegridfree.com/solar-energy-facts/.

the earth. By including the impacts throughout the product life cycle, LCA provides a comprehensive view of the environmental aspects of the product or process and a more accurate picture of the true environmental trade-offs in product and process selection. Table 3 displays LCA results for conventional and renewable sources.

Table 3: Emissions by Source of Electricity Generation (Grams/kWh)

Phase	Emission	Coal	Gas	Wind	Nuclear	Solar	Biomass
Construction and Decommission	CO_2	2.59	2.20	6.84	2.65	31.14	0.61
	NO_x	0.01	0.01	0.06	0.00	0.12	0.00
	SO_x	0.06	0.05	0.02	0.00	0.14	0.00
Production and Operation	CO_2	1,022.00	437.80	0.39	1.84	0.27	58.60
	NO_x	3.35	0.56	0.00	0.00	0.02	5.34
	SO_x	6.70	0.27	0.00	0.01	0.00	2.40
Total	CO_2	1,024.59	440.00	7.23	4.49	31.42	59.21
	SO_x	3.36	0.57	0.06	0.01	0.14	5.34
	NO_x	6.76	0.32	0.02	0.01	0.14	2.40

Coal and gas produce significantly more emissions of all three gases than all the other technologies. Nuclear and wind produce the least emissions of the nonconventional types, with solar and biomass significantly higher due to construction and decommission for solar and production and operations for biomass. However, the construction and decommission phases of wind and solar produce non-trivial levels of emissions, with solar several factors higher than the others. Nevertheless, LCA analysis shows that wind, nuclear, solar and biomass produce significantly less emissions than coal and gas.

However, this LCA analysis is incomplete. The analysis shows that wind and solar technologies derive benefits from their ability to produce electricity with no consumption of fossil fuels and subsequent pollution without adequately addressing the intermittency of these technologies. These intermittent technologies cannot be dispatched at will and, as a result, require reliable back-up generation running — idling per se — in order to keep the voltage of the electricity grid in equilibrium. For example, if the wind dies down, or blows too hard (which trips a shutdown mechanism in commercial windmills), another power source must be ramped up (or cycled) instantaneously. Therefore, new wind and solar generation plants do not replace any dispatchable generation sources.

This cycling of coal and (to a much lesser extent) gas plants causes them to run inefficiently and produce more emissions than if the intermittent technologies were not present. As a result, according to a recent study, wind power could actually increase pollution and greenhouse gas emissions in areas that generate a significant portion of their electricity from coal.[14] The current LCA literature ignores this important portion of the analysis, and thus provides a distorted assessment of wind and solar power.

[14]See "How Less Became More: Wind, Power and Unintended Consequences in the Colorado Energy Market," Bentek Energy, LLC. (Evergreen Colorado: May, 2010).

Even if renewable sources, by themselves, produce much fewer emissions than conventional sources alone, their incorporation into a state's power system displaces only a small amount of emissions from conventional sources.

To better judge the actual total benefit derived from switching from the current energy source portfolio to one that involves more renewable energy, as the RPS dictates in Nevada, BHI compared the total emissions impact according to our projections using a life cycle analysis for the various energy sources. Table 4 displays the results.

Table 4: Change in Emissions Due to the Nevada RPS Mandates ('000 metric tons)

Emission Gas	2025	Total 2013-2025
No Capacity Factor Differences		
Carbon Dioxide	-2,511.34	-18,702.54
Sulfur Oxide	-4.10	-31.03
Nitrogen Oxide	-7.00	-54.04
Capacity Factor Differences		
Carbon Dioxide	-794	-5,910
Sulfur Oxide	-0.61	-4.65
Nitrogen Oxide	-2.03	-15.74

The RPS mandates reduce emissions of CO_2 by 794 million metric tons in 2025, with a total cumulative reduction in emissions between 2013 and 2025 of 5.91 billion tons. If no back-up capacity was required due to the intermittency issues of renewables, then the reduction would be more than three times as much.

Conclusion

The prologue to Assembly Bill 3, which incorporated energy-efficiency measures into Nevada's RPS law, states, "The Nevada Legislature encourages a sound financial economy, the reduction of usage and demand of fossil fuels, and a reduction of harmful emissions."[15]

While Nevada's abundance of geothermal potential has mitigated the cost of the RPS law, the law is unlikely to deliver significant progress on any of these fronts. For a small group of favored industries the RPS has and will continue to generate economic benefits. But all of Nevada's electricity customers will pay higher rates, taking resources away from household spending, savings and business investment.

The increase in electricity prices will harm the competitiveness of Nevada businesses, particularly in the energy-intensive manufacturing industries. Firms with high electricity usage will likely move their production, and emissions, out of Nevada to locations offering lower electricity prices. Thus, the RPS policy will not reduce global emissions, but merely send jobs and capital investment outside the state.

[15] Assembly Bill No. 3–Committee of the Whole, http://www.leg.state.nv.us/Session/22nd2005Special/bills/AB/AB3_EN.pdf.

As a result, Nevada residents will have fewer employment opportunities as investment flees to other states with more favorable business climates. At the very least, policymakers should monitor utilities' RPS compliance reports for further cost increases and, when possible, curb the mandates that benefit only a few special interests.

Appendix

Electricity Generation Costs

As noted above, governments enact RPS policies to prop up the price of renewable electricity generation. They begin with two disadvantages: Renewables are less efficient and thus more costly than conventional sources of generation. They thus are demanded and valued less in the open market place. RPS policies force utilities to buy electricity from renewable sources. These policies guarantee "a market" for the renewable sources. As standard economic theory suggests, these price supports are passed to electricity consumers, including residential, commercial and industrial customers.

The U.S. Department of Energy's Energy Information Administration (EIA) estimates the Levelized Energy Cost (LEC), or financial break-even cost per MWh, to produce new electricity in its *Annual Energy Outlook*.[16] The EIA provides LEC estimates for conventional and renewable electricity technologies (coal, nuclear, geothermal, landfill gas, solar photovoltaic, wind and biomass) assuming the new sources enter service in 2017. The EIA also provides LEC estimates for conventional coal, combined cycle gas, advanced nuclear and onshore wind only, assuming the sources enter service in 2020 and 2035.

While the EIA does not provide LEC for hydroelectric, solar photovoltaic, geothermal and biomass for 2020 and 2035, it does project overnight capital costs for 2015, 2025 and 2035. We estimate the LEC for these technologies — and years — using the percent change in capital costs to inflate, or deflate, the 2017 LECs. In its *Annual Energy Outlook*, the EIA incorporates many assumptions about the future price of capital, materials, fossil fuels, maintenance and capacity into their forecast. Table 5 shows the EIA projects that the LEC for all four electricity sources (coal, gas, nuclear and wind) will fall significantly from 2017 to 2035. The fall in capital costs drives the drop in total system LEC over the period.

Using the EIA change in overnight capital costs for solar and biomass produces reductions in LECs similar to wind from 2017 to 2020. The biomass LEC drops by 23.7 percent and solar by 15 percent over the period. These compare with modest cost increases of 13.2 percent for coal and 1.4 percent for gas, and a drop of 8.9 percent for nuclear over the same period. EIA does provide overnight capital costs for renewable technologies under a "high cost" scenario. However, for each renewable technology the EIA "high cost" scenario projects capital costs to drop between 2015 and 2035.

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[16] U.S. Department of Energy, Energy Information Administration, *2017 Levelized Cost of New Generation Resources from the Annual Energy Outlook 2012* (2010/$MWh), http://www.eia.doe.gov/oiaf/aeo/electricity_generation.html.

Table 5: Levelized Cost of Electricity from Conventional and Renewable Sources (2009 $)

Plant Type	Capacity Factor	Levelized Capital Costs	Fixed O&M	Variable O&M (with fuel)	Transmission Investment	Total Levelized Cost
Coal - 2017	0.85	64.9	4.0	27.5	1.2	97.7
2020		71.3	6.7	28.2	1.2	107.3
Gas - 2017	0.87	17.5	1.9	45.6	1.2	66.1
2020		16.9	1.92	47.0	1.2	67.0
Advanced Nuclear -2017	0.90	90.1	11.1	11.7	1.0	113.9
2020		79.5	11.6	11.9	1.1	103.7
Geothermal - 2017	0.91	75.1	11.9	9.6	1.5	98.2
2020						87.0*
Onshore Wind - 2017	0.33	82.5	9.8	0	3.5	96.0
2020		80.3	9.8	0	3.8	93.9
Solar PV - 2017	0.25	140.7	7.7	0	4.3	152.7
2020						129.8*
Biomass -2017	0.83	56.0	13.8	44.3	1.3	115.4
2020						88.0*
Hydro -2017	0.53	76.9	4.0	6.0	2.1	88.9
2020						69.0*

* Authors' projections based on linear changes in EIA estimates for overnight capital costs during these time periods. For overnight capital costs, see "Assumptions to the Annual Energy Outlook 2012," (U.S. Energy Information Administration, 2012), 168, http://goo.gl/irI69.

Table 5 also displays capacity factors for each technology. The capacity factor measures the ratio of electrical energy produced by a generating unit over a period of time to the electrical energy that could have been produced at 100 percent operation during the same period. In this case, the capacity factor measures the potential productivity of the generating technology. Due to their intermittent nature, solar, wind and hydroelectricity have the lowest capacity factors. EIA projects a 33 percent capacity factor for wind power, which, as we will see below, appears to be at the high end of any range of estimates.

Wind capacity factors have been estimated to be between 20 percent and 40 percent.[17] The other variables that affect the capacity credit of wind are the quality and consistency of the wind and the size and technology of the wind turbines deployed. As the U.S. and other countries add more wind power over time, presumably the wind turbine technology will improve, but the new locations for power plants will likely have less productive wind resources.

The EIA estimates of LEC and capacity factors paint a particularly rosy view of the future cost of renewable electricity generation, particularly wind. Other forecasters and the experience of current renewable energy projects portray a less sanguine outlook.

[17] Renewable Energy Research Laboratory, University of Massachusetts at Amherst, "Wind Power, Capacity Factor and Intermittency: What Happens When the Wind Doesn't Blow?" Community Wind Power Fact Sheet #2a, http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2a_Capacity_Factor.pdf.

Today wind and biomass are the largest renewable power sources and are the most likely to satisfy future RPS mandates in most states. However, as stated above, utilities are tapping the abundance of geothermal resources available in Nevada. Thus, Nevada avoids some of the most prominent issues that will affect the future availability and cost of renewable electricity resources: diminishing marginal returns and competition for scarce resources. These issues will affect wind and biomass in different ways as state RPS mandates ratchet up over the next decade. NV Energy plans to use less than 10 percent wind and biogas power to meet the RPS mandates through 2015.[18]

Calculation of the Net Cost of New Renewable Electricity

To calculate the cost of renewable energy under the RPS, BHI used data from the EIA to determine the percent increase in utility costs that Nevada residents and businesses would experience. This calculated percent change was then applied to calculated elasticities, as described in the STAMP modeling section.

We collected historical data on the retail electricity sales by sector from 1990 to 2010 and projected its growth through 2025 using sales' historical compound annual growth rate (see Table 6).[19] This information was supplemented with estimates from NV Energy's 2011 compliance report which projects retail electricity sales and the mix of renewable technologies that it will use to meet the RPS through 2015.[20] We utilized these figure to estimate the growth of retail electricity sales and the mix of renewable technologies used to meet the Nevada RPS mandates.

Next, we projected the growth in renewable sources that would have taken place absent the RPS. We used the EIA's projection of renewable energy sources by fuel for the Western Electricity Coordination Council/Northwest Power Pool Area through 2025 as a proxy to grow renewable sources for Nevada. We used the growth rate of these projections to estimate Nevada's renewable generation through 2025 absent the RPS. [21]

We subtracted our baseline projection of renewable sales from the RPS-mandated quantity of sales for each year from 2013 to 2025, to obtain our estimate of the annual increase in renewable sales induced by the RPS in MWhs. The RPS mandate exceeds our projected renewables in all years (2013 to 2025). Table 6 contains the results.

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[18] NV Energy Portfolio Standard Annual Report, Compliance Year 2011, https://www.nvenergy.com/renewablesenvironment/renewables/images/2011_Compliance_Report.pdf.

[19] U.S. Energy Information Administration, "Electric Power Monthly: Table 8. Retail Sales, Revenue, and Average Retail Price by Sector, 1990 Through 2011," (2012), http://www.eia.gov/electricity/state/washington/xls/sept08wa.xls (accessed Oct. 2, 2012). The historical compound growth rate was calculated independently for each sector — residential, commercial and industrial as well as transportation — using the years for which data were available. These independent rates were then used to project sales for each sector in subsequent years, with the projected total annual retail sales calculated as the sum of the projected annual sector sales.

[20] NV Energy Portfolio Standard Annual Report, Compliance Year 2011, https://www.nvenergy.com/renewablesenvironment/renewables/images/2011_Compliance_Report.pdf.

[21] U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook 2012*, "Table 99: Renewable Electricity Generation by Fuel," http://www.eia.doe.gov/oiaf/archive/aeo10/aeoref_tab.html.

Table 6: Projected Electricity Sales, Renewable Sales and 25 Percent RPS Requirement

Year	Projected Electricity Sales MWhs (000s)	Projected Renewable MWhs (000s)	RPS Requirement MWhs (000s)	Difference MWhs (000s)
2013	27,793	290	5,003	4,713
2014	27,874	291	5,017	4,726
2015	28,270	295	5,654	5,359
2016	28,184	294	5,637	5,343
2017	28,242	295	5,648	5,353
2018	28,320	296	5,664	5,368
2019	28,397	296	5,679	5,383
2020	28,474	297	6,264	5,967
2021	28,391	296	6,246	5,950
2022	28,579	298	6,287	5,989
2023	28,650	299	6,303	6,004
2024	28,729	300	6,320	6,020
2025	28,807	301	7,202	6,901
Total	**253,944**	**3,849**	**76,925**	**73,076**

However, the NV Energy compliance report shows that in 2011 the company produced 16.7 percent of power from renewables, exceeding its RPS mandate of 15 percent. Therefore, we used the details of the company's actual compliance for 2011 and projected compliance for 2012 to 2015 to calculate the amount and mix of renewables and energy-efficiency measures to comply with the RPS mandate. We extrapolated these numbers though 2025.

To estimate the cost of producing the additional extra renewable energy under an RPS against the baseline, we used estimates of the LEC, or financial breakeven cost per MWh, to produce the electricity.[22] However, as outlined in the "electricity generation cost" section above, the EIA numbers provide a rather optimistic picture of the cost and generating capacity of renewable electricity, particularly for wind power. A literature review provided alternative LEC estimates that were generally higher and capacity factors that were lower for renewable generation technologies than the EIA estimates.[23] We used these alternative figures to calculate our "high" LEC estimates and the EIA figures

[22] U.S. Department of Energy, Energy Information Administration, *2017 Levelized Cost of New Generation Resources from the Annual Energy Outlook 2012* (2010/$MWh), http://www.eia.doe.gov/oiaf/aeo/electricity_generation.html.
[23] For coal, gas and nuclear generation we used the production cost estimates from the International Energy Agencies, Energy Technology Analysis Programs, "Technology Brief E01: Cola Fired Power, E02: Gas Fired Power, E03: Nuclear Power and E05: Biomass for Heat and Power," (April 2010 http://www.iea-etsap.org/web/Supply.asp (accessed February 2012). To the production costs we added transmission costs from the EIA using the ratio of transmissions costs to total LEC costs. For wind power we used the IEA estimate for

to calculate our "low" cost estimates and the average of the two to calculate our "medium" cost estimates. Table 7 displays the LEC and capacity factors for each generation technology.

Table 7: LEC and Capacity Factors for Electricity Generation Technologies

	Capacity Factor	Total Production Cost (2012 $/MWh) 2010	2020	2025
Coal				
Low	.740	67	65	64
Medium	.795	83	86	79
High	.850	98	107	95
Gas				
Low	.850	63	67	73
Medium	.860	65	70	75
High	.870	66	73	78
Nuclear				
Low	.900	77	59	63
Medium	.900	98	85	81
High	.900	114	104	98
Biomass				
Low	.680	111	87	83
Medium	.755	112	95	93
High	.830	114	104	98
Wind				
Low	.155	96	94	83
Medium	.269	111	109	102
High	.355	173	169	165
Solar p.v.				
Medium	.269	119	89	89
Solar thermal				
Medium	.200	176	132	132
Geothermal				
Medium	.910	105	87	77
Low	.910	90	87	77

The NV Energy Compliance reports contained gross cost information and details of the mix of renewable technologies the company uses to comply with the RPS mandate for 2011. Moreover, the report provided gross cost information of $536 million to comply with the RPS mandate in 2011, but did

levelized capital costs and variable and fixed O & M costs. For transmission cost we used the estimated costs from several research studies that ranged from a low of $1.3 per kWh to a high of $79.77 per kWh, with an average of $15 per MWh. The sources are as follows:
Andrew Mills, Ryan Wiser, and Kevin Porter, "The Cost of Transmission for Wind Energy: A Review of Transmission Planning Studies," Ernest Orlando Lawrence Berkeley National Laboratory, http://eetd.lbl.gov/EA/EMP; Competitive Renewable Energy Zones (CREZ) Transmission Optimization Study, The Electric Reliability Council of Texas, April 2, 2008, http://www.ercot.com/news/presentations/2006/ATTCH_A_CREZ_Analysis_Report.pdf; Sally Maki and Ryan Pletka, Black & Veatch, California's Transmission Future, August 25, 2010, http://www.renewableenergyworld.com/rea/news/article/2010/08/californias-transmission-future.

not break the cost by renewable technology.[24] We assume that Nevada has a competitive cost advantage in providing both solar PV and geothermal energy over other states and regions. Therefore, we adjust the costs of solar PV and geothermal energy down until our medium cost scenario matches the 2011 gross cost of $536 million, or $102 per MWh for renewable energy and $137 per MWh for energy efficiency and net metering systems.

NV Energy reported that in 2011 the company produced 16.7 percent of power from renewables, exceeding its RPS mandate of 15 percent. In doing so, the company was able to bank those extra renewable credits. As of the 2011 compliance period, the company had 862.9 million non-solar PECs and 194 million solar PECs in the bank. The compliance report detailed how NV Energy would continue to build its bank of non-solar PECs through this year and then begin to slowly reduce it over time. We assume this trend continues until the non-solar bank is reduced to zero in 2025.[25]

NV Energy reported that in 2011 the company produced 10 percent of it renewables from solar, exceeding its RPS mandate of 5 percent. NV Energy projects the solar compliance will increase to 295 million MWhs by 2015, which is only 50 million MWh below the 2025 mandate. We assume that the solar bank will increase through 2015, and then slowly draw down over the period, but not reach zero by 2025.[26]

To account for the solar and energy-efficiency multipliers (2.45 and 1.05 respectfully), we adjust PECs by multiplying each KWh of production by its multiplier. We use the full 2.45 multiplier for solar, but only the 1.05 multiplier for energy-efficiency measures, since the compliance reports provided no information on the peak hours of energy saved to earn the additional 2.0 multiplier.

We used the 2017 LEC for the years 2015 through 2019 to calculate the cost of the new renewable electricity and avoided conventional electricity, assuming that before 2017 LEC underestimates the actual costs for those years and for 2018 and 2019, the 2017 LEC slightly overestimates the actual costs. We assume that the differences will, on balance, offset each other. For 2019 and 2025 we used the 2020 LEC. The assumption is that LEC will decline over time due to technological improvements.

We use the EIA's reference case scenario for all technologies. We adjusted the 2017 LECs to 2025 by using the percentage change in the capital costs from 2015 to 2025, since capital costs often represent the largest component of the cost structure for most technologies. For the technologies for which the EIA does not forecast LECs in 2020, we used the average of the 2017 and 2025 LEC calculations, assuming a linear change over the period.

Once we computed new LECs for the years 2020 and 2025 we applied these figures to the renewable energy estimates for the remainder of the period.

For conventional electricity we assumed that the technologies are avoided based on their costs, with the highest cost combustion turbine avoided first. For coal and gas, we assumed they are avoided based on

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[24] NV Energy Portfolio Standard Annual Report, Compliance Year 2011, https://www.nvenergy.com/renewablesenvironment/renewables/images/2011_Compliance_Report.pdf.
[25] Ibid.
[26] Ibid.

their estimated proportion of total electricity sales for each year. Although hydroelectric and nuclear are not the cheapest technology, we assume no hydroelectric or nuclear sources are displaced since most were built decades ago and offer relatively cheap and clean electricity today.

To determine the impact of the RPS standard in a given year, we calculated the amount of renewable energy NV Energy projects it will produce that year and compared it to our renewable energy baseline sales for that year; the difference represents the renewable sales attributable to the RES policy. We then determined which renewable energy source(s) would be used to meet the renewable energy sales attributable to the RPS and calculated the additional renewable energy costs by using the LEC(s) for the relevant energy source(s).

The increased total costs in renewable energy lead to decreased total costs in conventional energy, since less conventional energy would be needed and sold. The decrease in conventional energy production is not as large as the increase in renewable energy production, however. Wind power and solar power in particular are intermittent (as reflected in their relatively low accredited capacity), and it would still be necessary to keep backup conventional energy sources online and ready to meet any sudden electrical demands that renewable sources could not instantly provide. To estimate the share of conventional energy that would still be running as backup, we used a ratio of the renewable energy capacity factor to the conventional energy capacity factor.[27]

Tables 8, 9 and 10 on the following pages display the results of our medium, low and high-cost calculations for the 25 percent RPS respectively. We converted the aggregate cost of the RPS into a cost per-kWh by dividing the cost by the estimated total number of kWh sold for that year. For example, under the medium cost scenario above, we divided $174 million into 28.807 billion kWhs for a cost of 0.6 cents per kWh.

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[27] For example, if the RPS will require 100 MWh more wind than would otherwise be produced, then that 100 MWh of wind will produced at the LEC for wind. Ideally, then, 100 MWh of natural gas-based energy would no longer be needed, and the forgone costs would be computed at the LEC for natural gas. Since wind would require a backup, however, we would estimate the amount of natural gas energy production needed on standby by employing a ratio of the capacity factors of the two energy sources (using, for example, the mid-range estimates from Table 7): 0.269/0.86 * 100 MWh of natural gas = 31.3 MWh of natural gas energy production.

Table 8: Medium Cost Case of 25 Percent RPS Mandate from 2013 to 2025

Year	Gross Cost (2010 $000s)	Less Conventional (2010 $000s)	Total (2010 $000s)
2013	555,050	378,746	176,304
2014	557,119	379,385	177,734
2015	624,221	425,918	198,303
2016	633,731	432,696	201,035
2017	634,988	433,592	201,396
2018	636,690	434,806	201,885
2019	598,847	448,449	150,398
2020	661,832	497,116	164,716
2021	621,475	465,933	155,542
2022	625,451	469,005	156,445
2023	626,975	470,183	156,792
2024	628,640	467,883	160,757
2025	710,279	536,323	173,956
Total	**8,115,297**	**5,840,036**	**2,275,262**

Table 9: Low Cost Case of 25 Percent RPS Mandate from 2013 to 2025

Year	Gross Cost (2010 $000s)	Less Conventional (2010 $000s)	Total (2010 $000s)
2013	549,852	450,785	99,067
2014	551,921	451,463	100,459
2015	619,023	506,787	112,236
2016	628,452	514,901	113,551
2017	629,698	515,974	113,725
2018	631,386	517,426	113,960
2019	593,528	545,192	48,336
2020	655,936	605,503	50,433
2021	615,949	566,860	49,089
2022	619,888	570,666	49,221
2023	621,398	572,126	49,272
2024	623,048	573,721	49,328
2025	703,869	659,185	44,684
Total	**5,475,745**	**4,674,890**	**800,855**

Table 10: High Cost Case of a 25 Percent RPS Mandate from 2013 to 2025

Year	Gross Cost (2010 $000s)	Less Conventional (2010 $000s)	Total (2010 $000s)
2013	577,572	296,298	281,275
2014	579,641	312,696	266,945
2015	646,743	350,852	295,891
2016	656,607	368,944	287,663
2017	657,911	353,277	304,634
2018	659,676	384,826	274,850
2019	620,122	376,644	243,479
2020	685,417	422,352	263,065
2021	643,580	390,276	253,304
2022	647,701	391,486	256,215
2023	649,282	378,395	270,886
2024	651,008	378,318	272,691
2025	737,201	426,863	310,338
Total	**8,412,462**	**4,831,227**	**3,581,235**

Ratepayer Effects

To calculate the effect of the RPS on electricity ratepayers, we used EIA data on the average monthly electricity consumption by type of customer: residential, commercial and industrial.[28] The monthly figures were multiplied by 12 to compute an annual figure. We inflated the 2011 figures for each year using the average annual increase in electricity sales over the entire period.[29]

We calculated an annual per-kWh increase in electricity cost by dividing the total cost increase – calculated in the section above ─ by the total electricity sales for each year. We multiplied the per-kWh increase in electricity costs by the annual kWh consumption for each type of ratepayer for each year. For example, we expect the average residential ratepayer to consume 12,209 kWhs of electricity in 2025 and we expect the medium cost scenario to raise electricity costs by 0.60 cents per kWh in the same year. Therefore, we expect residential ratepayers to pay an additional $73 in 2025, rounded to $70 in Table 2.

Modeling the RPS using STAMP

We simulated these changes in the STAMP model as a percentage price increase on electricity to measure the dynamic effects on the state economy. The model provides estimates of the proposals'

[28] U.S. Department of Energy, Energy Information Administration, Table 5A, 5B, 5C"Average Monthly Bill by Census Division, and State," (September 2012) http://www.eia.gov/electricity/sales_revenue_price/index.cfm.
[29] U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook 2012*, "Table A8: Electricity Supply, Disposition, Prices, and Emissions," http://www.eia.gov/forecasts/aeo/er/index.cfm.

impact on employment, wages and income. Each estimate represents the change that would take place in the indicated variable against a "baseline" assumption of the value that variable for a specified year in the absence of the RPS policy.

Because the RPS requires Nevada households and firms to use more expensive "green" power than they otherwise would have under a baseline scenario, the cost of goods and services will increase under the RPS. These costs would typically manifest through higher utility bills for all sectors of the economy. For this reason we selected the sales tax as the most fitting way to assess the impact of the RPS. Standard economic theory shows that a price increase of a good or service leads to a decrease in overall consumption, and consequently a decrease in the production of that good or service. As producer output falls, the decrease in production results in a lower demand for capital and labor.

BHI utilized its STAMP (State Tax Analysis Modeling Program) model to identify the economic effects and understand how they operate through a state's economy. STAMP is a five-year dynamic CGE (computable general equilibrium) model that has been programmed to simulate changes in taxes, costs (general and sector-specific) and other economic inputs. As such, it provides a mathematical description of the economic relationships among producers, households, governments and the rest of the world. It is general in the sense that it takes all the important markets, such as the capital and labor markets, and flows into account. It is an equilibrium model because it assumes that demand equals supply in every market (goods and services, labor and capital). This equilibrium is achieved by allowing prices to adjust within the model. It is computable because it can be used to generate numeric solutions to concrete policy and tax changes.[30]

In order to estimate the economic effects of a national RPS, we used a compilation of six STAMP models to garner the average effects across various state economies: New York, North Carolina, Washington, Kansas, Indiana and Pennsylvania. These models represent a wide variety in terms of geographic dispersion (northeast, southeast, midwest, the plains and west), economic structure (industrial, high-tech, service and agricultural), and electricity sector makeup.

First, we computed the percentage change to electricity prices as a result of three different possible RPS policies. We used data from the EIA from the state electricity profiles, which contains historical data from 1990-2011 for retail sales by sector (residential, commercial, industrial and transportation) in dollars and MWhs and average prices paid by each sector.[31] We inflated the sales data (dollars and MWhs) through 2025 using the historical growth rates for each sector for each year. We then calculated a price for each sector by dividing the dollar value of the retail sales by kWhs. Then we calculated a weighted average kWh price for all sectors using MWhs of electricity sales for each sector as weights. To calculate the percentage electricity price increase, we divided our estimated price increase by the weighted average price for each year. For example, in 2025 for our medium cost case we divided our

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[30] For a clear introduction to CGE tax models, see John B. Shoven and John Whalley, "Applied General-Equilibrium Models of Taxation and International Trade: An Introduction and Survey," *Journal of Economic Literature* 22 (September, 1984): 1008. Shoven and Whalley have also written a useful book on the practice of CGE modeling entitled Applying General Equilibrium (Cambridge: Cambridge University Press, 1992).

[31] U.S. Energy Information Administration, "Electric Power Monthly: Table 8. Retail Sales, Revenue, and Average Retail Price by Sector, 1990 Through 2010," http://www.eia.gov/electricity/state/nevada/ (January 2012).

average price of 10 cents per kWh by our estimated price increase of 0.60 cents per kWh for a price increase of 6 percent.

Table 11: Elasticities for the Economic Variables

Economic Variable	Elasticity
Employment	-0.022
Investment	-0.018
Disposable Income	-0.022

Using these three different utility price increases — 1 percent, 4.5 percent and 5.25 percent — we simulated each of the six STAMP models to determine what outcome these utility price increases would have on each of the six states' economies. We then averaged the percent changes together to determine the average effect of the three utility increases. Table 11 displays these elasticities, which were then applied to the calculated percent change in electricity costs for the state of Nevada discussed above.

We applied the elasticities to percentage increase in electricity price and then applied the result to Nevada economic variables to determine the effect of the RPS. These variables were gathered from the Bureau of Economic Analysis Regional and National Economic Accounts as well as the Bureau of Labor Statistics Current Employment Statistics.[32]

Life Cycle Analysis

For our LCA we used various studies to determine the figure for the cradle-to-grave emissions per MWh, taking into account construction, decommission, operation and maintenance.

For coal we reviewed three different system types: an "average system" that accounts for emissions from typical coal fired generation in 1995; New Source Performance Standards based on requirements put into effect for all plants built after 1978; and Low Emission Boiler Systems, which are newer, more efficient coal plants.[33] The LCA calculations account for various inputs including, but not limited to, mining, transportation of minerals, power plant operation as well as decommissions and disposal of a plant. Natural gas plants LCAs were based on the LCA for Gas Combined Cycle Power Generation plants, a type of plant that is similar to the majority of the natural gas plants in the United States.[34]

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[32] For employment, see the following: U.S. Bureau of Labor Statistics, "State and Metro Area Employment, Hours, & Earnings," http://bls.gov/sae/. Private, government and total payroll employment figures for Michigan were used. For investment, see "National Income and Product Account Tables," U.S. Bureau of Economic Analysis, http://www.bea.gov/itable/; BEA, "Gross Domestic Product by State," http://www.bea.gov/regional/. We took the state's share of national GDP as a proxy to estimate investment at the state level. For state disposable personal income, see "State Disposable Personal Income Summary," BEA, http://www.bea.gov/regional/.

[33] Pamela L Spath, Margaret K Mann, Dawn R Kerr, "Life Cycle Assessment of Coal-fired Power Production." National Renewable Energy Laboratory, June 1999.

[34] Pamela L Spath, Margaret M Mann. "Life Cycle Assessment of a Natural Gas Combined-Cycle Power Generation System." National Renewable Energy Laboratory. September 2000.

The LCA for wind power accounted for both onshore and offshore wind power, which has different values for manufacturing, dismantling, operation and transportation for each type.[35] Solar photovoltaic estimates were wide ranging, but a *Science Direct* paper supplied an in-depth, comprehensive review.[36] It reviewed three different types of crystalline silicone modules as well as a CdTe thin film version and induced many different costs such as emissions from building the module and frame (for the crystalline silicone version) as well as operation and maintenance emissions. For biomass and wood waste LCA we used a report that looked at the production of energy using wood and biomass byproducts to produce energy.[37] There are different types of delivery systems (lorry, train and barge) for the fuel, as well as construction, operation and decommissioning.

With total emissions per MWh calculated, we were able to use our in-house model to calculate the total emissions that would be added to and removed from the Nevada energy system. The first calculation used the amount of renewable energy added per the Class I RES law, as well as the amount of conventional power that would be removed, after accounting for capacity factor requirements to keep a constant amount of energy produced. Each MWh added was multiplied by its respective LCA emission, and then we subtracted the amount of conventional time LCA emissions. With a basic conversion from grams to metric tons, we had calculated the results seen in Table 4. An identical calculatio was done, but not accounting for capacity factors.

[35] ELSAM Engineering S/A "Life Cycle Assessment of Offshore and Onshore Sited Wind Farms." October 2004.
[36] V M Fethankis, H C Kim. "Photovoltaics: Life Cycle Analysis." *Science Direct*. October 2009.
[37] Christian Bauer. "Life Cycle Assessment of Fossil and Biomass Power Generation Chains." Paul Scherrer Institute. December 2008.

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