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Optimizing New York’s Reforming the Energy Vision

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Abstract

Similar to other efforts worldwide, New York’s Reforming the Energy Vision (NY REV) is an ambitious initiative to fundamentally reorient the State’s power sector from a primarily centralized system to a distributed one. Its success depends on the Distribution System Implementation Plan (DSIP), which in turn depends on which proposals for distributed energy resources (DERs) and utility distribution assets are selected to constitute the plan. The selection approach uses a benefit-cost analysis (BCA), which will not be sufficient to achieve an optimal DSIP. Instead, an optimization approach should be used, phased in to ensure its success and not delay the Commission’s initiative.

Keywords

Distributed energy resources, Benefit-cost analysis, optimization, New York Reforming the Energy Vision

Highlights

- Expanding the scale and scope of distributed energy resources is a challenging and difficult problem.
- Benefit-cost analysis will be quickly overwhelmed if it is used to determine distribution system implementation plans as proposed by the New York Reforming the Energy Vision.
- A four step phased approach to replace benefit-cost analysis with an optimization approach is proposed.
In 2014, New York State initiated its Reforming the Energy Vision (NY REV) to fundamentally reshape its electric power system from a primarily centralized grid to a decentralized one. Its goal is to substantially improve the system’s performance across six objectives: customer bill knowledge, market animation and leverage, system wide efficiency, fuel and resource diversity, system reliability and resiliency, and reduction of carbon emissions (NYPSC 2015, p. 4). The means by which New York will make this transformation is to “…build a lasting market structure to support investment in, and the adoption of, clean energy at scale” (p. 18) by integrating distributed energy resources (DERs) into the planning and operation of electric distribution systems.

New York is not alone in its efforts; similar developments to make distribution planning more transparent and integrated are occurring in California (CPUC Distribution Resources Plan Order 2014), Hawaii (Order No. 32053), Massachusetts (Grid Modernization and Integrating Distributed Generation), and Minnesota (e21 Initiative) as well as other countries (Dierk Bauknecht, 2011) such as the United Kingdom (Innovation Funding Incentive and Registered Power Zones), Denmark (System 21, Cell Controller Pilot Project and EcoGrid) etc. (p. 13).

The New York Public Service Commission (NYPSC) proposes to have electric distribution companies (EDCs) initially be the Distribution System Platform providers (DSP), which will develop a multiyear Distribution System Implementation Plan (DSIP) filed with the Commission (p. 32). At first, the plan will be combined with an open access tariff based upon “system value” (p. 66-7), not with auctions (p. 44). The DSIP can be thought as an integrated resource plan (IRP) but at the distribution level. The Commission sees a need “to achieve optimal systems efficiencies” (p. 3) and “develop optimal planning around new models as soon as possible” (p. 20).

Other initiatives must be accomplished in tandem in order for this open access tariff procurement model to be achieved. One initiative is implementing a performance based rate structure for EDCs so that their financial incentives are indifferent to utility and DER solutions, as the Commission expects a role for both (NYS DPS Staff, 2014, p. 47 and p. 58). Another is determining the technological platform and infrastructure that DERs can expect to have available to leverage their proposals (NYPSC 2015, p. 96). Finally, since there is a considerable range of views on both the categories of costs and benefits along with their particular values, more work is needed to develop the specifics of the benefit-cost analysis (BCA), the methodology to be used to develop the DSPs (NYS DPS Staff, 2014, pp. 16-18). The review of the literature for this policy note did not reveal why the NYPSC chose BCA, but perhaps the combination of familiarity and experience with it, especially in the context of investment approval for energy efficiency programs, along with the simplicity of BCA led to the NYPSC to extend it in order to select proposals.

The focus of this policy note is on the use of a BCA methodology to determine what combinations of network infrastructure and DER proposals should be part of the DSIP. The claim of this policy note is that the BCA will not be able to handle the evaluation of proposals and therefore should be replaced by an optimization approach that is phased in over time. This
policy note does not discuss how NY REV interacts and reverses New York’s wholesale and retail electricity markets by implementing a centralized procurement system along the lines of integrated resource planning in order to accomplish its goals of decentralizing its power system. Moreover, this note does not discuss the broader and critical issues of whether the NY REV effort overall will result in actual benefits to consumers, whether consumers are bearing undue risks associated with this effort, and whether many consumers (particularly retail and smaller commercial and industrial consumers), desire the additional complications under NY REV. Though analyzing these broader concerns is beyond the scope of this policy note, the authors suggest that such analysis would benefit from having a quantitative methodology such as the proposed optimization approach, which is capable of both analyzing DSIPs within the NY REV context and aiding in broader analyses of whether NY REV and similar efforts are desirable.

Presumably, the intent of the NYPSC is to conduct a BCA for each proposal, rank them from highest to lowest, and then procure all proposals with a benefit-cost ratio above one. There are several problems with this BCA Rank approach. There may not be sufficient budget to implement all projects whose BCA exceeds one. If the BCA includes non-monetized benefits and costs, as seems to be indicated by the NY DPS Staff (p. 17-18), then it is entirely possible that the cost to retail electricity consumers would increase even though all of the accepted proposals have benefits that exceed their costs, including heretofore non-monetized social benefits and costs. Recall that an important element of the NY REV is stabilizing customer utility bills (NYPSC, 2015, p. 20). Thus, there may have to be a cutoff regarding the number of proposals whose benefits exceed their costs due to the associated impact on utility bills.

One could modify this BCA Rank approach and adopt all measures for which the BCA exceeds one and the total cost is less than a pre-specified impact (including requiring reductions) on utility bills. Under this BCA Constraint approach, however, it is not guaranteed that selecting the highest benefit-to-cost ratio proposals that do not exceed the utility-bill-impact constraint will result in the most efficient outcome. The efficient use of society’s resources (such as maximizing social welfare) occurs not by implementing the maximum number of proposals whose BCA ratios exceed one, but by selecting the combination of proposals that maximize their collective net present value (NPV) (Boardman et al, 2008). Once one or more constraints are imposed on the selection process, it may be preferable from a social welfare objective to select a proposal with a lower benefit-cost ratio but a higher NPV (Proposal A) than one with the reverse (Proposal B). If one or more constraints prevent the selection of both Proposals A and B, then the BCA Constraint approach would give the incorrect result.

The BCA approach should be converted to a NPV approach. Doing so addresses the fact that benefit-cost ratio criteria can lead to an incorrect result (Hendrickson and Matthews, 2011), but it does not ignore the fact that once a constraint is imposed upon the NPV Constraint approach (such as constraints on utility bills, environmental emissions, distributional impacts, etc.) then it is no longer the case that the most efficient outcome is to rank all of the proposals based upon their NPV and then keep selecting projects so long as their NPV exceeds zero if and until the most limiting constraint is met. Using the utility bill constraint as an example, a proposal with a relatively high NPV may also have a substantial upward pressure on the budget. It may be more efficient to select several other projects whose NPVs are less attractive but have a substantially smaller budgetary impact. One could construct a situation in which a proposal has a negative
NPV but actually reduces rather than increases contribution to the constraint, such as a demand response proposal that reduces customers’ bills but has a negative NPV.

Furthermore, proposals may interact with each other. In some cases they are substitutes (using more of one proposal means that it is cost-effective to have less of another) and in other situations they are complements (using more of one means that it is cost-effective to have more of another). The fundamental premise of NY REV is that there are many efficiency gains in achieving the optimal combination of utility and DER investments (NYPSC, 2015, pp. 10-12). To help understand how to integrate DER on a larger scale (and presumably the multiple and complex interactions), the NYPSC has directed the utilities to develop demonstration projects (p. 115).

To obtain an optimal solution, a mechanism is needed to identify and quantify all of the possible interactions among proposals, and then to calculate the combined NPV of all possible combinations of proposals, which can quickly become overwhelming. The total number, \( N \), of possible combinations given \( n \) proposed projects is shown by formula (1):

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N = \sum (n, i),
\]

where \((n, i)\) is read as “n choose i” and is the number of combinations that exist when choosing \( i \) objects from \( N \) and the summation occurs from \( i = 1 \) to \( n \).

To illustrate how quickly the number of possible combinations that would need to be evaluated increases with the number of proposed projects, when \( n \) equals 10, \( N \) equals 1,023, and when \( n \) equals 20, \( N \) equals 1,048,575.

Given the number of combinations that need to be considered, it may be tempting for the DSP to reduce its analytical burden by simplifying assumed interactions among proposals. Doing so, however, creates several important risks. The first risk is allowing for combinations of solutions that are collectively not technically feasible. The second risk is having a DSIP that is less efficient than possible. The last risk involves opening the door to regulatory and legal challenges to the DSIP by those whose proposals were not selected and who might be willing to challenge the ability of the DSP to accurately evaluate their proposal. Many stakeholders commented that they do not think the utilities should be the DSP (pp. 46-48) and therefore are already skeptical. Simplifying interactions to reduce the analytical burden on the DSP may obscure the transparency that the NY REV seeks in the formation of the DSIP (NYPSC Staff, 2014, p. 15). In theory, the DSP would be governed by a new ratemaking structure that makes it indifferent to both the type of DERs that are being procured and to DER versus traditional utility solutions. Developing and implementing such a neutral ratemaking structure that is neutral in both reality and perception is a monumental task. Stakeholders are likely to challenge this notion in order to advance their proposals.

In addition, the \textit{NPV Constraint} approach should account for the downward sloping “demand curve” for goods and services such as electricity, reliability, resiliency, and emissions. The term “demand curve” does not strictly represent a customer’s demand in light of given price and quantity combinations, but rather it is a schedule based on projected resource needs and
estimated costs. If NPVs are conducted on individual projects, they do not capture the fact that the value of having more of a good or service X decreases the marginal value to consumers. The NPV for each proposal assumes a fixed value for the good or service in question. For instance, the NYISO, among others, has a demand curve for generation adequacy as part of its tariffs regarding its installed capacity markets, as well as for its other products and services. As reserve margins increase (decrease), the incremental value of having more (less) generation decreases (increases). When the value placed on providing a good or service is a function of how many of those goods and services are produced, then the NPV value of each proposal is now a function of all of the other proposals. So not only must each combination of proposals be considered, but each proposal’s NPV for each combination must be re-calculated to account for that proposal’s interaction with all of the other proposals being considered as part of that specific combination. It is no longer a matter of calculating N NPVs, but rather potentially calculating different NPVs for each proposal for each (n,i) combination.

Up until now, the discussion has focused on one constraint, but in reality there will be multiple constraints falling into various categories such as technical constraints, time constraints, policy constraints, and so forth. The REV proceeding has listed six policy objectives, all of which are potential policy constraints (NYPSC, 2015, p. 4). With multiple constraints and the potential interaction among proposals on each of the constraints, in addition to all of the complexities discussed above, the NPV Constraint approach is not practical unless it is formulated and solved as an optimization problem. A Phased Optimization approach is proposed to resolve these difficulties.

Step one of this phased approach is to develop, in parallel with the NPV approach, the formal optimization problem statement. As REV ramps up, a NPV method (although not ideal) is likely to be sufficient to conduct the necessary analyses for pilot projects and relatively few numbers of DER projects. As the DSP goes about identifying, characterizing, and assessing projects for its DSIP, this is an excellent opportunity to simultaneously develop the optimization framework, problem statement, assumptions, and data.

Step two is to use the Optimization approach to inform the DSIP but not be dispositive. The DSIP would be determined as it was prior to the development of the optimization model, but now it can be compared to the results from the optimization. This is important not only as part of testing the optimization approach but also as a means of probing the DSIP itself in order to make sure it is cost-effective, robust, and transparent.

Step three is to use the Optimization approach as the basis of determining the DSIP. At this point, backed by testing and comparisons with past DSIPs, the NYPSC, the DSP, and stakeholders should have sufficient confidence in the optimization model.

Regarding step four, if the NYPSC chooses to move to an auction mechanism, it would be preferable to use the optimization model as the basis to do so. This would be analogous to what happened with optimization models used by power pools, such as the former New York Power Pool, that became the foundation to set prices in the real-time and day-ahead markets.
The advantage of phasing in the proposed Optimization approach versus a one-step implementation is that if difficulties arise, the NY REV can still proceed. If an Optimization approach can be successfully developed and implemented, it will likely improve upon the results of conducting NPVs, and may reduce disputes and associated litigation potentially arising out of the NPV approach, which introduces judgment and discretion by the DSP.

Developing an Optimization approach is by no means a straightforward or simple task. It requires putting into mathematical equations the objectives and policy constraints desired by the NYPSC, along with developing the precise mathematical formulations of the technical constraints among a wide range of utility and DER solutions, some of which are undergoing major technological advances. The DSIP problem is an example of a multi-objective, constrained optimization under uncertainty, a notoriously difficult problem to solve and whose tractability depends, in part, on how it is formulated.

To provide one example of the associated difficulty in problem formulation, policy objectives can either be incorporated into the objective function of the optimization problem or be formulated as constraints. Determining which approach is preferable depends in part on how easy it is to monetize an objective. Those objectives that are easy to monetize should be considered as part of the objective function. Those policy objectives that are hard to translate into a dollar cost or benefit, such as the value of not having utility bills increase, perhaps are better considered as constraints that the DSIP must satisfy.

Ideally, the determination of the common technical platform on which utility and DER solutions would compete to become part of the DSIP should be part of the formulation of the DSIP itself via the Optimization approach, as opposed to a decision made prior to the determination of the first DSIP. The underlying technology platform is likely to evolve over time as experience accumulates and technologies advance, opening up the opportunity to include future technology platform enhancements as part of the Optimization approach.

The NYPSC has proposed an ambitious policy to fundamentally reorient the State’s power sector from a primarily centralized system to a distributed one. The success of this effort depends on the NYPSC’s cornerstone initiative, the DSIP. The DSIP’s success depends on which proposals are selected. A BCA approach will not be sufficient to achieve an optimal DSIP that the Commission envisions and instead should be replaced by a phased Optimization approach.
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