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November 15, 2019

VIA ELECTRONIC MAIL

Ms. Aida Camacho-Welch
Secretary of the Board
New Jersey Board of Public Utilities
44 South Clinton Avenue
Trenton, NJ 08625
EMP.comments@bpu.nj.gov

Re: Comments on Draft IEP

Dear Secretary Camacho-Welch:

Public Service Enterprise Group Incorporated ("PSEG" or the "Company") appreciates the opportunity to submit these written comments to the New Jersey Board of Public Utilities ("Board" or "BPU") on the November 1, 2019 public webinar and materials presented by Rocky Mountain Institute ("RMI") and Evolved Energy Research ("EER" and, collectively with RMI, the "Consultants"). In addition to the comments contained in this letter, attached hereto is a technical review and analysis of the Consultants' materials provided to date.

As detailed in PSE&G's comments dated September 16, 2019 on the Draft Energy Master Plan ("EMP"), PSEG supports the objectives of the Draft EMP, which seeks to lay out a plan to achieve 100% clean energy and an 80% reduction of economy wide greenhouse gas emissions by 2050. Similarly, PSEG commends RMI for its efforts in evaluating the potential pathways that New Jersey can take to meet these clean energy goals. Their presentations have reflected careful analysis, and RMI has employed relatively transparent methods and assumptions, particularly considering the complexity and scope of their charge. We note in particular how the analysis has highlighted important "macro" aspects of the task ahead of New Jersey. For example, the scenario approach has illustrated that achieving New Jersey's clean energy and emissions objectives without extending the operating licenses of the State's nuclear power plants will be significantly more expensive than meeting those objectives if those plants are retired at the end of their license terms.[1] Similarly, we note that the analysis highlights the

[1] RMI and EER, New Jersey Integrated Energy Plan, Public Webinar (November 1, 2019)("Webinar Presentation"), slides 44-45.

continued need for transmission investments, dispatchable gas-fired generation, and nuclear for year-round availability and its carbon benefits.

While the analysis conducted to date is a beneficial "first step" in understanding the challenges in achieving these policy goals, we believe it is nonetheless incomplete. As discussed in these comments and in the attached technical review, important details regarding the modifications required to accomplish the dramatic transformation in energy infrastructure and customer behavior contemplated have been omitted or not adequately considered, with concomitant understatement of some of the costs and challenges to achieving those goals.

Of particular importance to PSEG, a sizeable share of the required investment, incentives, and consumer information services will be utility focused. To develop a more complete understanding of the efforts required to effectively achieve the State's energy and environmental goals, additional work should be undertaken in collaboration with the State's utilities regarding the scale of utility investments that will be required to transform the State's transmission and distribution systems, and to integrate the renewable and distributed resources envisioned in the analysis.

As this work is undertaken, we emphasize our concern that these are very dramatic changes that will take a considerable amount of time to specify, design, finance, and then implement. While 2050 may seem distant at the moment, the scope and magnitude of change is so significant that the State should not overlook the near-term steps that should be taken to move the State down this policy path. An important first step will be approval and implementation of several PSE&G initiatives currently before the Board. These program filings all align with the near-term goals of the State: expanding the opportunities for customers to participate in energy efficiency, building the electric vehicle infrastructure, deploying energy storage, and modernizing electric meters.

As those relatively near-term efforts are undertaken, the IEP analysis begun by RMI should be further developed, increasingly reflecting the reality of the challenges ahead, the likely actual costs, required additional programs, and the means and processes by which success can be achieved in a fashion and in a time-frame that meets the State's objectives. Some of PSE&G's near-term programs are summarized below. In addition, as part of the on-going process of developing and executing the IEP, there is need for more in-depth review of RMI's key assumptions and critical methods; those issues are discussed in the attached technical discussion.

PSE&G Programs and Initiatives

The Draft EMP is an ambitious plan, which will not succeed if it is pursued as simply more of the same, or similar, kinds of programs and processes that utilities and regulators have undertaken in the past. PSE&G, as well as the other electric and gas utilities in New Jersey, must play an essential role to bring this vision to reality. PSE&G has been focused on the key role the utility plays in bringing new technology, cleaner air, and opportunities to control energy use to our entire customer base, including and especially the communities and individuals who need it the most. The following summarizes PSE&G's near-term efforts to achieve the key scenario assumptions set forth in the IEP.

Energy Efficiency -- The IEP scenarios assume achievement of the energy efficiency targets mandated by the Clean Energy Act (CEA) to reduce electric and gas consumption annually by 2% and 0.75% respectively, generally on an accelerated basis. To achieve this goal, it is important to establish utilities as the implementers of energy efficiency programs due to the unique advantages they hold, the success and prevalence of the utility-led model across the United States, and the CEA's mandate regarding the utilities' role in energy efficiency. PSE&G's Clean Energy Future – Energy Efficiency (CEF-EE) filing is designed to make energy efficiency available to all segments of customers, ensuring universal access and, when combined with State-led initiatives such as building codes and appliance standards, will support achievement of the energy savings targets set forth in the CEA and assumed in the IEP.

Electric Vehicles – The IEP also includes ambitious targets for electric vehicles ("EVs"). Again, with regard to electrification of the transportation sector, the EMP should include a partnership with the State's electric utilities. As other leading EV states have shown, electric utilities have a critical role to play in deploying EV charging infrastructure for light and medium duty vehicles, and providing solutions for more specialized vehicles, including school buses, transit, and other medium and heavy-duty vehicles in locations such as ports and airports. With PSE&G's Clean Energy Future - Electric Vehicle and Energy Storage (CEF-EVES) filing, PSE&G is prepared to jumpstart the electric vehicle industry in New Jersey by implementing approximately 40,000 "smart chargers," which will also provide data to help optimize electric distribution system planning and operation, and support improvements to rate design to better align rates with cost causation.

Energy Storage – The IEP includes very aggressive goals for energy storage. PSE&G believes that many larger, distribution-related issues can be addressed more quickly, efficiently, and securely through utility-managed deployments than through decentralized deployments. PSE&G's CEF-EVES filing contains a plan for deployment of 35 MW of energy storage, both at the grid level and at customers' sites, contributing to the established goals of installing 600 MW of storage by 2021 and 2,000 MW by 2030.

Nuclear -- The IEP results make clear that without the continued presence of nuclear power, the Governor's goal of 100% clean energy by 2050 could not be attained without exorbitant cost. Governor Murphy, the State legislature, and the Board are to be commended for their support of the Zero Emission Credit legislation, which will help ensure the continued viability of this vital, emission-free electric generation resource. While supporting solar for the near-term and mid-term, and wind for the mid-term and long-term, PSEG emphasizes that continued operation of New Jersey's nuclear capacity, as long as those plants are capable of operating, is required if the State is to achieve its clean energy goals and obligations at reasonable cost.

Solar – The IEP scenarios all assume solar growth at a level that currently is unprecedented. PSE&G believes that the state's utilities play an important role in the continued success of the solar market in New Jersey, with a focus on customer and market segments where clean energy investments are lagging and in providing a strong support for environmental justice concerns. PSE&G can effectively reach public entity customers that lack the financial strength and tax circumstances to invest in solar energy. There are additional opportunities for utility participation in public and municipal solar, in the landfill and brownfield sector (where thousands of acres of land still sit dormant), and in Community Solar in the urban low and moderate income sector, where PSE&G can support solar for those customers that have been left behind in the market's rapid expansion over the past decade.

AMI – The Draft EMP acknowledges the benefits of Advanced Metering Infrastructure ("AMI") and suggests that the Board consider issuing recommendations to utilities for accelerated AMI installation in a strategic, coordinated, efficient, and cost-effective manner. As the draft EMP notes, AMI is a "foundational component of a modernized distribution grid" and a "prerequisite of many additional clean energy objectives." The Board has now observed and its consultants have enthusiastically endorsed a real-world demonstration of the benefits of AMI in the service territory of Rockland Electric Company.[2] AMI also will enable the piloting and implementation of modified rate designs to encourage and support many of the state's energy goals such as electric vehicle adoption and energy efficiency. The Draft 2019 Energy Master Plan sets the stage for the widespread implementation of AMI as contemplated in PSE&G's Clean Energy Future - Energy Cloud Program, the cornerstone of which is the deployment of AMI throughout PSE&G's electric service territory.

Next Steps and Conclusion

While the attachment to this letter highlights several challenges and gaps in the RMI anlaysis, we remain committed to working with the BPU and the State in achieving these aggressive goals. We recommend consideration of the following next steps:

- *Transformation of the State's utilities to a 21st century model* - The State and BPU should undertake a targeted effort to work with the New Jersey utilities to transform the utility business model to one that drives mass adoption of energy efficiency and clean energy technologies, and optimizes the grid to safely and reliably integrate renewable and distributed energy resources throughout the State. Utility business goals and incentives need to be aligned with the energy policy goals of the State so that utilities become partners with the market players that will be the solution providers in this new clean energy economy.

- *Establishment of near-term goals to put the State on a path toward achieving its long-term clean energy goals* - While the long-term investments needed to achieve EMP goals

[2] In their just-issued Capstone Report (November 14, 2019) on the very first page, titled "Findings and Conclusions", the Board's consultants (Navigant) found that "there is a high likelihood that RECO's AMI business case will be cost-effective" under the ratepayer impact measure ("RIM"). The report goes on to describe how well RECO's AMI program performs on the RIM test under more appropriate assumptions, and how well the program fares on another familiar cost-benefit test. Navigant also found that RECO's AMI program can "deliver additional benefits that, while difficult to quantify at the time of this report, are expected to have beneficial impact to RECO's customers and the state of New Jersey." Finally (also on page 1), Navigant paraphrased the Draft Energy Master Plan, stating "[m]ost notably, RECO's AMI program serves as a foundational investment to support the key goals of New Jersey's Energy Master Plan."

require additional evaluation, there are a number of steps the State can take in the near term to put it squarely on the path toward achieving the goals. The costs and benefits of these steps are more modest, and many of them are already codified within the Clean Energy Act and simply await implementation by the BPU. For example, timely review and approval of PSE&G's CEF program filings will move the State forward in energy efficiency, electric vehicle adoption, energy storage deployment, and customer awareness of energy usage to encourage better decision making. Similarly, replacement of the current SREC program with one that allows all customers to enjoy the benefits of solar, rewards innovation, and minimizes costs will help put the State on the appropriate path.

- *Collaboration with the State's electric and gas utilities and other appropriate stakeholders to gain a more complete and accurate assessment of the investments that will be needed to achieve these policy goals* - This assessment will be needed for the State to make informed future policy decisions on solar, offshore wind, vehicle electrification, and many other aspects of New Jersey's energy future.

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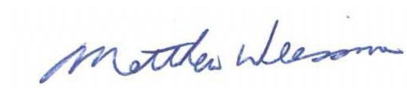
Once again, PSEG thanks for the Board for the considering these written comments and looks forward to continuing to partner with the Board, stakeholders, and the State, as New Jersey pursues its goal of achieving 100% clean energy.

Very truly yours,



Matthew M. Weissman

Technical Review and Analysis

RMI concluded that the incremental investment to undertake the Least Cost approach to the EMP's goals (i.e., new investments in low-carbon generation, the electricity grid, demand-side equipment, and biofuels) is, on average, approximately $12 billion per year (in 2018 constant dollars – in notional dollars it may be 1.5 to 2 times higher) over the period 2030 to 2050 above those costs associated with its Business as Usual Case (Reference 1) – where the latter reflects no impacts from the Clean Energy Act or the Global Warming Response Act through 2030. These incremental investment costs are projected to be offset by estimated avoided costs (predominantly from reduced spending on natural gas and refined oil products (gasoline, diesel)) of about $10 billion per year over the same period.[1] Thus, net statewide *incremental* costs (i.e., gross investment minus avoided costs) range from a low of $1.38 billion per year to a high of $2.64 billion per year.[2] Other strategies could cost considerably more, and there is not yet any assessment of which approach will be most feasible in light of what agencies and entities will bear what share of the implementation costs or what institutional barriers need to be overcome.

RMI foresees incremental investment costs of about $240 billion over the 2030 – 2050 period (i.e., 20 years x $12 billion per year), which will be even greater in nominal dollars. This tremendous investment level is largely in the electric sector, including the purchase of higher cost appliances and electric vehicles by residential and commercial customers). While these costs are estimated to be offset significantly, but not completely, by reduced natural gas and fuel costs, it is important to note that there is likely to be an asymmetric pattern of investment requirements versus avoided costs among New Jersey citizens. That is, the savings will occur in gradually avoided customer consumption of past fuels, while the costs will be borne more immediately, first as investments by the utilities and then expressed in rates as much larger electric bills (more than twice the electricity consumption in 2050 as in 2018), and possibly higher unit costs of that electricity.

Distinguishing <u>gross</u> costs from <u>net</u> costs or from net value inclusive of benefits is important – gross costs are what will have to be paid/financed by specific parties while net costs include offsets, such as savings from substitution, to all parties in the state. The net value is relevant for state policy endorsement, but the gross amounts are essential for understanding what has to be accomplished by consumers and the utilities in order to reach the goals, and what is the best way to do it. Also, the required costs and wealth transfers will depend on how the process is structured, e.g., the extent to which market mechanisms (prices) are the primary tool versus mandates and/or subsidies. This will affect demand (via feedbacks, for example, if prices become high due to carbon penalties) as well as budgets (as mandates and subsidies will have to be funded with taxes or socialized utility surcharges).

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[1] RMI and EER, New Jersey Integrated Energy Plan, Public Webinar (November 1, 2019)("Webinar Presentation"), slide 33. Estimated gross investment and avoided costs are approximations based on a visual inspection of the exhibit on the noted page. The Company has not reviewed the data underlying the presentation.

[2] Id.

Notwithstanding the incremental capital requirements identified by RMI as necessary to achieve EMP goals, there are areas of cost uncertainty within the RMI analysis worth highlighting here if only to provide a more complete view of potential cost impacts. The ultimate extent of these impacts will likely depend on how the implementation programs are designed.

In particular, there are five areas of cost uncertainty worth expanding upon via additional analyses and feasibility studies or regulatory reviews:

- *Electric Transmission and Distribution*: There will be costs associated with delivering, monitoring and controlling a doubling of electricity demand, and a projected three and one-half times increase in supply resources, the majority of which will be intermittent, as well as transmission costs associated with delivering and distributing 11,000 MWs of offshore wind within the state. It will be prudent to start tying specific grid analyses to the new supply elements of the deemed Least Cost solution to see if its delivery requirements are a barrier or would suggest alternative supply mixes, greater use of offsets, DERs or other changes.

- *Energy Efficiency (EE) Deployment*: The IEP contemplates sustaining 2% annual reductions in residential and commercial electricity demand over 30 years. This is a critical assumption, because any demand not reduced has to become electrified and supplied. While technical potential for such savings may be real, it is prudent to assume the payback for these savings will become longer over time. In particular, if near-term reductions in this range can be primarily achieved via lighting demand, then the longer term will require more significant upgrades, such as swapping out building heating systems and increasing efficiency of building envelopes. These will be more costly for customers and may need large incentive payments to be induced.

- *Complexities of De-Gasification*: The IEP involves nearly complete backing out of natural gas from end-use with little discussion of the costs or complexities of this dramatic change. This is likely to engender industry and customer resistance, and even once imposed or accepted, the conversion process is highly uncertain, involving stranded costs, significant billing revisions, and interventions of some kind to overcome customer difficulties in adopting increased electrification and other new technologies. Thus, we recommend that the Board conduct a transition plan analysis.

- *Transition Costs and Processes*: The IEP appears to recognize the end-use hardware costs associated with transitioning the economy (consumers) from a carbon-based energy infrastructure to one almost completely electrified. However, it also seems to assume these conversions will occur naturally with the turnover in appliances as customers see the long run benefits of the net avoidable costs. It is likely that that assumption overstates the ease of achieving these changes in behavior. Past evidence from EE and other utility incentive programs indicate that much more active efforts will be required, sponsored by utilities or state agencies.

- *Other Costs and Challenges*: Miscellaneous categories of costs, e.g., lost tax receipts from reduced or eliminated gasoline consumption, are presented.

Each of these areas is discussed in greater detail below.

Electric Transmission and Distribution

RMI has stated that its analysis included electric transmission and distribution system impacts.[3] The basis for RMI's estimates appears to be the Energy Information Administration's (EIAs) 2019 Annual Energy Outlook (AEO). The AEO's 2019 report shows electric distribution and transmission costs (2018 dollars) in 2050 rising in the region that includes New Jersey (known as Reliability First – East) by approximately 45% from 2018 levels.[4] However, the AEO report projects less than 10% of electricity generation from renewable sources in 2050 in the region – a seemingly anomalous figure. AEO does project, though, that nationally 31% of electricity generation in 2050 will be from renewable resources.[5] Regardless of the differences in AEO's projection of electricity generation in 2050 from renewable resources, those projections are significantly lower than RMI's projection of electricity generation in New Jersey from renewable resources in 2050, i.e., 78% (the balance coming from biogas and nuclear).[6]

Consequently, it is reasonable to assume that higher renewable energy penetration levels with their concomitant effects on the need for greater control, monitoring and operating flexibility and sophistication will result in transmission and distribution costs potentially well above those estimated by EIA and used by RMI. Further, the AEO does not appear to account for the integration of meaningful levels of energy storage into the T&D grid given the lower level of renewable resources, while the IEP includes the deployment of 9 GW of batteries (which itself may not be sufficient, depending on how readily non-standard biogas or hydrogen based substitution for natural gas generation can be developed). This will further impact the T&D investment needed to maintain reliability and day to day operation of the grid.

RMI's estimates of costs associated with transmission and distribution due to increased renewable and battery penetration needed to be based on high level estimates such as the AEO figures cited above, as there are no projects, nor project-specific costs, yet identified. However, upgrades to the distribution system are likely to include broad hosting capacity, dynamic two-way flow, voltage protection, DER integration, ancillary service provision and other non-traditional products and services. While transmission and distribution system incremental costs are difficult to project, it is undeniable that significant investment beyond RMI's initial estimates would be required to replace and/or upgrade the current system to meet the objectives outline.

It is not inconceivable that State-wide transmission and distribution asset values could be almost double current net plant in service. This amount of system upgrade is a significant challenge. Finally, while RMI forecasts the need for 11,000 MWs of offshore wind by 2050,[7] it

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3 New Jersey IEP – Incorporation of stakeholder input and response to outstanding questions/requests, RMI, October 4, 2019, pg. 7

4 EIA, Annual Energy Outlook 2019 With Projections to 2050, Table 55.9, January 2019. https://www.eia.gov/outlooks/aeo/data/browser/#/?id=62-AEO2019&region=3-9&cases=ref2019
Note that it is not clear whether these costs are the basis for RMI's transmission and distribution cost estimates.

5 EIA, Annual Energy Outlook 2019 With Projections to 2050, January 2019 pg. 21

6 Webinar Presentation, slide 31

7 Webinar Presentation, slide 28

does not appear to adequately account for the costs of the transmission buildout that will inevitably be required to absorb, transmit and distribute that amount of generation. The AEO's cost estimates, which appear to reflect the cost of onshore wind, are based on demand (i.e., kwh), not on capacity. While a demand-based calculation may include some need for additional transmission, it likely does not include the impacts of 11 GW offshore wind injections on the bulk transmission system in New Jersey, since such costs are localized to those coastal areas of the state favorable to the location of offshore wind farms. Those costs are likely to be considerable. The projected 11 GW of offshore wind may require about thirty points of onshore interconnection, 1,700 miles of offshore transmission, and 900 miles of onshore transmission to interconnect to the existing bulk transmission system to make it flow-feasible and beneficial to all of the State.[8] Assuming an average of $5 million per mile of offshore and onshore transmission, the total transmission investment to serve offshore wind alone would be about $13.0 billion, i.e., $8.5 billion for offshore transmission and $4.5 billion in onshore transmission. (Some of the offshore transmission costs may be embedded in the assumed costs for offshore wind - both generation and offshore transmission facilities - in the RMI analysis.)

Energy Efficiency Deployment

Energy efficiency has been and will be a central focus of achieving the decarbonization objectives in NJ and all other regions pursuing such goals. However, efficiency efforts will need to shift from relatively operational changes, like upgrading lighting or other appliances with high efficiency replacements, to a greater emphasis on inducing large, discrete reductions in the energy demand from other major energy services, primarily space and water heating within residential and commercial buildings, with a focus on beneficial electrification. In addition to changing out that equipment, significant building retrofits to enable their use (*e.g.*, air ducting for heat pumps) and capital improvements to reduce the overall energy demand of these sectors will be required. These may, like most EE activities, "pay for themselves" within the economic lives of the equipment, but because they require large up-front capital expenditures and lifestyle changes, past experience suggests it will be much harder to induce. It does not appear that the IEP includes these significant building investments needed to transition this equipment.

RMI provides limited details on the growing share of energy efficiency opportunities. While existing programs aim for 2% reduction in annual electricity demand and 0.75% reductions in gas demand, RMI projects "accelerated efficiency."[9] Analysis by BPU consultant Optimal Energy on the maximum achievable energy efficiency potential in New Jersey found that 21% reductions in electricity demand (about 2% per year) could occur by 2029 relative to a baseline forecast. This savings involved the deployment of $9 billion through new construction, equipment replacement, and building retrofits with the majority of the costs ($5 billion) from residential and commercial retrofits.[10] The Optimal study does not provide the number of housing units or commercial buildings that would be required, or the scale-up of the energy

[8] One estimate found that 20 GW of offshore wind along the Atlantic seaboard near New Jersey will require about 3,000 miles of offshore transmission plus significant onshore upgrades and 50 landing points, which would amount to 1,700 miles of transmission and 28 landing spots for 11 GW in New Jersey. Pfeifenberger, et al, U.S. Offshore Wind Generation, Grid Constraints, and Transmission Needs, September 18, 2019, p. 17.

[9] Webinar Presentation, slide 14.

[10] Optimal Energy, Energy Efficiency Potential in New Jersey, May 24, 2019, slide 13.

retrofit workforce to achieve this level of penetration, but it is likely to be very significant. RMI appears to aim for even greater reductions, exceeding the maximum achievable potential identified in the New Jersey-specific Optimal study, which will require even greater efforts. Electric and gas utilities will need to take a leadership position for these efforts to be pursued in the most cost-effective manner.

Complexities of De-Gasification

One of the most difficult and likely contentious areas of policy included in the IEP and acknowledged in the draft EMP is the intent to drastically reduce natural gas usage outside of the electric generation sector and to replace it within the electric sector with new biogas or H2 generation. Reducing natural gas consumption in end-use applications will be an enormously complex, time-intensive and costly undertaking. It will require considerable regulatory and legal guidance to make this occur.

As also mentioned above regarding EE, additional consideration of the demand side is required. The RMI report seems to assume that gas appliances can naturally be replaced with electric ones, such as heat pumps or electric water heaters, as the appliances reach their normal obsolescence. In fact, RMI notes that "[i]n most scenarios, we assume that users will choose the most efficient option when they replace their equipment."[11] Even if it is true that the electric alternative assumed by RMI saves money for the consumer over the long term, there are significant barriers to conversion, due to general reluctance to change, high up front appliance costs, lack of familiarity with the new electric technology, and asset integration costs into the dwelling or business that are not part of the direct cost of the new appliance.

For example, homes with gas-fired boilers and no central air conditioning may need tens of thousands of dollars in new ducting to take advantage of a heat pump. In New Jersey, 80% of homes (3.5 million residential customers) have natural gas heating and about 60% have air conditioning (as of the 2009 EIA Residential Energy Consumption Survey).[12] This suggests that at least 20% could need new ducting. With a potential cost of roughly $5,000[13] for retrofitting the dwelling this equates to a total cost of $3.5 billion just to make the homes heat-pump compatible. The heat pumps themselves can be several times this cost: a 2019 NYSERDA study estimated single-family home costs of $13,000 to $18,000 for Air Source Heat Pumps (ASHPs) and $35,000 to $40,000 for Ground Source Heat Pumps (GSHPs). This suggests heat pump costs alone could reach several tens of billions of dollars for the customers. Lack of customer liquidity alone (to finance the upgrades) may block a significant number of such conversions, or at least significantly delay them. It is not clear that these costs have been considered.

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[11] New Jersey IEP – Incorporation of stakeholder input and response to outstanding questions/requests, RMI, October 4, 2019, pg. 7

[12] EIA, Household Energy Use in New Jersey: A closer look at residential energy consumption, https://www.eia.gov/consumption/residential/reports/2009/state_briefs/pdf/NJ.pdf.

[13] https://budgeting.thenest.com/much-cost-add-air-conditioning-house-22940.html -- describes air ducting as costing $2,000 - $7,000 for a 2000 square foot house, depending on how it is configured. Other studies suggest $3,000-$10,000 for these conversions. (https://mspplumbingheatingair.com/blog/whats-the-cost-of-adding-air-conditioning-to-a-home-with-no-ductwork)

Further, at least low-income customers will need assistance from the utility or the state to handle the financial burdens of such conversions even after installation. For example, a recent analysis by NYSERDA in New York found that replacing heating oil in single family homes with ASHPs results in a lifetime cost increase of $2,000 and $4,000 for GSHPs.[14] A next step in pursuing this goal would be for the BPU to provide clarity around how utilities may help finance (or own, or own portions of) these assets to make their broad acquisition possible.

Additionally, there will be a complex problem of how to significantly reduce natural gas use economically and fairly on the supply side. If gas delivery assets are used less and less but remain needed until the last moment when the system is "turned off" there will be a dramatic increase in fixed costs per unit of delivered gas, likely causing significant disputes regarding cost recovery. This will require better rate design on the gas side, *e.g.*, fixed charges that are not by-passable, and eventually stranded cost recovery assurances and mechanisms, such as state support and authorization for securitization of sunk costs.

As an example of potential cost shifting, initial results for a study on the future of gas distribution in California finds that natural gas customers who do not take significant steps to electrify will find their gas bills increase 2.5 times by 2050.[15] Note that scheduling degasification in local neighborhoods is challenging. One of the primary approaches considered in the study to reduce costs is to implement "targeted retirements" of the gas distribution system in which the distribution system is retired neighborhood by neighborhood to avoid on-going costs. Even with these changes, gas bills will still increase dramatically. This study highlights the need to begin planning for the future of the distribution system and the role it will play in the transition to a decarbonized economy.

Finally, RMI's recommendation to retain the natural gas generation assets for use with biogas or H2 is important in light of how difficult it would be to cope with a "drought" of renewable energy production that could last for days or weeks. These gaps could not be addressed economically with battery storage as recognized by RMI, although RMI does assume the availability of 36-hour batteries for Variation 5 even though no such battery storage capacity currently exists. Current estimates are that the costs (and electric supply requirements) of making biogas or H2 are very high, perhaps 10 times or more higher per MMBtu than natural gas currently costs. These costs may fall materially over time, but not soon. Therefore, retention of natural gas generation "as is" may be much more economical, with little carbon footprint if such plants are only used under stress conditions with low capacity factors.

A critical next step will be more closely evaluating the most economical path for degasification, because if is to actually occur, developing the transition mechanisms, the replacement fuel infrastructure, and the regulatory and legal requirements, is a daunting task that may itself require decades to accomplish.

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[14] NYSERDA, New Efficiency: New York Analysis of Residential Heat Pump Potential and Economics, January 2019, pg. S-3.

[15] Energy and Environmental Economics, Draft Results: Future of Natural Gas Distribution in California, CEC PIER-16-011, June 6, 2019, pg. 28-30.

Transition Costs and Processes

A theme arising in all of the above observations about possible missing or understated elements in the IEP is that these gaps are indicative of the administrative and financial complexity that will accompany achieving NJ's clean energy goals. The IEP necessarily has not looked closely at the implementation details, many of which may involve transfer payments from one New Jersey entity to another (e.g., subsidies paid by tax credits or utility incentive payments that are socialized to non-participants). That is, they will not impose a net cost, but they will involve an out of pocket payment, or gross cost, on whoever sponsors the change. But it matters who will be those sponsors and how many of what kinds of activities will be pushed in different ways.

For instance, if the state plan were to rely primarily on carbon prices to motivate change, as is often advocated, those prices may have to become quite high after the industries with "easy" substitution like electric power (which can substitute away from carbon-intensive generation) are weeded out, leaving only users for whom carbon input costs are a tiny part of their products' value-added. For instance, many industrial products are like this, and for them even a carbon price of $100s per ton might only add a few percent to their final costs -- so they might not change their production or energy supply. In contrast, they might be more influenced by mandates and technology control policies that can be targeted at those specific applications and subsidized as needed with tax deductions or direct payments. Indeed, a combination of price-induced and directed mandates will likely be part of the solution. But the precise mix and form of those price and non-price incentives will have large implications for the way the New Jersey EMP unfolds, in two respects: it will determine who is responsible for paying the transition costs, and it will also affect how demand patterns change and how much control the state has over hitting the targets. That is, the path may go in different directions depending on what incentive and enforcement mechanisms are used. This means it will be important to have discussions soon about what mechanisms will be applied, by whom, and for what purposes. Understandably, the IEP is silent on this issue, but now it becomes ripe.

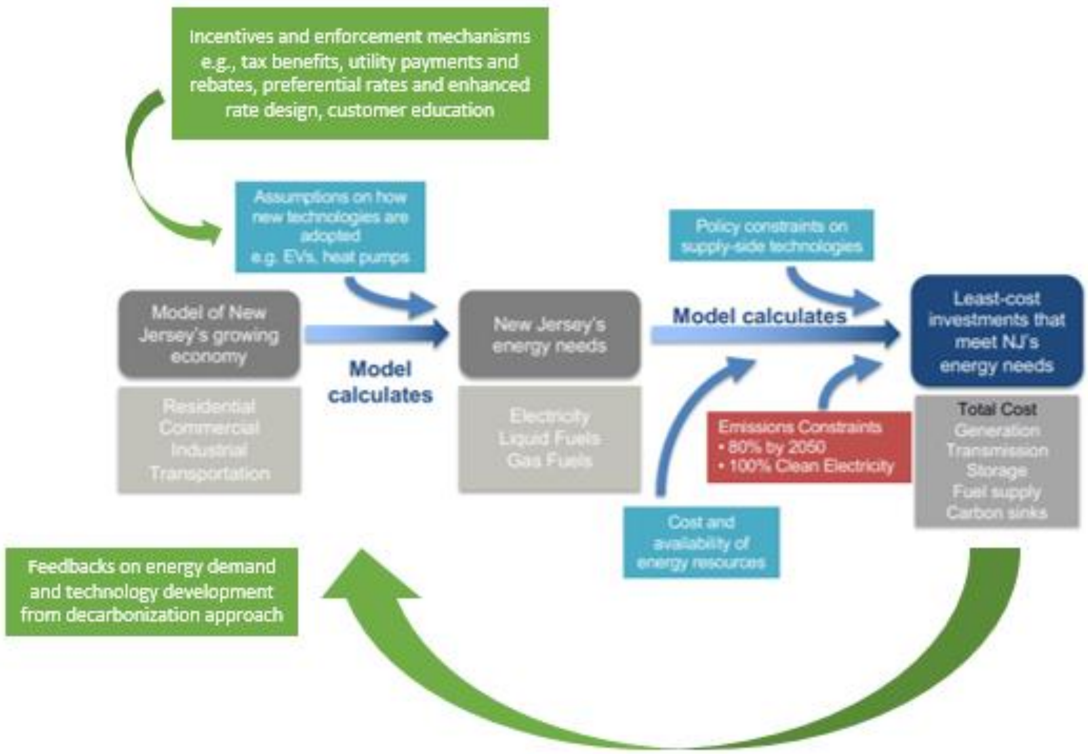
Other Costs and Challenges

There a number of other costs and challenges worth noting because they have gross cost or cost-shifting impacts or are complex from an implementation perspective. For example, one category of costs not identified by RMI is that associated with lost tax receipts due to drastically reduced gasoline consumption. New Jersey currently imposes taxes of 41.4 cents per gallon of gasoline, generating billions of dollars in tax receipts. It would be unusual and unexpected if these tax receipts, diminished in amount over time due to reduced gasoline consumption, in whole or part, were not recouped via a new mechanism.

Siting requirements are a challenge for almost all renewables. The amount of solar generation projected to be installed in New Jersey is a concern given the dense population of the state, combined with its established policy against siting solar on farmland. RMI has projected that the least cost plan will require about 30,000 MWs of solar capacity. While some of this capacity may be placed on brownfields and landfill sites, it is instructive to note that at 5 acres per MW it would take about 234 square miles of land to accommodate that capacity.

Electrification of some industrial applications will be especially difficult because they often require very high temperature processes that are hard for electric furnaces to achieve (e.g., chemicals, the largest sector of New Jersey's business economy). The BPU should consider what is expected of these industries, which should be encouraged to continue operating in New Jersey.

The implications of these major changes to the system, should be examined iteratively (as shown in RMI modeling approach figure[16] below, modified with new green boxes and arrows to reflect the demand feedback loop as well as the need for an active policy to specify the incentive and enforcement mechanisms that will shape customer adoption and prices). These implications are likely to have a significant impact on how policymakers and utilities choose to cover the costs, either through the provision of electricity (e.g., retail rates, rebates) or government programs funded through taxes.



Note: Green boxes and arrows added to figure included in Nov 1 materials.

[16] Webinar Presentation, slide 12