ENERGY FUTURES GROUP

Atlantic Vision:

Comparative Analysis of Long-Term Resource Plans and Energy Scenarios

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Introduction

New Brunswick and Nova Scotia are engaging in long-range electric and energy system planning, with a keen eye toward the comparative results in several critical domains:

- **Affordability**. How do various plans and portfolios compare with respect to total costs or utility system revenue requirements? Ratepayers ultimately pay for the costs of delivered energy services. This is true for both investor owned and public utilities. Are portfolios that rely more heavily on conventional supply side generation resources always more or less costly than cleaner portfolios that include higher levels of demand side resources, and/or renewable energy resources? What strategies help to address energy affordability for the most vulnerable members of the population?
- **Sustainability**. Can targets for reducing greenhouse gas emissions and other environmental impacts be met? What range of costs are associated with meeting targets?
- **Reliability**. Are portfolios relying more heavily on intermittent renewable resources reliable and can they meet typical system design and operational requirements?
- **Financial Viability**. Recognizing all portfolios will require new capital are there indicators that clean portfolios have difficulty in attracting equity in comparison to conventional portfolios?

The Conservation Council of New Brunswick (CCNB) asked Energy Futures Group (EFG) to provide a comparative analysis on a selection of long-term resource plans and energy scenario studies to examine these questions. This report, and the accompanying data workbook, will support of work that CCNB is conducting in partnership with the Ecology Action Center (EAC). The four main sections in this report provide:

1. Critical review and comparative analysis of how the mix of electricity supply and demand options in portfolios impact total costs and revenue requirements and by extension affordability for consumers.
2. Critical review and comparative analysis of how the mix of electricity supply and demand options in portfolios impacts lifetime greenhouse gas emissions estimates as a proxy for sustainability.
3. Critical review and comparative analysis of the technical system viability (a general indicator for system reliability) for electric system portfolios with varying mixes of electricity supply and demand options.
4. Critical review and comparative analysis of the implications of the portfolio mixes examined in items 1-3 for utility, public and non-utility financing. Qualitative consideration of the timing, modularity, and scale of investment requirements for portfolios of varying natures.

The analysis and findings include two dozen cases drawn from scenario studies and integrated resource plans with which we are familiar to provide context to inform the planning processes in New Brunswick and Nova Scotia (Table 1). The references cited are not a random sample and are not fully representative of energy system planning work in Canada nor the United States.

Table 1 : Comparative Studies and Plans

#	Title, Author and Date	Type and Jurisdiction	Notes
1,2	*Vermont Solar Market Pathways*, VEIC, 2017	Scenario study, Vermont	Using Solar Development Pathway and Reference as comparative scenarios. Efficiency based on total final demands all fuels, includes efficiency from electrification of transport and replacement of combustion technologies for heating. Results for near term 2025 and long term 2050 scenarios presented.
3	*Pennsylvania's Solar Plan*, PA Department of Environmental Protection, 2018	Scenario study, Pennsylvania	Examines in state solar providing for 10% of Pennsylvania's total electric requirements by 2030 factor of 10x increase in solar compared to reference case.
4,5,6	*Electricity Futures Study*, National Renewable Energy Laboratory, 2012	Renewable Energy Future Scenarios, US National	USA National High RE study - highlights technical viability of 80%+ total Electricity from RE, estimates no cost increase for saturations up to 30%.
7,8	*Estimating Renewable Energy Economic Potential in the United States*, National Renewable Energy Laboratory, 2016	Economic Potential Analysis, US National	U.S. National estimate of economic potential for renewable energy. Findings in this study based on case 3 with capacity value and declining value for utility scale PV and wind at higher saturations. Study estimates current potential, not future projections. With environmental externalities current economic potential is 4x to 10x total system requirements.
9,10	Deep Decarbonization Study, 2015	Emissions Reduction Scenarios, US National	Mixed case (renewables, carbon capture and nuclear) median incremental cost estimates for 2030 and 2050. No environmental externalities.

11	Nevada Energy, 2019	IRP Nevada	Low Carbon Portfolio is preferred case; RPS is 22% by 2020, 25% by 2025. 32% RE by 2025 doubles renewable Generation from 2018 baseline. Nevada Energy was acquired by Berkshire Hathaway in 2014 and average customer rates have decreased by 15% since 2009.
12	California, 2019	IRP, California	All cases need to meet legislated GHG targets. The "conventional portfolio is meeting the state 46 MMT target. RE is share for 38 MMT case, GHG reduction is 38 MMT case reduction from 2020 levels for CAISO LSEs.
13	Portland General Electric ("PG&E"), 2019	IRP, Oregon	PG&E included the results of a Customers Insights Survey that indicated 54% of residential customers are willing to pay 10% or more for incremental renewables; 34% of general business customers are willing to pay 10% or more for additional renewables; and 64% of business customers are willing to pay 5% or more. Oregon RPS requirements are 20% for 2020 – 2024; 27% for 2025-2029; 35% for 2030-2034; 45% for 2035-2039; and 50% for 2040+.
14	Indianapolis Power & Light ("IPL"), 2019	IRP Indiana	The PVRR of the plan that retires all 4 Pete units is lower than the PVRR for the business as usual plan under the Carbon Tax scenario.
15	Vectren, 2020	IRP Indiana	Issued an all-source Request for Proposals ("RFP"). Resources that bid into the RFP were modeled for the IRP analysis. Vectren modeled a Renewables by 2030 case that did not add in any new gas resources and retired 730 MW of coal capacity. The PVRR of the Renewables by 2030 case is 10.3% lower than the PVRR of the Business as Usual until 2039 case that did not include coal retirements. The Renewables by 2030

			portfolio does include some capacity market purchases.
16	Northern Indiana Public Service Company ("NIPSCO"), 2018	IRP Indiana	Issued an all-source RFP to include in the new resource modeling. NIPSCO did a two-step modeling process where retirement portfolios were modeled first, and replacement portfolios were modeled second. The Preferred Retirement portfolio PVRR was 26.34% less than the PVRR of the portfolio containing no coal retirements.
17	Xcel Minnesota, 2020	IRP Minnesota	Xcel calculates the Present Value of Societal Costs ("PVSC") to evaluate plans. The PVSC includes environmental externality costs for resources. Xcel hardcoded the Sherco CC (835 MW) into all of the portfolios modeled for the IRP.
18	Tucson Electric Power, 2020	IRP Arizona	Tucson's Preferred Plan has 476 MW of new wind, solar, and storage by 2021 and 3,400 MW of new wind, solar, and storage by 2035. It also includes the retirement of 1,073 MW of coal by 2032.
19	TVA, 2019	IRP Tennessee Regional	Comparison of Base and RE Strategies: under scenario 5 rapid DER adoption which shows the largest potential GHG reductions. Volume 1 page 7-22, Study Results. RE Percent includes hydro.
20	NorthWestern, 2019	IRP Montana	NorthWestern's No Carbon Additions portfolio added 1,680 MW of wind, 300 MW of pumped hydro, and 631.2 MW of battery storage. The Base case added 985.2 MW of new RICE units.
21	Dominion Energy South Carolina (DESC), 2020	IRP South Carolina	Comparison of RP 2 and RP 8. RP 8 RE share based on estimated 2034 total GWH and average annual RE generation. RP 2 share is 7.8%

22	Consumers Energy, 2018	IRP Michigan	Consumers projects significant growth in DR and Energy Waste Reduction programs from 360 MW in 2019 to 1447 MW in 2030 (539 MW coming from new incremental DR). The Preferred Course of Action projects that DSM and renewables will account for 57% of the generation supply and all coal will be retired by 2040 to help reach Consumers 80% carbon reduction by 2040 goal.
23	Nova Scotia Power ("NSP"), 2020	Draft IRP Nova Scotia	NSP modeled different assumptions for the level of DSM, strategies for regional interconnection, timing of thermal retirements, and electrification levels. The clean portfolio has a higher 25 year PVRR, but it has a reduction in CO2 emissions of 89%, as all coal units retire by 2030.
24	New Brunswick, 2017	IRP New Brunswick	The plans include the 621 MW from Energy Smart NB. The PVRR of the portfolio containing new wind resources is the same as the PVRR for the Integrated Plan. New Brunswick modeled an Extreme Energy Efficiency case that included 1,084 MW for Energy Smart NB with a PVRR that had a .4% higher PVRR compared to the Integrated Plan.

The research we present provides context for, but does not replace, detailed technical and economic analysis, for electric system and total energy planning at the Provincial level.[1] We also do not attempt to individually critique or examine the cases presented in detail. The accompanying workbook includes additional details for reference from each study. The meta-analysis presented in our research supports the position that across a range of geographies and jurisdictions clean portfolios are technically viable and cost competitive with conventional portfolios.

[1] The Canadian Institute for Climate Choices, *Clean Growth in Nova Scotia*, September 2020, is a recent example of a province-based case study on progress and potential for reducing greenhouse gas emissions and meeting climate targets. https://climatechoices.ca/wp-content/uploads/2020/09/CICC-NS-Case-Study-Eng-final.pdf

The research also illustrates a trend towards an increasing number of clean portfolios being selected as preferred resource plans. Our research is a small contribution to identifying this momentum, and to supporting continued planning and analysis at the jurisdictional level.

Approach

Our analysis includes quantitative and qualitative comparisons across four categories, affordability, sustainability, reliability, and financial viability as summarized in Table 2.

Table 2: Key Metrics for Comparison

Characteristic	Quantitative	Qualitative
Affordability	Ratio of Revenue Requirements or Costs	Consideration of Income Equity
Sustainability	Medium and long-term share of renewable energy in portfolio Medium and long-term reduction in greenhouse gas emissions	Many of the clean portfolios include accelerated retirement of fossil fuel generation stations. Some portfolios and scenarios limit new or extended life for nuclear
Reliability	Not included	All the studies use foundational assumption that safe and reliable service delivery is required. Some studies (NREL 2012), Vermont Solar Pathways (2017) analyze or discuss implications for high renewable energy portfolios.
Financial Viability	Limited observation of debt to equity ratios	Technology cost trends

For each of the studies identified in Table 1 we used professional judgement to select a conventional and clean portfolio for comparison. Most of the studies include a range of additional portfolios. It is beyond the scope of our work to include the full range of scenarios from each study, and so we aimed to select representative clean and conventional portfolios for our work. In order to compare cost estimates across studies and jurisdictions we use normalized ratios of a clean and conventional portfolio from within each study. The ratio calculation for each study permits us to compare studies with different time horizons, scale, and other assumptions.

Table 3 is an example of the cost/revenue requirement ratio calculation based on study number 15, the Vectren 2020 Integrated Resource Plan.

Table 3: Example of Revenue Requirement Ratio

	Clean Portfolio	**Conventional Portfolio**
Description	Renewables by 2030 case no new additions of gas capacity and retirement of 730 MW of coal generation, includes some capacity market purchases	Business as usual no coal capacity retirements through 2039.
Estimated Revenue Requirements (2020-2039)	$2.616 Billion	$2.914 Billion
Comparative Ration Clean to Conventional Calculated	**$2.616 Billion divided by $2.914 Billion = 0.897**	

Affordability: Comparative Revenue Requirements

The first metric examines system cost estimates for clean and conventional portfolios. Results show a range of outcomes +24% to -12% differential between the clean and conventional portfolios. For almost 80 percent of the cases (19 out of 24) the clean portfolio is either less expensive, or within 4% of the conventional portfolio. Figure 1.

Across a range of studies and jurisdictions this finding indicates that clean portfolios are economically viable. The planning horizons for these studies are typically twenty years or longer. Note that most of the computed ratios do not include environmental externality valuation. If externalities are valued, based either on cost of compliance or on estimated damage costs, it is likely the clean portfolios would have lower costs than the conventional portfolios in all, or almost all cases. From this perspective, the cost and revenue requirements for the clean portfolios can be reasonably considered to be affordable.

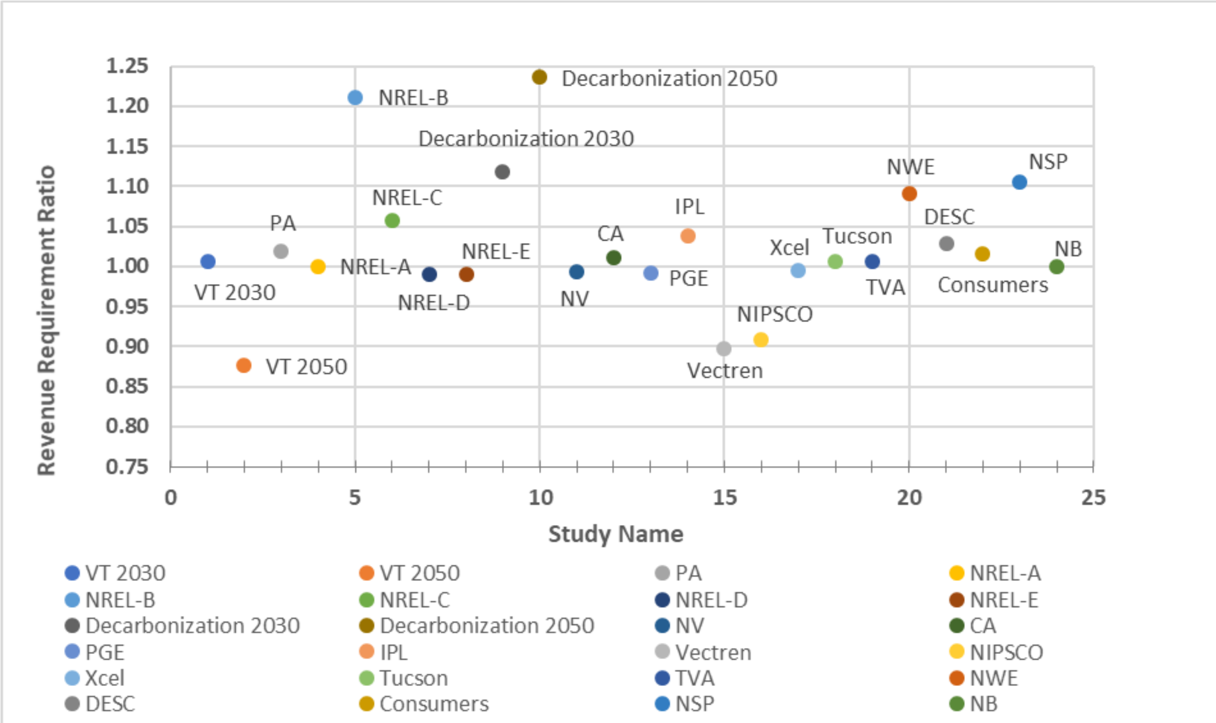

Figure 1: Comparative Cost/Revenue Requirements: Clean to Conventional

Discussion Social Equity and Local Economic Development:

As Figure 1 illustrates most studies estimate costs for clean portfolios that are less than, equal to, or with a few percent of conventional portfolios. Affordability also touches on issues of social equity, support for local economic development, use of local resources, and volatility. The energy efficiency and renewable energy elements of clean portfolios commonly keep more dollars in the local economy, reduce exposure to future fuel costs, improve the performance of local buildings.

Energy efficiency initiatives and investments directly improve energy affordability by helping to reduce energy bills for participating customers. The American Council for an Energy Efficient Economy (ACEEE) 2020 Utility Scorecard ranking 52 utilities across a twenty-six-performance metrics found that thirteen utilities achieved annual incremental savings of 1.5% or greater, and that twenty-five had savings greater than 1% of 2018 sales. [2]

The ACEEE study also found an increasing trend toward energy efficiency initiatives targeted to serve low- and moderate-income households with energy savings increasing by 60% since 2015 and with a current average of ten percent of program spending targeted for income qualified participants.[3]

[2] ACEEE, 2020 Utility Scorecard Table 8 p. 20.

[3] ACEEE 2020 Utility Scorecard p. 18.

The percent of program spending for income eligible households has been the most common metric and mechanism for addressing the equity issue. Many clean energy portfolios are required by legislation or through regulatory directive to apportion a specific share of their spending for services targeting income eligible populations. The ACEEE 2020 scorecard estimate that roughly ten percent of program spending is directed towards low income programs, is indicative of a continuing gap and challenge, as depending on qualification levels and geography income eligible households can represent one-third or even more of the population.[4] This is particularly true when income eligibility is designated to include low and moderate income households, most often defined as 80 percent or less of an area's median income.

Over the last several years growing attention has been paid to defining additional metrics to assess the impacts on energy affordability, inclusion and equity within the clean energy industry and for clean energy initiatives.[5] Starting with the recognition that participation, benefits and design of clean energy initiatives often disproportionately benefit more affluent and well educated segments of the population, these efforts look beyond just program spending to include items such as:

- Participation for the non-residential commercial and non-profit entities that are located in and provide services for eligible communities;
- Participation in contracting for program management and delivery of services;
- Realized savings by customer class (not just spending);
- Dimensions other than income (e.g. housing tenancy, primary language, and environmental justice communities) to help identify eligible communities and target outreach and marketing;
- Representation of target communities in the job applicant pool, management and Board composition for entities delivering clean energy services.

Regular reporting[6] upon, and the establishment of metrics with baselines for measuring impacts[7]are leading indicators of planning and program design can help make sure program impacts, considered broadly, are reaching and benefiting all segments of the population.

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[4] ACEEE, Building Better Energy Efficiency Programs for Low-Income Households Rachel Cluett, Jennifer Amann, and Sodavy Ou. March 2016 Report Number A1601.

[5] See for example, VEIC, The State of Equity Measurement: A Review of Practices in the Clean Energy Industry, September 2019. https://www.veic.org/Media/default/documents/resources/reports /equity_measurement_clean_energy_industry.pdf

[6] Energy Trust of Oregon, 2019 Progress Toward Diversity, Equity and Inclusion Goals, April 2020. https://www.energytrust.org/wp-content/uploads/2020/04/ETO.2019.DEI_Appendix.pdf

[7] Connecticut Department of Environmental Protection, DEEP Seeks Input to Help Make Energy Efficiency Programs More Equitable. Sept. 2020. https://portal.ct.gov/DEEP/News-Releases/News-Releases---2020/DEEP-Seeks-Input-to-Help-Make-Energy-Efficiency-Programs-More-Equitable

Sustainability: Renewable Resources and Reduction of GHG Emissions

The second comparative analysis is a simultaneous consideration of affordability and sustainability criteria. Looking at two dimensions facilitates consideration of potential trade-offs between costs and environmental targets. Figures 2 and 3 illustrate the level of Renewable Energy as a share of total or electric system energy needs for both near term 2025 to 2030 and longer term 2050 analyses. The vertical axis in both figures is the revenue requirement ratio as presented in Figure 1.

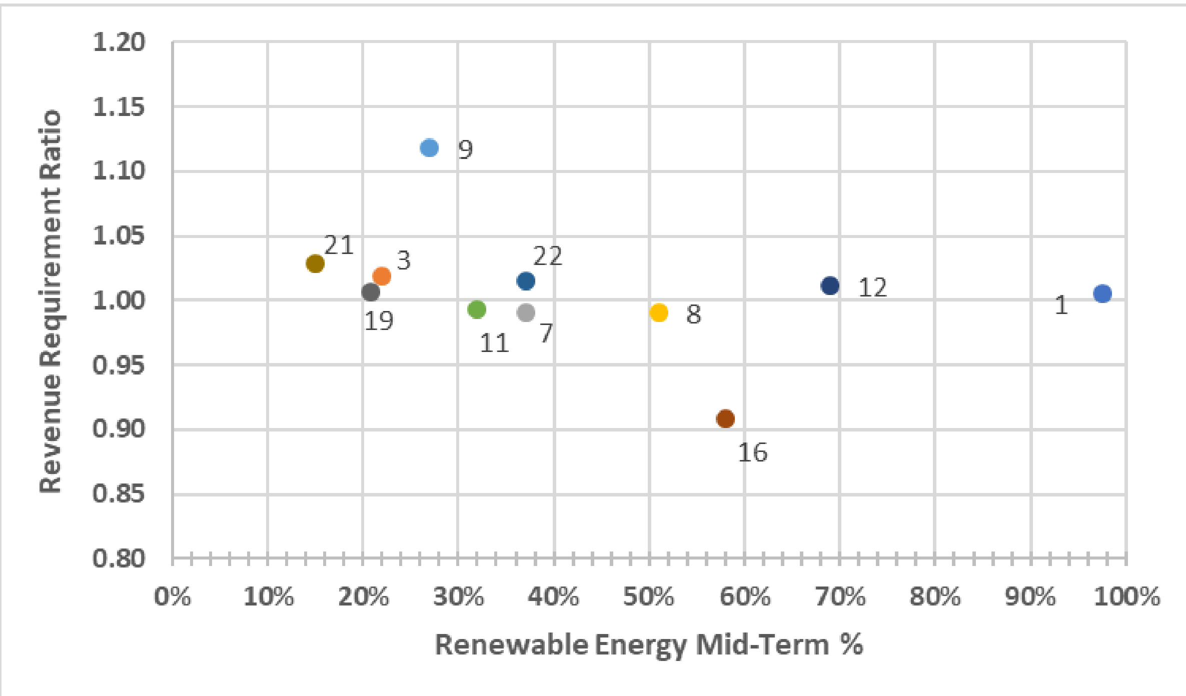

Figure 2: Cost Ratios and Mid Term Renewable Supply

Figure 2 illustrates the levels of renewable supply in the mid-term portfolios ranges from 15% up to 98%, with most cases having a renewable saturation in the 20% to 40% range. For all but one of the data points (number 9), the estimated costs are within 3% of the conventional portfolio mix.

The cost ratio estimates and long term (2050) renewable energy supply are represented in Figure 3. The long-term shares of renewables are generally higher than the ranges in Figure 2, ranging from 30% to 99%, with most cases having renewable energy shares in excess of 50%. Half the cases in Figure 3 show a cost ratio of 1.0 or less in comparison to the conventional portfolio, and only 2 cases (5 and 10) show increased costs of greater than 6%.

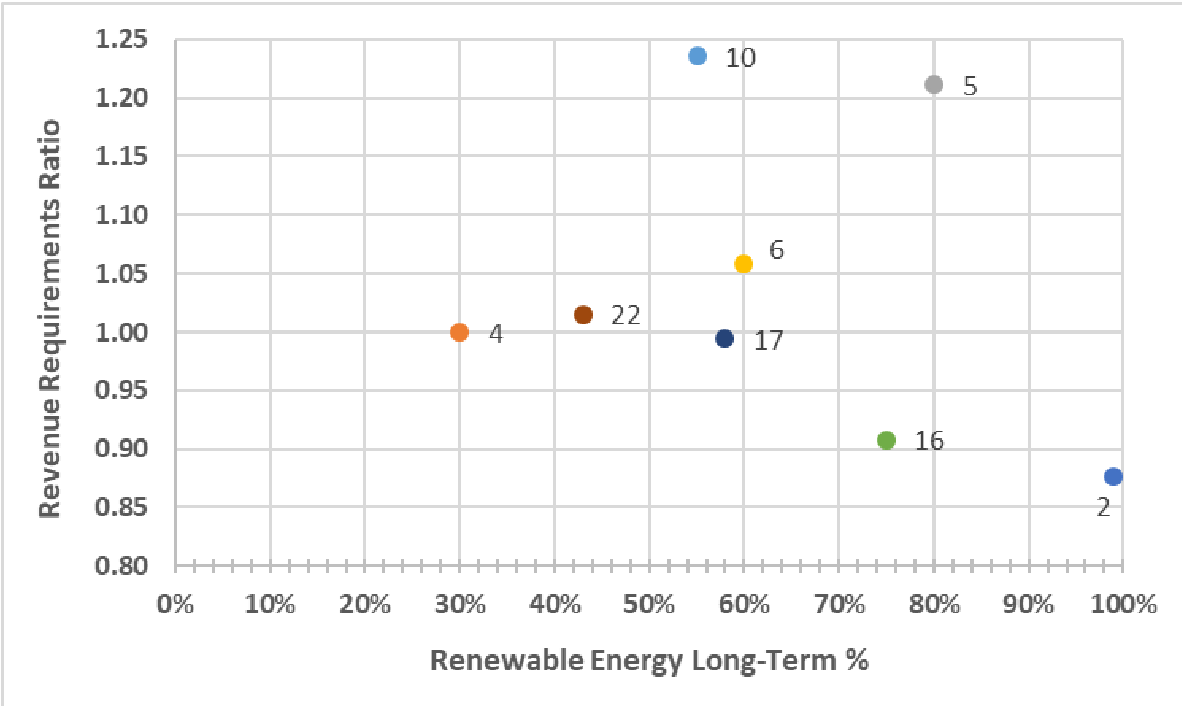

Figure 3: Cost Ratios and Long-Term Renewable Supply

A similar pattern is seen for medium-term GHG reductions in Figure 4, with most cases estimating reductions in GHG emissions are either less costly of only slightly more than conventional portfolios.

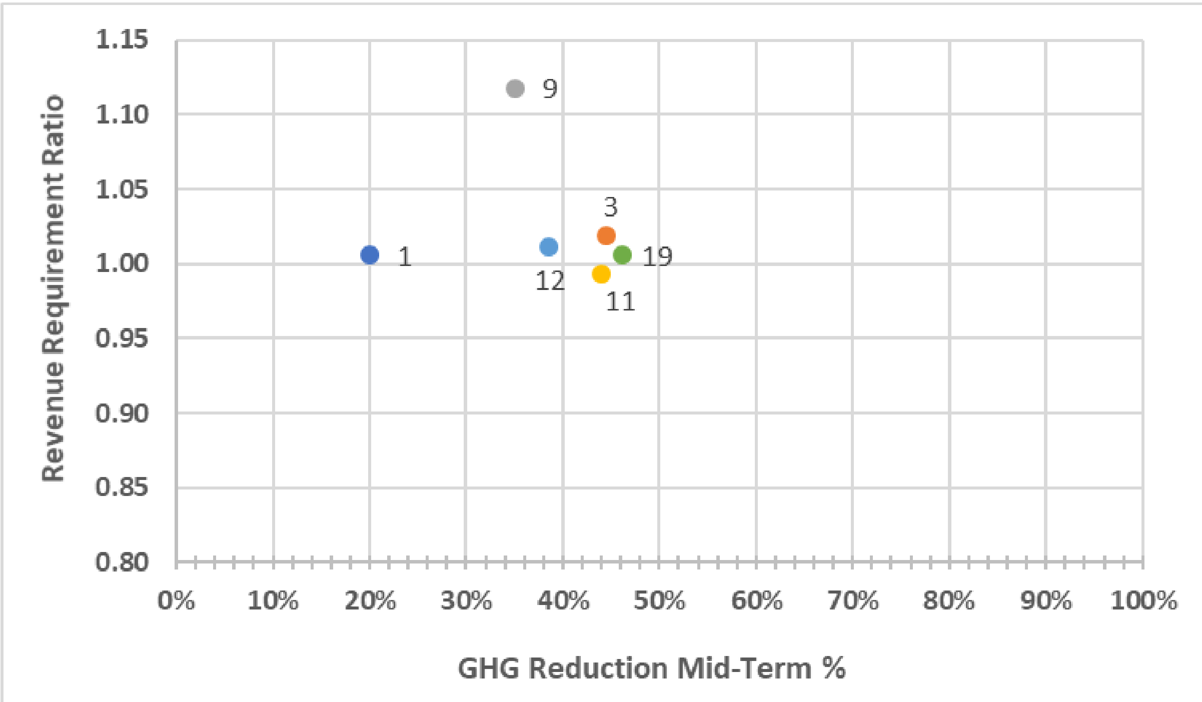

Figure 4: Cost Ratios and Mid Term GHG Reductions

Figure 5 illustrates that for the longer term GHG reductions, particularly those greater than 80% there is a wider spread in the estimated cost ratios, although only two of the cases listed estimate costs increases of more than 9%.

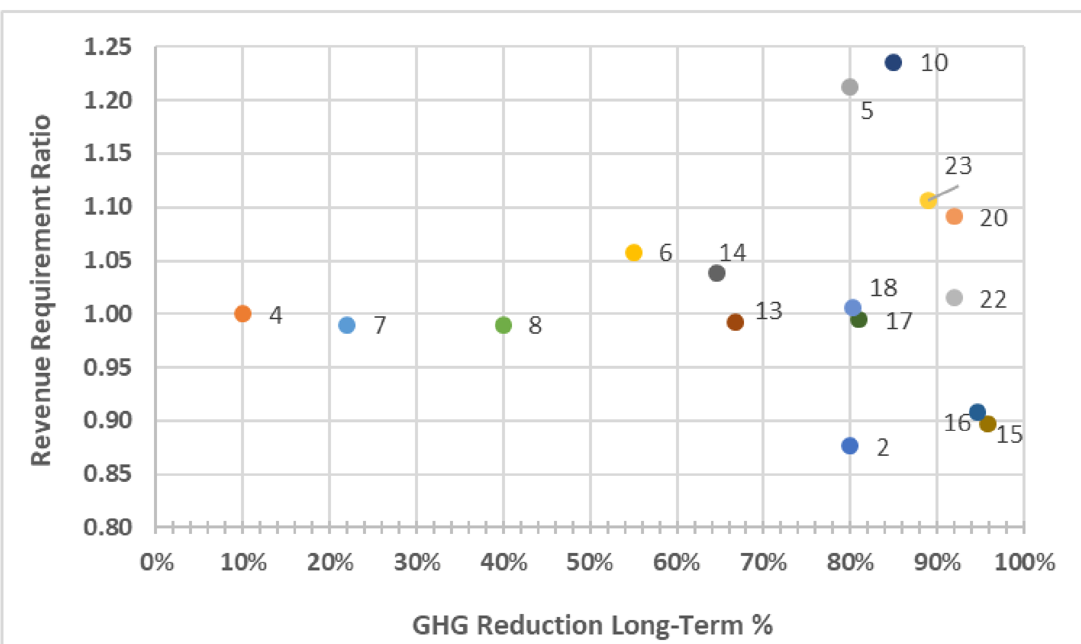

Figure 5: Cost Ratios and Long-Term GHG Reductions

Discussion Technology Costs:

Costs for solar, wind and battery storage technologies have continued to decline, often at a more rapid pace than projected in studies such as those presented in our comparisons. Lazard v. 13 provides a comparison of the levelized cost estimates for generation technologies over the past decade. Solar PV costs have declined by 89%, wind by 70%, while nuclear has increased by 26%.[8]

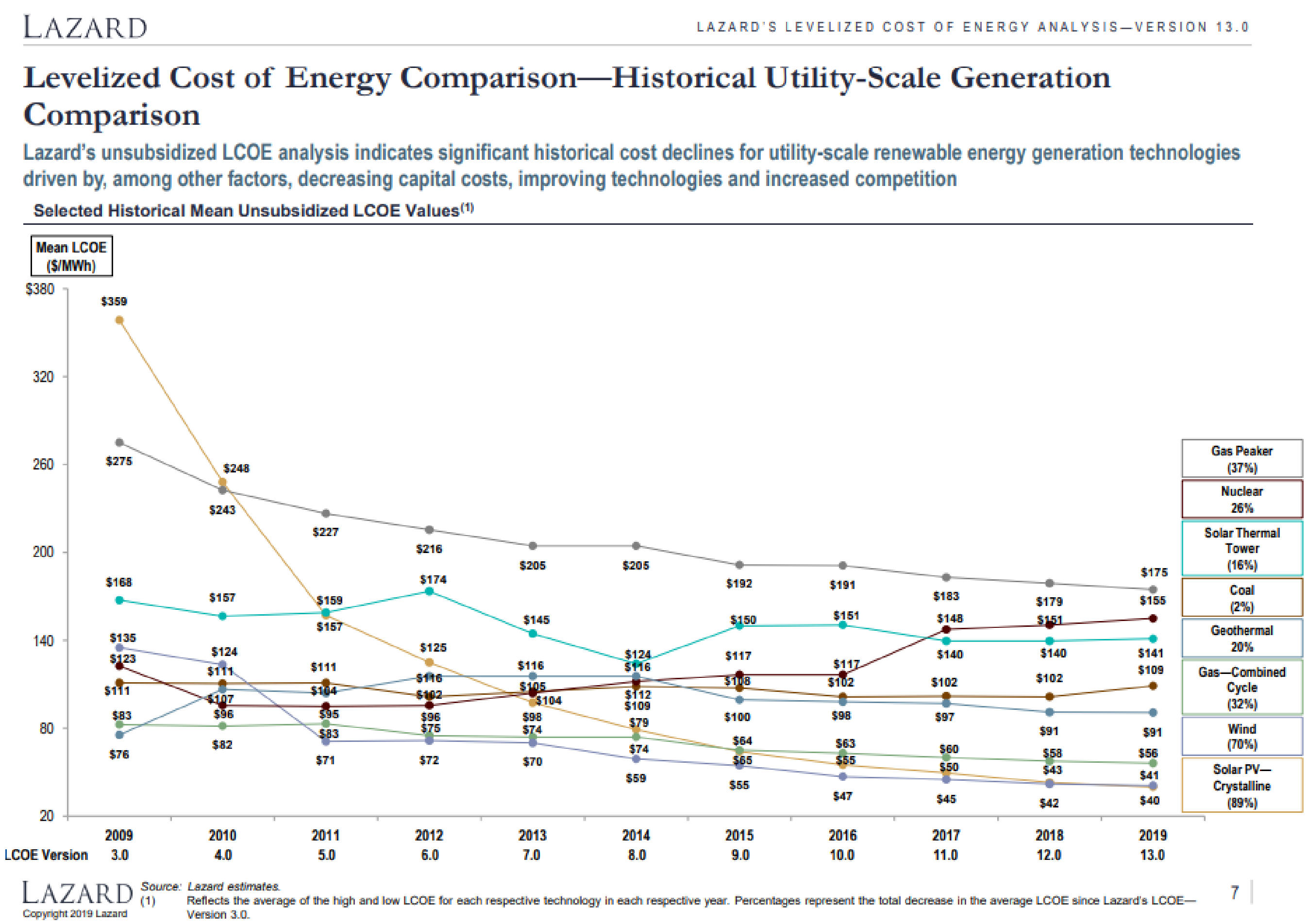

Figure 6: Historical Levelized Cost Comparisons, Lazard 2019.

[8] Lazard's Levelized Cost of Energy Analysis, Version 13.0, November 2019. Note Version 14.0 released October 2020, updates estimated Levelized costs and shows continuing trend for competitiveness of new wind and solar versus nuclear, coal and gas fired alternatives.

Increasing cost estimates for nuclear cited from Lazard can be compared against estimates in the Canadian Roadmap for small modular reactors.[9] Note the SMR Road map estimates are in Canadian dollars while Lazard estimates are in US dollars. The Lazard estimate of the non-nuclear technologies tend to be lower than the SMR analysis, while the SMR analysis for nuclear is much lower than Lazard.

2018 Lazard estimate $148 US *1.3 = $192.4 CDN/MWh.

SMR roadmap estimates: range from $55 to $90 CDN/MWh. (Best Case)

SMR roadmap estimates: range from $80 to $145 CDN/MWh. (Worst Case)

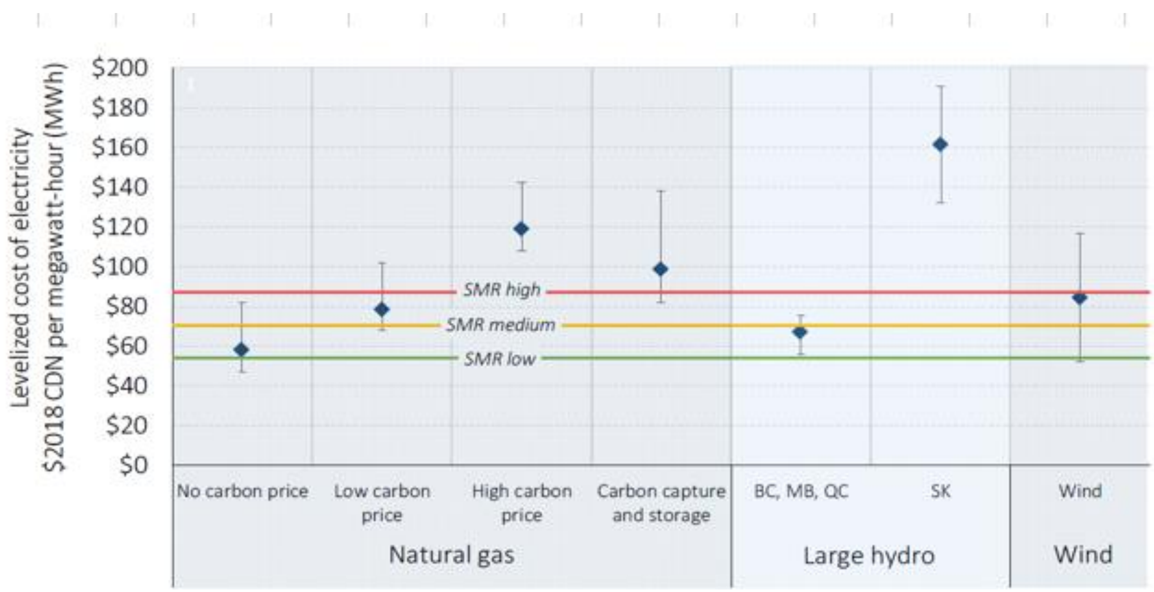

Figure 7: Projected Costs compared to Small Modular Reactors (Best Case). SMR Roadmap[10]

[9] Canadian Small Modular Reactor Roadmap Steering Committee (2018). A Call to Action: A Canadian Roadmap for Small Modular Reactors. Ottawa, Ontario, Canada.
[10] SMR Roadmap Figure 1, page 33.

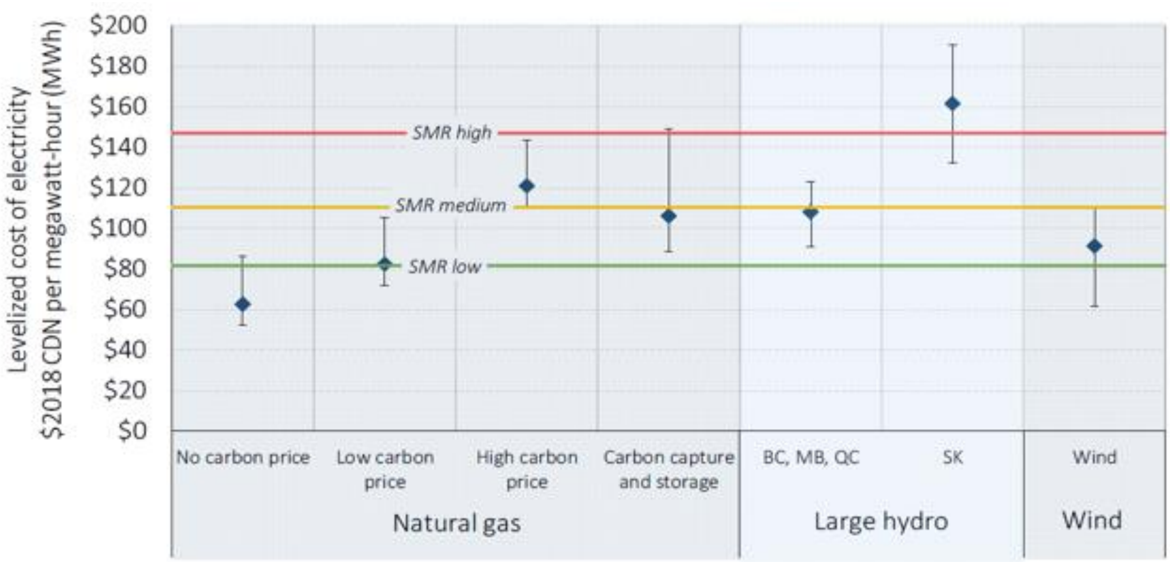

Figure 8: Projected Costs compared to Small Modular Reactors (Worst Case). SMR Roadmap[11]

Continued cost reductions for solar and wind now make new renewables cost competitive with the marginal operating costs for existing coal and nuclear plants as illustrated in Figure 9. Lazard notes that these findings now make the development of new renewable resources cost competitive with the continued operation of existing coal and nuclear plants. This finding is consistent with the retirement of coal and some nuclear plants in the IRP studies included above in our analyses.

Recently published research comparing historic emissions reductions for countries with varying renewable and nuclear generation profiles indicates that emissions reductions are greater for countries with higher shares of renewable generation.[12] This study also finds that renewables and nuclear can tend to "crowd each other out" and that countries with large commitments to nuclear are often lagging both in emissions reductions as well as development of renewable resources.

[11] SMR Roadmap, Figure 2, p. 34.
[12] Sovacool, Benjamin et al. 2020. *Differences in Carbon Emissions Reduction Between Countries Pursuing Renewable Electricity Versus Nuclear Power*, Nature Energy, https://doi.org/10.1038/s41560-020-00696-3.

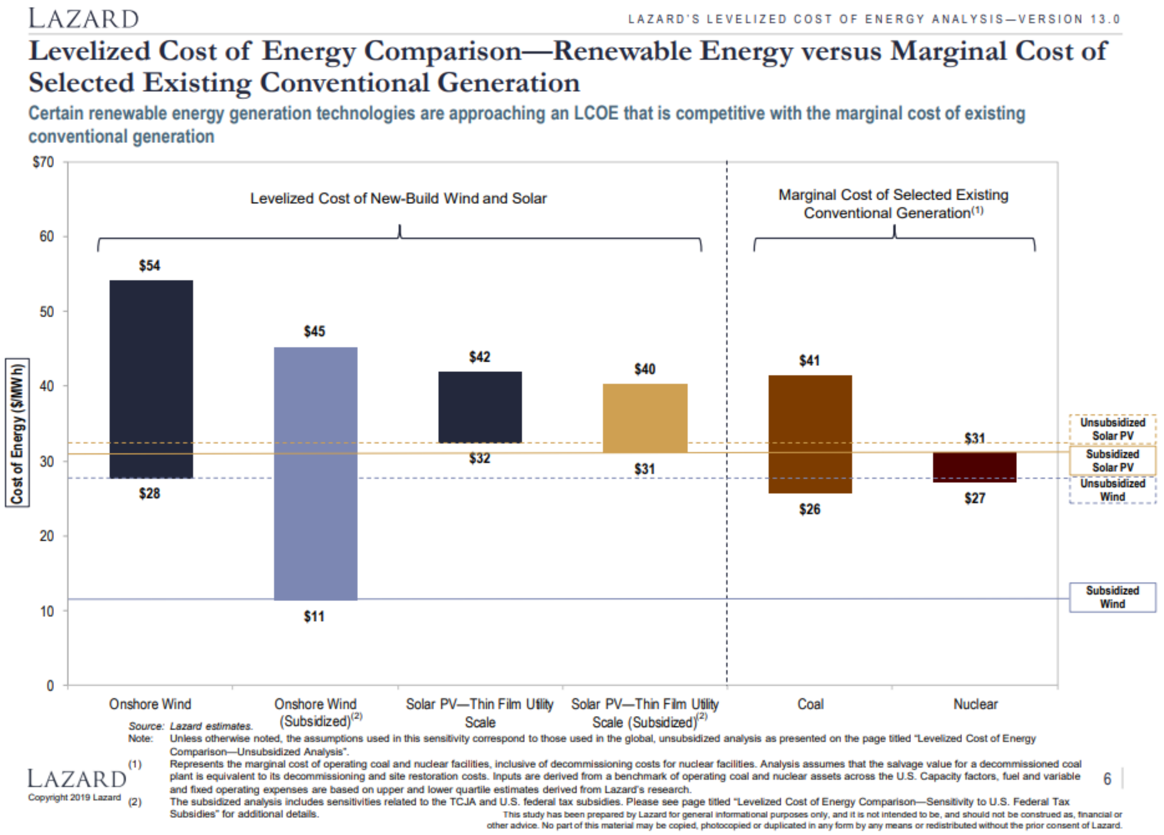

Figure 9: Levelized Costs for New Renewables Competitive with Marginal Operating Costs for Existing Coal and Nuclear Facilities. Lazard 2019.

The Lazard cited cost ranges are based on high and low estimates for US site locations. While sites in Atlantic Canada may be expected to be on the higher end of these ranges, the levelized cost estimates for solar in Wind from the NB Power 2017 IRP shows the NB cost estimates to be in the range of 2 to 3 times higher.

Table 4: Comparative Renewable Levelized Cost Estimates

	NB Power 2017 IRP[13]	Lazard 2019 v. 13*[14]
Solar	Large solar single axis = $142/MWh Large solar fixed tilt = $154/MWh	Utility Scale Thin Film unsubsidized = $42/MWh to $54/MWh
Wind	Large wind = $96/MWh Small wind = $100/MWh	On Shore Unsubsidized = $36/MWh to $70/MWh

[13] NB Power 2017 IRP, Figure 27 p.56.

[14] Adjusted to Canadian Dollars using $1US = $1.3CDN

Recent renewable procurement in Maine resulted in 482 megawatts of solar projects selected with an average cost of 3.5 cents per kilowatt hour, indicating that even in climates not typically considered to have favorable solar resources that costs for new generation are highly competitive.[15] These recent market based results provide solar costs in a similar climate zone that are 75 percent or more below the NB Power planning estimates for solar in their 2017 IRP.

Reliability: Clean Portfolios and Keeping the Lights On

While they do not replace the need for distribution circuit or power flow studies and detailed engineering analysis, all the cases and studies presented in the findings above take ongoing system reliability and safety as fundamental constraints.

IRP's (cases 11 through 24) in the results outlined above, commonly include reserve planning margins and the ability of intermittent renewable resources to meet anticipated peak loads. Flexible load management and coordination of loads are likely to play an increasingly important role in the development of least cost clean energy portfolios. For example, in electrified buildings coordinating loads so that electric water heating is not coincident with other electric space conditioning, cooking or vehicle charging loads is emerging as a strategy to reduce peak loads. The ACEEE 2020 Utility Scorecard indicates many utilities are developing new program initiatives including integration of distributed energy resources, better use of automated metering infrastructure and data, geo-targeting and flexible load management.

The Renewable Electricity Futures Study[16], conducted by the National Renewable Energy Laboratory specifically examined and modeled the resource requirements and challenges posed by high levels of renewable generation ranging from 30% to 90%. Key findings include:

> "Renewable electricity generation from technologies that are commercially available today, in combination with a more flexible electric system, is more than adequate to supply 80% of total U.S. electricity generation in 2050 while meeting electricity demand on an hourly basis in every region of the country." Renewable Electricity Futures Study, NREL, 2012.

Data visualizations representing the modeling results of high renewable futures illustrate hourly grid operations and loads, and power flows in 2050.

[15] Greentech Media, September 22, 2020. https://www.greentechmedia.com/articles/read/solar-dominates-maines-largest-renewables-procurement-on-record

[16] National Renewable Energy Laboratory. (2012). Renewable Electricity Futures Study. Hand, M.M.; Baldwin, S.; DeMeo, E.; Reilly, J.M.; Mai, T.; Arent, D.; Porro, G.; Meshek, M.; Sandor, D. eds. 4 vols. NREL/TP-6A20-52409. Golden, CO: National Renewable Energy Laboratory. http://www.nrel.gov/analysis/re_futures/.

Figure 10: Data Visualization[17], 2050 Hourly Load and Generation. NREL Renewable Electricity Futures Report.

Integrating higher levels of intermittent renewable resources onto the grid requires careful analysis and engineering at both the distribution and transmission system level. The Electric Power Research Institute (EPRI) conducted a study designed to help planners, regulators and engineers place the opportunities and challenges of an electric grid system that relies more on integrated distributed energy resources (DERs) into a common cost and benefit framework.[18]

The specific needs and costs for a given system will vary according to the nature of the existing system components, design, configuration, and age. For example the following graphic, taken from a study conducted by PEPCO's distribution system, illustrates that many feeders can host relatively high levels of photovoltaics (Base-PV (%) without costly upgrades, while other feeders may require relatively costly upgrades to host even lower amounts of PV integration.

[17] https://www.youtube.com/watch?v=fQI7PS243Dg
[18] K. Forsten, "The Integrated Grid: A Benefit-Cost Framework" Electric Power Research Institute, February, 2015.

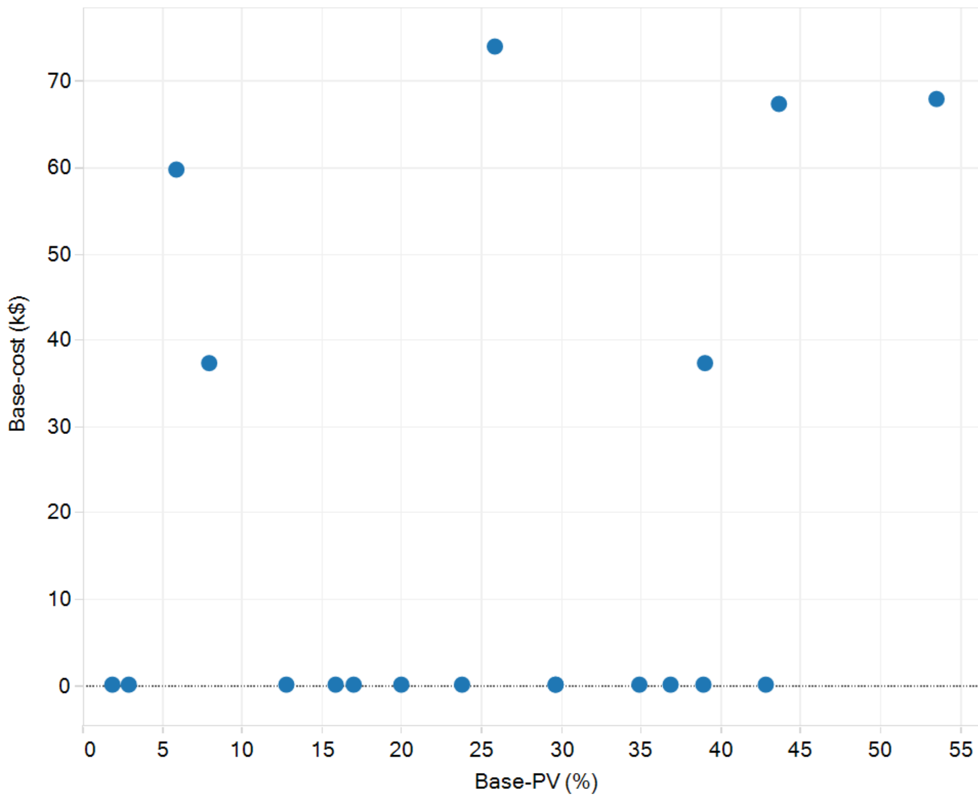

Figure 11. Solar capacity as a percentage of feeder rated capacity versus distribution system upgrade cost, the base case before optimizing for PV. [19]

Planning and incentives to locate new distributed resources such as PV on feeders where they can be accommodated without costly upgrades can be facilitated by hosting capacity mapping with updated data sets as illustrated in the example from Green Mountain Power in Figure 12.

[19] Data from Pepco analysis is presented as part of "Preparing for a Distributed Energy Future: What Can Be Done Today to Integrate DERs Cost Effectively."[19]

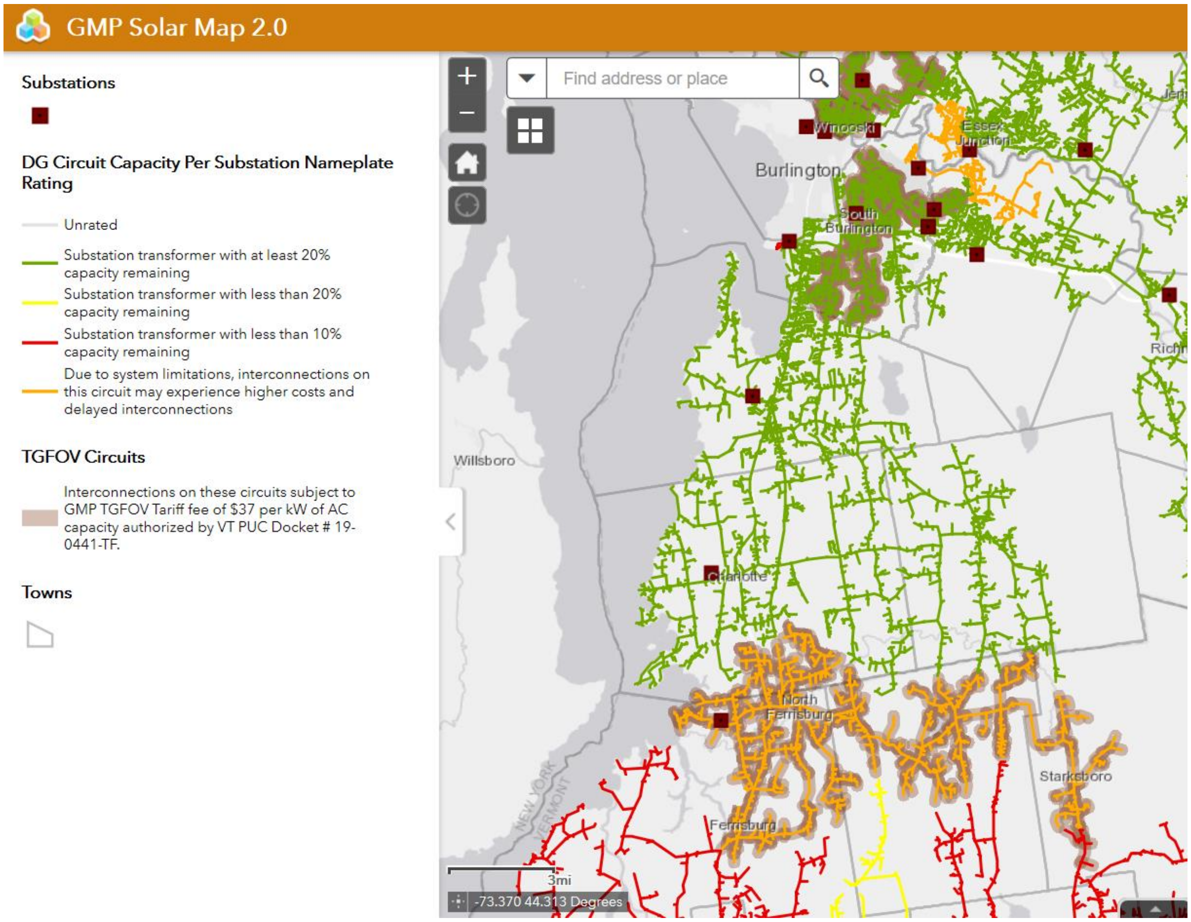

Figure 12. Solar Hosting Capacity Map, Green Mountain Power[20]

Financing: Raising Capital and Reducing Risk

While the cost of debt is less than the cost of equity due to a reduced level of risk, utilities, both investor owned and public, must maintain debt at a level that allows for on-going meeting of debt repayment and provides a buffer against risk and economic cycles. While equity requires a higher return than debt, it provides a buffer against risk, as a return to equity can be reduced or eliminated under unfavorable circumstances.

It was beyond the scope of our research to characterize the capital structure of the cases presented in Table 1. However, we did want to provide a more limited comparison of the debt equity ratios for a small number of investor owned utilities in the U.S. to provide some insight into the question of whether clean energy portfolios (or Companies pursuing them) appear to face greater than normal challenges in attracting investment capital. Figure 13 compares historical debt to equity ratios for a selection of utilities in the United States. NextEra Energy,

[20] http://gmp.maps.arcgis.com/apps/webappviewer/index.html?id=4eaec2b58c4c4820b24c408a95ee8956

Hawaiian Electric, and Eversource are three utilities that have emphasized the development of clean energy resources in their territories.

While the patterns of debt to equity ratios have shifted over the 15 year period represented in the graphic, but over time - as all of these companies have increased the share of renewable power on their systems - they have been able to maintain equity investment. Southern Company has also increased its share of renewable and retired coal from its portfolio over the last five years, but still has roughly half as much renewable in its portfolio as the others, has seen the greatest increase and currently has the highest debt to equity ration in this comparison group.

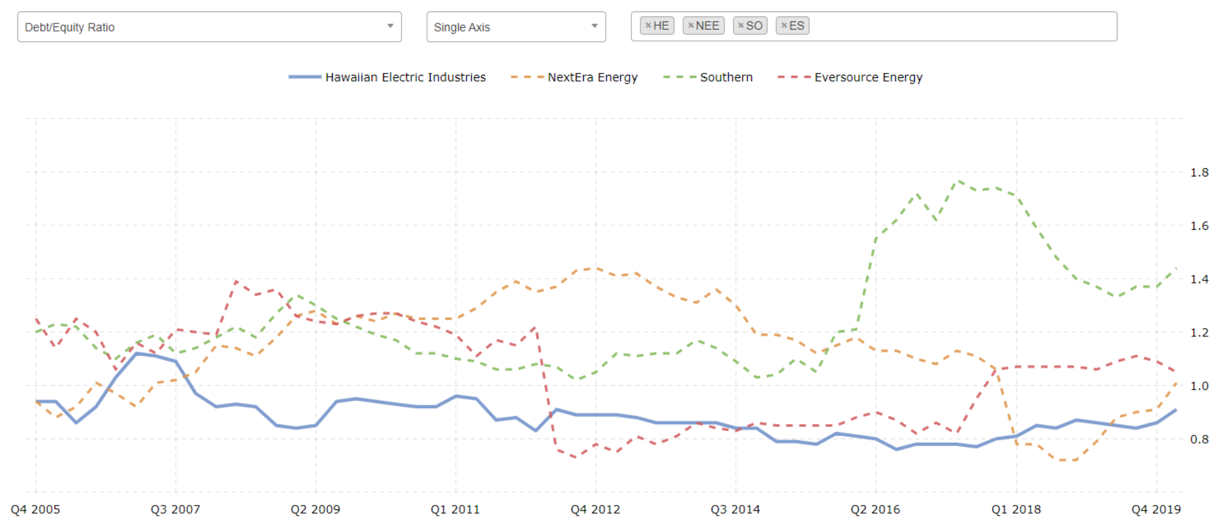

Figure 13. Comparative Debt to Equity Ratios

Another indicator of how easy or hard it is to finance clean energy portfolios is the sensitivity of technologies to the cost of capital. Lazard estimates the levelized cost estimates for wind and solar are the least sensitive to changes in the cost of capital than alternative technologies as illustrated in Figure 14.

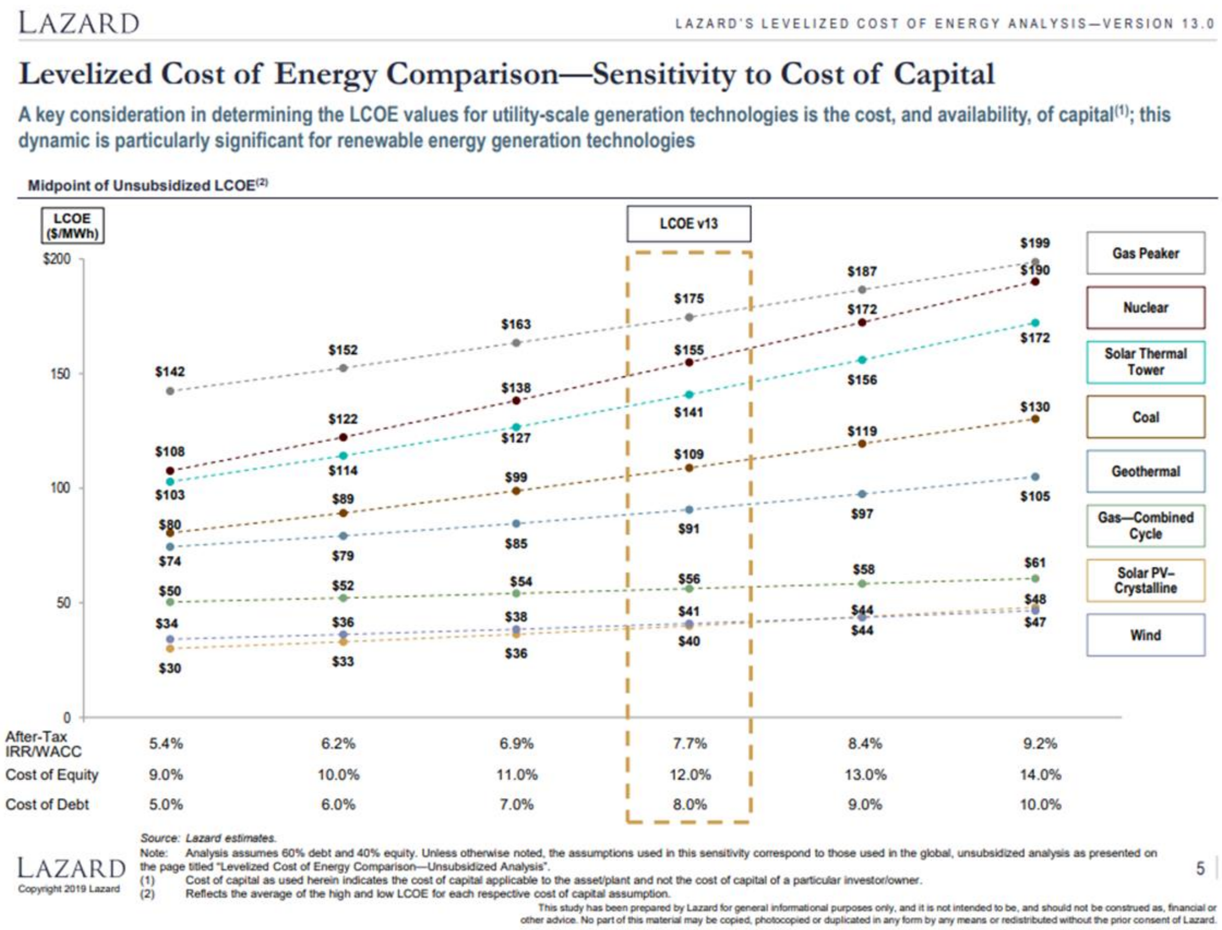

Figure 14. Cost of Capital Sensitivity, Lazard 2019

Technologies that are more sensitive to cost of capital (e.g. nuclear, gas peaker and solar thermal) have steeper slopes than those that are less sensitive (solar PV and wind) in Figure 14. Generally speaking, across a range of possible capital structures, the technologies that are more sensitive are subject to greater financing risk and will be more expensive to finance.

Finally, many of the IRP's presented in Table 1 and included in Figures 1 through 5 include sensitivity analyses that examine portfolio results under a range of possible economic, demographic, and regulatory assumptions. Clean portfolios, with greater reliance on renewable fuel sources, are protected from potential escalation and volatility of fossil and nuclear fuel prices. Compared to fossil and nuclear generation, renewables also typically have lower costs and risks for environmental compliance and decommissioning, and this again makes them more resilient under a range of sensitivity analyses. The modularity with which many renewable resources can be developed also help to reduce risk, as they can be more precisely matched to the location and size of resource needs in comparison to central generating stations.

Conclusions and Recommendations

This whitepaper presents a broad-scope view of more than two dozen studies and scenarios to provide context and support for energy system planning in Atlantic Canada. Key findings include:

- Clean energy portfolios are cost competitive with conventional portfolios. Even when environmental externalities are not valued and quantified, clean energy portfolios from a variety of studies have costs that are lower or very close to conventional portfolios. With few exceptions, our research indicates clean portfolios are affordable. They can also be expected to keep more spending, investment and jobs local, thereby contributing to healthy and sustainable economic growth.
- Growing attention is being given to social equity metrics as a means to improve ability of clean energy portfolios and initiatives to benefit all customer classes, and to enhance the equity of economic development impacts from more equitable investment and job creation.
- Clean portfolios, based on renewable energy, demonstrate significant greenhouse gas reductions. In both the electricity sector and economy wide, the combination of decarbonized electric supply, efficiency, strategic electrification, and flexible load management can be used to create plans that result in 50% medium term, and 80% to 90% long-term reductions in greenhouse gas emissions.
- The end use and supply side technologies required to create such portfolios are available today. Moreover, electric systems can reliably, and cost effectively, be designed and operated with high levels of renewable energy saturation.
- The financing for clean energy portfolios, for both investor owned and public utilities, can reasonably be expected to be less costly and less risky than for fossil fuel and nuclear projects. With lower operating costs, lower operating risks, lower environmental compliance risk, lower risks for decommissioning, and greater modularity, clean portfolios are likely to have increasing advantage over conventional resources in attracting capital investment.

Our research provides starting references and grounds for further investigation on many of these points. It also clearly illustrates the trends we highlight above, and points towards an increasingly bright future for clean energy portfolios.

References

In addition to the footnote citations above, our research included critical review and analysis of the following Planning Studies and Integrated Resource Plans. The study numbers in the left column represent the data point labels in Figures 1-5.

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