Evolving Paradigms in State-Level Integrated Resource Planning

by

Nina Peluso

B.A., The Gerald R. Ford School of Public Policy, The University of Michigan (2016)

Submitted to the Institute for Data, Systems, and Society
in partial fulfillment of the requirements for the degree of

Master of Science in Technology and Policy

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

June 2021

Author____

Technology and Policy Program
May 14, 2021

Certified by____

Michael Kearney
Executive Director, The Roosevelt Project
Thesis Supervisor

Accepted by____

Noelle Selin
Director, Technology and Policy Program
Associate Professor, Institute for Data, Systems, and Society and Department of
Earth, Atmospheric, and Planetary Science

Evolving Paradigms in State-Level Integrated Resource Planning

by

Nina Peluso

Submitted to the Institute for Data, Systems, and Society
on May 14, 2021, in partial fulfillment of the
requirements for the degree of
Master of Science in Technology and Policy

Abstract

As global energy systems electrify, long-term planning processes are evolving to allow flexible economic analysis and acknowledge rapid financial and operational transformation. State-level integrated resource planning (IRP) processes allow oversight of long-term electric utility resource planning. Yet, outdated rules, procedures, and practices may impede utilities in planning for a new energy future. Is the IRP process constrained by technical modeling decisions, when it ought to serve as a platform for stakeholders to shape optimal and just electricity system outcomes?

This paper assesses the state of integrated resource planning to inform utility planners, commissioners, and their staffs, along with the array of advocates that participate in such proceedings. I employ a case study methodology to assess docket filings and other relevant materials in recent IRP proceedings for four major utilities in Michigan, Georgia, New Mexico, and North Carolina. Section 3 details modeling software selection and use for those four cases. Section 4 uses capacity value assumptions to illuminate the iterative process around establishing model input assumptions. Section 5 takes a broader view of nascent efforts to include equity and justice into IRP processes.

Consistent commission oversight and robust stakeholder processes are integral to ensure that utilities' integrated resource plans reflect the pace of change in the U.S. energy sector. Policymakers can encourage advanced modeling methodologies (software, settings, and assumptions) through three channels: (1) written IRP rules, (2) commission procedure, and (3) intervention in utility processes. Furthermore, as equity and justice come to the forefront of utility planning, policymakers should consider intervenor compensation programs, energy justice assessments, and forms of public ownership to incorporate energy justice principles into the planning process.

Thesis Supervisor: Michael Kearney
Title: Executive Director, The Roosevelt Project

Acknowledgements

To my advisor, Michael Kearney, my most sincere thanks. Your guidance and support have made my time at MIT rewarding and productive. Your willingness to constantly dig deeper and re-assess ensured that our work focused on answering the important questions.

Thank you also to the entire Roosevelt Project team. To David Foster, who is the ultimate model for compassion and professionalism. To Chris Knittel, the CEEPR staff, and the inspiring group of scholars who comprise our team. I was honored to work with you all.

To the TPP community, staff, and my 2021 cohort, thank you for making the in-person time we did have memorable, and for making virtual grad school bearable. I look forward to sharing your community for years to come. A special thanks to Sade, Erin, Axelle, and Lama for providing daily solace, laughter, and inspiration.

Many thanks to the MIT Policy Hackathon organizing committee, and to our participants, who displayed unmatched passion and enthusiasm in the midst of a difficult year. Thanks also to my fellow student organizers at the MIT Energy Conference, *Science Policy Review*, and Technology & Policy Student Society.

This thesis was inspired in large part by my many past colleagues who do the hard, daily work of making our energy system function. Thank you to my former colleagues at Synapse Energy Economics, DTE Energy, and ICF, who demonstrate a true commitment to energy wonkiness in service of the public interest.

To my parents, thank you for your unconditional love and unbounded faith in me. To my friends and family, thank you for your company and encouragement. And to Harry, my partner in life and long walks around Allston, the biggest thanks.

Contents

List of Figures

List of Tables

1. Introduction

Across the United States, integrated resource planning (IRP) processes determine the composition of our electricity system. These recurring proceedings, overseen by state public utility commissions, force electric utilities to publicly consider whether their current system serves their customers, and requires them to demonstrate a path forward that maintains reliable and affordable service. Though IRP proceedings exist in the public sphere, they are largely invisible to all but the most entrenched energy policy actors. As climate change spurs rapid transformation in the energy sector, we must re-assess the processes that already exist to protect consumers and ensure that they are adaptable in the face of change.

In *All We Can Save*[1] Maggie Thomas encourages us to embrace climate policy "as a living document – an evolving, improving set of ideas."[2] I propose approaching IRP policy with the same mindset. As climate activism reveals previously unconsidered elements of what it means to serve the public good, do IRP processes support productive change or do they inhibit participation? How can energy policy advocates and utilities collaborate to translate the deeply technical undertaking of utility resource planning into positive outcomes for the communities they serve?

By assessing the current state of integrated resource planning, I aim to illuminate successful or outdated elements of these intricate commission proceedings. Ultimately, IRP differs for each state and each electric utility, but by comparing them we can identify the modes in both technical analysis and social advocacy that strengthen outcomes for communities. I am not interested in selecting a "best" approach to integrated resource planning. Rather, this paper aims to clarify opaque integrated resource planning processes, to provide guidance for interacting with them, and

---

[1] *All We Can Save* is a 2020 essay collection edited by Ayana Elizabeth Johnson and Katherine Wilkinson that compiles thoughts from leading women across the environmental movement.
[2] Maggie Thomas, "The Politics of Policy."

ultimately, to promote understanding of the contradictions inherent in building a clean, equitable, and reliable electrical grid.

Section 1 of this paper contextualizes the history of integrated resource planning, explains the diverse set of stakeholders involved, and centers the utility mission to serve the public interest. Section 2 introduces the detailed case study methodology I employ, primarily assessing docket filings in the IRP proceedings for four major state utilities. In section 3, I report on modeling software selection and use for those four case study areas, and document any relevant analytical changes within the period. In section 4, I summarize key filings and comments related to capacity value assumptions for the four cases to illuminate the iterative process around model input assumption development. In section 5, I step away from the case study model to take a broader view of nascent efforts to include equity and justice in IRP processes.

I find that commission oversight and robust stakeholder processes are integral to ensure that utility integrated resource plans reflect the pace of change in the U.S. energy sector. State processes that correctly balance commission oversight and utility deference lead to productive changes to modeling methodologies. Iterative decision-making processes around model input assumptions require renewed attention. Using capacity values as an example, I identify emerging techniques that better reflect clean energy resources, and the utility or advocate attitudes that may constrain them. Finally, as equity and justice come to the forefront of utility planning, I outline three areas where IRP processes can better incorporate those principles: (1) intervenor compensation programs, (2) energy justice assessments, and (3) discussions around public ownership.

1.1. Utility Regulation & the Emergence of Integrated Resource Planning

In the early 1900s, as electricity service flourished, state governments faced the critical question of how to regulate a service that constituted a new type of public good. Electric utilities benefit from enormous economies of scale and must make large capital expenditures in order to provide reliable service. Without utilities, in a completely free market, electricity might be too expensive for individual consumers. Thus, to ensure a reliable and affordable flow of electricity, states designated monopoly power to their local utilities, and formed state-level regulatory bodies to oversee their operation. Eventually, a set of regulatory structures emerged to facilitate energy sharing between separate vertically integrated, investor-owned utilities (IOUs), as well as other utility models (e.g., power pools and municipal power agencies). Over the past few decades, utility regulation has shifted regionally to encourage competition or de-regulate market structures. Ultimately, many states still rely on traditional regulatory structures, and utilities operate as highly regulated monopolies.[3]

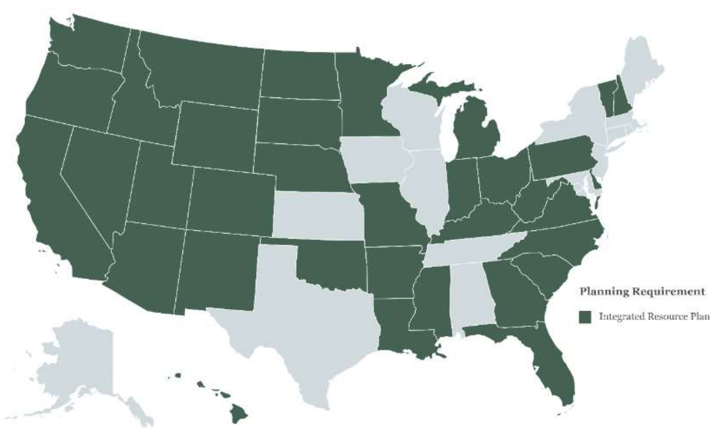
State policymakers developed integrated resource planning (IRP) processes to ensure that utilities were planning for major capital investments with market efficiency and consumer cost in mind. IRPs serve several purposes, but primarily function to ensure thoughtful planning on the future of utility systems and to make that process transparent to state regulators (and, thus, open to intervention). As with most utility business functions, the administrative effort required to develop an IRP is integrated into that utility's rate base – in other words, the utility can recover any costs associated with preparing the IRP. IRPs reduce informational asymmetries between electric utilities, their regulators, and any other stakeholders invested in the outcome, primarily utility customers. The IRP process is just one of many mechanisms designed to guarantee oversight of these natural monopolies.

IRP processes play out differently across states and jurisdictions based on differences in initial rulemaking and the relative strength of utility commission oversight. Generally, there is a standard sequence to IRP proceedings, though some states diverge in implementation. First, the utility initiates a comprehensive economic planning process. The utility then works to refine their

[3] Federal Energy Regulatory Commission, "Energy Primer: A Handbook for Energy Market Basics."

planning analysis in concert with interested stakeholders, via a set of public workshops and/or opportunities for public comment. Independent monitors or consumer advocates may also oversee the process. Following the utility's release of its draft integrated resource plan, the intervention stage, which plays out largely within one designated utility commission docket, provides interested parties (intervenors) with an opportunity to assess and then affirm or critique the published plan. Through this iterative process of comments from intervenors, commission staff and the utility, the commission makes a final order accepting or denying the proposed plan. The final order has different consequences in different jurisdictions, but, at its simplest, an approved IRP indicates the commission's approval of the utility's plan.

Figure 1. U.S. States with Integrated Resource Planning Processes[4]



At the latest count, 36 U.S. states require utilities to file some kind of integrated resource plan.[5] There's some alignment with ISO/RTO (independent system operator/regional transmission organization) areas and de-regulated markets. Texas and New York each embody their own

[4] Girouard, "Understanding IRPs."
[5] Girouard.

markets, and thus, rely on other planning mechanisms. Similarly, most states in New England, which is fully deregulated, do not rely on IRPs.

Most IRP processes were initiated in the 1980s and 1990s via a patchwork process of legislation and regulatory refinement. Some attribute this emergence to a renewed push toward advocacy in the energy sector in the late 1980s.[6] Accordingly, states have a variety of integrated resource planning paradigms and abide by different structures, primarily a set of written regulations governed by state utility commissions accompanied by some legislative guidance. Some IRP rules have been adjusted over time to adapt to developments in electrical delivery and service. Public utility commissions often initiate these changes themselves, but change can also arise from state legislative action, as was the case in Michigan in 2017, discussed later in this paper. Either way, in order to be effective at driving comprehensive and reasonable planning, IRP rules should be reevaluated on a regular basis as the energy system undergoes a major clean energy transition.[7]

When considering the impact of IRP processes, it is crucial to revisit the standards that allow regulated utilities to continue acting as natural monopolies – namely, their responsibility to serve the public interest. The concept of the public interest is generally traced to *Munn v. Illinois,* an 1876 case that surrounded the regulation of grain storage in Illinois. In that case, the court determined which businesses are "clothed with a public interest" and subsequently, that businesses clothed in the public interest are subject to regulation by the public to promote the public good.[8] As states established utility commissions, policymakers wrote concepts of public interest into the statutes governing them. Jeremy Knee finds that most of the language related to public interest in state regulation "boils down to three interrelated principles: (1) cost minimization, (2) nondiscrimination, and (3) service adequacy."[9]

---

[6] Duane, "Regulation's Rationale."
[7] Wilson and Biewald, "Best Practices in Electric Utility Integrated Resource Planning."
[8] "Munn v. Illinois, 94 U.S. 113 (1876)."
[9] Knee, "Rational Electricity Regulation."

These three principles of public interest take on different meanings depending on how the statute is written – in some states cost minimization will take precedence while in other service adequacy is more central. Take the rules in California and Michigan as an example. In California, regulators are directed to:

> prescribe such reasonable, uniform and nondiscriminatory rules in the interest and aid of public health, security, convenience and general welfare as, in its opinion, are required by public convenience and necessity.[10]

Meanwhile, Michigan's statute mandates that regulators "ensure that rates, terms, and conditions are just and reasonable and shall consider the interests of the attaching parties' customers as well as the utility and its customers."[11] California's rule requires a distinct focus on public health and general welfare, whereas Michigan's is limited to the disputable phrase "just and reasonable." How do these statutory requirements influence utility filings (such as an integrated resource plan)? And are there external pressures that drive utilities to consider factors around equity beyond cost minimization, nondiscrimination, and service adequacy? How might the success of environmental and climate advocacy shape what a utility deems as being in the public interest?

1.2. Key Stakeholders in IRP Processes

At its core, integrated resource planning requires action from electric utilities and the state commissions that regulate them. Traditional IOUs are the most common utilities governed by IRP processes, but some municipal and cooperative utilities must also submit plans on a recurring basis (though in those cases, there may not be as stringent obligations). Utility employees coordinate internally to assess the current state of their system, analyze potential forward scenarios, and draft final reports. Utility commissions are led by either appointed or elected representatives with existing knowledge of the political and/or technical aspects of the state's specific electricity system and are supported by a technical and regulatory staff. While these two parties dominate IRP

[10] "CAL. PUB. UTIL. CODE § 202."
[11] "Michigan Compiled Laws § 460.6g."

proceedings there is a central role for external stakeholders, as outlined in **Table 1** below. This is a simplified explanation of the nuanced roles that consumer advocates and external intervenors take on in IRP proceedings.

Table 1. Stakeholders in IRP Processes

Stakeholder	Role in the IRP Process
Electric Utility	▪ Assess system, perform analysis, draft reports. ▪ Respond to regulatory and intervenor questions & comments.
Utility Commission	▪ Approve or reject the final published plan. ▪ Ask for clarification and suggest relevant improvements.
Consumer Advocate	▪ Advocate for the forward plan that best serves electricity consumers. ▪ Advocate for the least-cost plan for consumers (in select states).
Intervenors	▪ Advocate for the forward plan that best serves the party they represent (e.g., a resource developer, a group of consumers, a trade association)

Overall, IRPs are just one tool used to oversee utilities, and they provide key pathways for public advocacy and external assessment of utility performance. By their very nature, IRP processes defer heavily to utility expertise. With few exceptions, utilities have the power to define their systems – which consumers they serve, how they serve those consumers, and predict how much operation will cost them, and ultimately the consumer. Utilities have the most expertise in the technical and financial operation of their organizations, so they are the default knowledge-bearer. Yet, IRP processes require predictive modeling years into the future, and prediction requires countless assumptions about future operations.

In reality, many of the default assumptions that go into integrated resource plans are subject to strong debate, even within utilities themselves. Take, for example, controversies around load forecasting. In order to determine the best path to providing electricity to consumers, utilities must first determine how much electricity their consumers will demand in the future. These demand (or load) forecasts are the foundation of integrated resource planning analysis and are hotly contested. Utilities use a variety of different methodologies to predict future load, from simple to complex. In a recent review of load forecasts developed for IRPs, Caravallo et. al. found that all but one of the utilities they surveyed "overestimated consumption growth" and that "eight of the eleven… that forecast peak demand also overestimated [that] quantity." Further, they found that LSEs (load-serving entities) that projected the highest growth rates in demand in fact experienced the lowest demand growth.[12] In these cases, while deferring to utilities may be necessary to determine current demand, stakeholder involvement, both from commissions and external intervenors is crucial to ensuring that demand forecasts are not unduly high. Frequently, these technical decisions don't even appear in front of commissions – utilities are left to alone to decide. The deference toward utilities abounds in integrated resource planning and beyond.[13] Yet, if there was no deference toward utilities, the load of technical decision-making would simply be too heavy for regulators to bear. Where then, is the right place to draw the line? That question lies at the heart of this paper.

As the U.S. electricity sector, and the entire energy industry, transitions away from traditional fossil-fuel powered technologies, forward planning will continue to be a crucial regulatory lever. The institutions and representatives involved will ultimately shape the power sector in both the near-term and for decades to come. In Eric Hirst's 1994 report outlining suggestions for integrated resource planning he writes, "because the interests of all stakeholders in a utility's resource plan are not identical, the ways in which these interests will be affected by utility actions will differ." Hirst highlights the importance of access and involvement of all stakeholders.[14] Nearly three decades later, stakeholders remain central to the success of IRPs in promoting the public interest.

[12] Carvallo et al., "Long Term Load Forecasting Accuracy in Electric Utility Integrated Resource Planning."
[13] Harvard Environmental & Energy Law, "Ari Peskoe Speaks with Leah Stokes about Interest Groups, Utilities, and Clean Energy Policy."
[14] Hirst, "What Constitutes a Good Integrated Resource Plan?"

2. Research Model

2.1. Three Key Topics in the IRP Space

This paper assesses three key topics related to integrated resource planning to illuminate the current state of the process and highlight emerging issues with a clean energy transition on the horizon. First, in Section 3, I assess the process by which utilities choose the software they use to perform the economic modeling analyses central to their IRPs. Further, I demonstrate how the selected modeling software affects the ultimate outcome of their forward plan. In Section 4, I turn to capacity values as an example of one key technical assumption made during IRP. Utilities must make thousands of decisions on technical and financial assumptions for their modeling efforts, all of which may be debated internally or externally, and which may influence the outcome of their plan. Capacity values are just one example of such an assumption, designed to clarify the iterative process of determining such values. Finally, in Section 5, I address the ways that equity and justice are currently or may be incorporated into IRP in the future. The conversation around energy justice has flourished over the past decade, and I assess methods that may incorporate seemingly intangible principles into the deeply technical IRP process.

Table 2. IRP Case Studies Assessed

State	Utility	Relevant IRP Years
Michigan	DTE Electric Company (DTE)	2019
Georgia	Georgia Power (Southern Company)	2019
New Mexico	Public Service Company of New Mexico (PNM)	2017, 2020*
North Carolina	Duke Energy Carolinas (DEC) / Duke Energy Progress (DEP)[15]	2018, 2020*

*Approval pending

[15] Throughout this paper I refer to these two utilities and the IRPs they file jointly as "Duke Energy". DEC and DEP both serve counties in North Carolina and South Carolina. I refer primarily to processes and decisions made related to North Carolina's IRP proceeding, except where new materials filed in South Carolina provide more recent insight into utility decision-making.

2.2. Case Study Methodology

To examine debates around modeling software, capacity values, and energy justice, I rely on case studies related to IRP in four states. These four cases represent a distinct sample of written IRP rules, regulatory and legislative action, and market and resource portfolio context, but this is not a comprehensive assessment of all such policies in the U.S. For each case, I reviewed all major filings in any relevant integrated resource planning docket for the state's largest electric utility for the period from January 2016 through April 2021. I reviewed filings in each docket from utilities, commission staff, and intervenors, as well as the ultimate commission rulings if available. Utility IRP dockets comprise hundreds of filings and while some are strictly procedural, many are substantive. To that end, I endeavored to review filings from traditional advocates as well as citizen activists. Some IRP processes prompted hundreds, and even thousands, of consumer emails and written comments.[16] Where appropriate, I also assessed public materials from utilities and regional advocates outside of the IRP docket.

[16] Michigan Public Service Commission, In the matter of the application of DTE ELECTRIC COMPANY for approval of its integrated resource plan pursuant to MCL 460.6t and for other relief.; 2018 Biennial Integrated Resource Plans and Related 2018 REPS Compliance Plans.

3. Model Representation

3.1. Economic Modeling for IRPs

Utility IRPs are almost always analyzed as a set of scenarios processed using least-cost optimization models whose goal is to jointly provide (1) a least-cost capacity resource portfolio (or set of expected online power plants, other energy supply/demand options, and planned builds and retirements) and (2) a least-cost demonstration of how that set of resources might be dispatched on the grid. The two modeling tasks are generally referred to as "capacity expansion" modeling and "production-cost" modeling respectively and utilities may use one model for both or separate models for each.

Capacity expansion problems deal with long-term forecasting. For example, given the most up-to-date capital cost projections for all resources and expected electricity demands, a capacity expansion model can find the "optimal" mix of built resources that satisfy a utility's demand. It compares the present value of existing utility resources (e.g., an existing hydro-powered dam), potential new resources (e.g., a new natural gas combined cycle plant or wind farm), and potential resource retirements (e.g., legacy coal units). The capacity expansion model will consider all of these units, the cost of operating and maintaining them, and the cost of complying with various regulations, then find the least-cost mix for a period of years in the future.

A production-cost model handles questions related to generation simulation. Once the capacity expansion exercise is complete, the production-cost model is used to assess the operating costs of each resource during a particular time period (increasingly at an hourly or sub-hourly granularity) by simulating a least-cost dispatch of those resources. While the capacity expansion model enables a utility to understand what resources it needs to have built or contracted to meet peak demand, the production-cost model estimates the true cost of dispatching those resources. Some newer models are capable of solving both the capacity expansion and production-cost simultaneously or in parallel.

Most utility planning models are comprised of enormous databases – they may contain data on nearly every generating unit in the utility's region (say, the entire U.S. Northeast and surrounding geographies) and optimize over an incredible set of variables: from the hourly electricity demand in a region, to fuel prices across different delivery points, types, and grades, to the expected output of a new wind farm, to the slew of state-specific environmental regulations. They process this massive dataset to arrive at one outcome – the previously mentioned "least-cost resource portfolio." As such, each input has the opportunity to affect the final resulting portfolio. Thus, utilities must engage in scenario analysis, whereby they adjust specific assumptions and re-run the model to produce a new least-cost portfolio for each new assumption. For example, many IRPs analyze separate scenarios for divergent natural gas forecasts, because fuel prices are nearly impossible to predict in the future. A low natural gas price scenario may make investment in a new natural gas power plant more attractive than a high natural gas price scenario, and thus a utility should consider multiple possible futures.

Policy proposals are central in many of the scenarios modeled during the integrated resource planning process. For instance, a utility might use scenario modeling to determine the least-cost path to meeting a new, more stringent, renewable portfolio standard requirement. They might also anticipate a dollar per ton carbon tax, levied at the federal or regional level, and can assess the cost impact of that tax on both their future construction plans, as well as their operational costs.

As such, any rule or order that impacts modeling input assumptions or the choice of modeling software or methodology can have a profound impact on the result of the IRP exercise. A utility that is subject to less modeling oversight risks defaulting to existing modeling techniques or using outdated software or input assumptions that do not accurately represent the state of their service territory. Conversely, if a utility commission requires specific modeling tools and scenarios and is not careful to continuously update them, a utility may be forced to use those outdated analytical tools. The balance between strong oversight and adaptable oversight is difficult to strike. IRP rules that emphasize risk assessment may encourage stochastic modeling, which better illustrates potential risk, but may also be less transparent to external intervenors. The written IRP rules and procedural determinations can have outsize impacts on modeling results.

For the sake of simplicity, I separate IRP modeling issues into three groups:

(1) **Modeling Software:** What analytical capabilities does the model(s) have? For example, does the model use a chronological method or rely on discrete load-blocks?
(2) **Model Settings:** How has the utility chosen to use the model? For example, do they model one on-peak and one off-peak day for each month, or do they run a longer, more representative, time period?
(3) **Model Inputs:** What technical and financial assumptions does the utility make? For example, what capital cost do they use for potential new wind facilities?

While utility modeling software selection may seem like a purely technical pursuit, it can have an outsize impact on the resulting built electricity system. Pielke writes generally about predictive modeling that, "the value of predictions … emerges from the complex dynamics of the prediction process, and not simply from the technical efforts that generate the prediction product."[17] Here, too, the utility model selection process indicates what a utility values in selecting new resources. For example, if a utility is most interested in the cost impact of continued investments in coal- and natural-gas-powered plants, legacy capacity expansion models may suit its needs well. If a utility is more interested in comparing fossil resources to clean energy technologies (e.g., wind, solar, storage), it may need to employ more advanced capacity expansion and production cost models.

[17] Pielke, "The Role of Models in Prediction for Decision."

A utility that continues to use outdated modeling tools may inadvertently over-value fossil resources, resulting in both a dirtier and less economic solution to meeting electricity demand. As utilities aim to best serve the public interest, they must select updated modeling software and settings that reflect the true value of all resources, fossil and clean alike.

In Sections 3.2-3.5 I assess the most recent modeling software used for IRP in each of the paper's four case study areas. When relevant, I outline how the utility manages model settings and model inputs. I also detail the written IRP rules that either restrict or encourage novel modeling methodologies. In Section 3.6, I reflect on recent trends in modeling software and discuss the influence of written IRP rules and commission decision-making on modeling going forward. Section 4 deals directly with an example of the influence of model inputs on IRP outputs.

3.2. DTE Energy (Michigan)

3.2.1. Written IRP Rules

Michigan requires all major electric utilities to file integrated resource plans comprising five-, ten- and fifteen-year projections of the utility's planned generating capacity and generation. The Commission must determine whether each submitted integrated resource plan represents the "most reasonable and prudent means of meeting energy and capacity needs." All utilities must file IRPs at least every five years after the initial filing.[18] The regulation governing integrated resource planning contains some language parallel with similar states.[19] Like many of its peer states, Michigan requires a public input process, but does not explicitly state that within the rule.

Of particular importance in all state integrated resource plan rules is the standard by which the commission judges the plan to be successful or appropriate. In Michigan, the Commission directs that the integrated resource plan must be:

---

[18] "Michigan Compiled Laws § 460.6t."
[19] "170 Indiana Administrative Code § 4-7."

> the most "reasonable and prudent means of meeting energy and capacity needs, [with consideration of appropriate balancing of seven factors: resource adequacy to meet system requirements, compliance with environmental regulations, competitive pricing, reliability, commodity price risks, diversity of generation supply and whether demand response and energy efficiency programs are] 'reasonable and cost effective.'

This focus on balancing several factors, some cost-based and some not, is unique amidst the array of state integrated resource planning rules. While the Michigan IRP rules demand reasonable and prudent cost outputs, they do not dictate that the chosen plan must be the "least-cost" option.[20]

In 2016, the Michigan Legislature passed Michigan Public Act 341, which required the Michigan Public Service Commission (MPSC) to further detail IRP guidelines and model parameters. The MPSC initiated a stakeholder process in 2017 to develop a set of modeling input assumptions, proposed modeling scenarios, and suggested sensitivity analyses.

Michigan's requirement that the MPSC develop modeling guidelines and suggested data sources for its IRP process is unique in its breadth. The recommendations that resulted from the stakeholder process include a set of publicly available resources (for example, U.S. Energy Information Administration and NYMEX data to develop natural gas price forecasts) and explicit recommendations about utility-specific data (i.e., for natural gas price "if utility-specific data is utilized, it should be justified and made available to all intervening parties"). The assumptions that the MPSC outlines are all relatively standard in the integrated resource planning arena, though these new recommendations do include a section encouraging the incorporation of "other/emerging alternatives" which acts as a catchall for newer or more novel resources.

While the MPSC guided parameters on modeling assumptions was robust in 2017, there was little guidance on modeling software selection save that models should "account for operating costs and

[20] "Michigan Compiled Laws § 460.6t."

location, [and] capital and performance variation" of modeled resources. The parameters do suggest that "forecasted energy efficiency savings should be aggregated into hourly units," ostensibly so that energy efficiency is correctly represented in hourly generation simulations. Most production-cost models do optimize in hourly units, but not all expansion models optimize a unique set of 365 days per year, relying on "typical week" or "peak/off-peak day" structures. Additionally, there has been a recent focus on production-cost models that provide dispatch optimization down to a sub-hourly granularity—say, every five minutes. Several stipulations of the 2017 Michigan IRP Parameters do point to such novel modeling trends. Take, for example, the requirement to "recognize the capacity and performance characteristics of variable resources." The benefits of variable resources are better represented by models that model dispatch in smaller time increments.[21] Modeling software selection got relatively little attention in Michigan until 2020, as described in the following section.

3.2.2. Michigan Modeling and Intervenor Work

To assess the debates in Michigan around modeling software and methodology for integrated resource planning, this paper assesses DTE's 2019 IRP and the following process they underwent to examine modeling software options.

DTE submitted its most recent IRP in 2019, its first since the full implementation of Public Act 341 and has faced corresponding feedback from the commission and public intervenors. DTE's IRP includes a technical appendix which provides detailed information on their modeling practices. Appendix J details the history of the Strategist model – one of the first industry resource planning tools, developed in 1982. By DTE's description, the model's development kept pace with evolving industry needs through 1999, when the most recent user interface was unveiled. DTE used Strategist as its primary capacity expansion model to generate "least-cost" build plans under four

[21] "In the Matter, on the Commission's Own Motion, to Implement the Provisions of Section 6s of 2016 PA 341."

utility IRP scenarios. In addition to Strategist, DTE used PROMOD (an hourly dispatch model) for its production-cost analysis, paired with an internal revenue requirement model to assess short-term energy and capacity purchases. Appendix K provides historical detail on PROMOD, including its potential collaborative use with Strategist, but does not explain the mechanism by which the utility uses the tool.[22]

Expert witnesses roundly criticized DTE's continued use of Strategist, identifying its weakness in ensuring (1) proper representation of current resource options and electricity system requirements and (2) modeling transparency. Anna Sommer, testifying on behalf of the Environmental Law and Policy Center and other environmental groups, and Avi Allison, testifying on behalf of the Michigan Environmental Council and other advocates, both expressed the need to move away from the Strategist model in future planning dockets. Sommer said, of Strategist, that not only is it "difficult to perform a pure optimization of all resources [using the model]," but also that ABB, Strategist's vendor, had announced that they would no longer support the software. Allison identified five key weaknesses with the model:

- Inability to conduct detailed hourly or sub-hourly modeling
- Inability to model ancillary services
- Lack of suitability for representing battery storage resources
- Limitations to number of resources that can be considered
- Lack of transparency in input/output structure[23]

Sommer added that the three key ingredients for ensuring model transparency are: readable data available without a model license, a well-documented manual available to non-licensees, and the ability to license the model at a reasonable cost if not provided by the utility. Sommer also performed her own re-modeling of the DTE IRP, demonstrating that their published "least-cost

[22] Branson, "DTE Electric Company's Official Exhibits A-1 through A-32."
[23] Allison, "Direct Testimony of Avi Allison on Behalf of Michigan Environmental Council, Natural Resources Defense Council, and Sierra Club."

portfolio" was in fact more expensive than alternative portfolios that relied more heavily on renewable resources.[24]

On February 20, 2020, the MPSC filed an Order recommending changes to DTE's submitted IRP, setting parameters for the subsequent IRP docket and directing the utility to file applications for other additional reviews. In the order, they addressed the concerns around the Strategist model, citing its lack of continued vendor support and inability to perform hourly chronological dispatch or reflect resource ramping. The Commission agreed with an administrative law judge's recommendation to require a two-day collaborative with stakeholders "to explore alternative modeling tools" and adopted a commitment by DTE to collaborate with PSC staff on future modeling software used.[25]

DTE held the required software collaborative in May 2020, attended by MPSC staff, past IRP intervenors, employees from other Michigan utilities, and representatives from software and analytical research centers. The collaborative was designed primarily to consider four different modeling software: Encompass (Anchor Power), PLEXOS (Energy Exemplar), Aurora (Energy Exemplar), and Capacity Expansion (ABB). DTE presented on the 33 attributes they considered for a new IRP, across 5 broad categories: (1) Model Capabilities, (2) Model Transparency, (3) Functionality, (4) Value and IRP process efficiency, and (5) Nice to Have.[26] Ultimately, EnCompass won out across the five categories, and DTE announced its use for its upcoming IRP.[27]

The recent activity in Michigan demonstrates the impact that IRP rules and recommendations have on chosen model software and methodology. The 2017 Michigan energy legislation pushed

---

[24] Sommer, "Direct Testimony on Behalf of the Environmental Law & Policy Center, the Ecology Center, the Solar Energy Industries Association, the Union of Concerned Scientists, and Vote Solar, and on Behalf of MiEIBC."
[25] Michigan Public Service Commission, "Order Recommending Changes to the Filed Integrated Resource Plan."
[26] DTE Electric Company, "DTE Electric's Integrated Resource Plan (IRP) | Modeling Software Collaborative Summary Report."
[27] Anchor Power, "DTE Electric Company Selects EnCompass Software."

the state to compile detailed IRP modeling input and methodology parameters. As a result, intervenors and the MPSC were able to point to specific structural deficiencies in the model used by the utility. DTE's choice of EnCompass for its next IRP proceeding will make it easier for external parties to understand both model settings and inputs, and thus make their recommended plan easier to assess. With a more updated tool and an accessible procedure, Michigan may see more efficient outcomes and better rates and system reliability for ratepayers.

3.3. Georgia Power (Georgia)

3.3.1. Written IRP Rules

Georgia requires all utilities under the Public Service Commission's rate-setting jurisdiction to file integrated resource plans every three years forecasting utility operation for a twenty-year period beginning with the filing year. Georgia's IRP rules build in some flexibility for goal setting, stating that the plan objective "should be based on current Commission policy concerning minimizing customer bills, minimizing overall rate and maximizing net societal benefit." Generally, the Georgia IRP rules point to a larger set of expected analytical tools and cost-benefit analyses, including a unique Societal Cost Test, which comprises a cost-benefit analysis that incorporates "economic, environmental and social factors."[28]

Beyond those additional cost-benefit analyses, the implied model requirements in the Georgia IRP rules are relatively straightforward. To model scenarios with an eye toward minimizing customer bills and overall rates while maximizing net societal benefits, the model must use a least-cost optimization structure. Georgia requires a request-for-proposal process as a part of the integrated resource planning structure and asks utilities to include all potential resources not excluded by "appropriate screening tests". This means that the model must be able to incorporate any resources bid in via the RFP process. Most models are built with some resource type flexibility in mind but

[28] "Ga. Comp. R. & Regs. 515-3-4-.01."

some legacy models aren't easily adjusted to incorporate new resource types. The Georgia rules also require a description of external relationships, implying some kind of ability to model energy and capacity flows to neighboring regions, as well as some description of resource operating performance.[29]

3.3.2. Georgia Modeling and Intervenor Work

For the purposes of understanding how Georgia's model rules interact with Georgia's written IRP rules, this paper examines the most recent 2019 Georgia Power IRP. Like DTE Energy, Georgia Power relied on Strategist as its main tool for capacity optimization and was criticized for using the outdated tool. In testimony on behalf of Sierra Club in the most recent Georgia IRP docket, Rachel Wilson outlines similar reasons to Anna Sommer and Avi Allison regarding the limited nature of Strategist as a modeling tool for modern resource planning. She points to several particularly egregious Strategist shortcomings – its analysis is limited to wholesale market forecasting and representing model constraints. Strategist uses a simplified approach to modeling intermittent resources and carries forward identical dispatch patterns for all weeks and future years.[30] Wilson suggested a few other potential models for utility use (EnCompass, PLEXOS, and System Optimizer) all of which have capacity to model electricity systems at an hourly granularity with chronological dispatch, thus better capturing flexible resource benefits and daily variation in thermal unit dispatch. These alternate models also all provide full forecasting of energy, capacity, and ancillary service markets. Mark Detsky, testifying about his experience with Xcel Energy's IRP modeling in Colorado, similarly found that Strategist was not capable of valuing storage resources appropriately. Further, he explains that Georgia Power's base case does not harness Strategist's ability to "optimize among different technologies", the model's primary function.[31]

---

[29] "Ga. Comp. R. & Regs. 515-3-4-.01."
[30] Wilson, "Direct Testimony of Rachel Wilson on Behalf of Sierra Club."
[31] Detsky, "Direct Testimony of Mark D. Detsky on Behalf of Southern Alliance for Clean Energy and Southern Renewable Energy Association."

Though Georgia Power's modeling runs do not incorporate all potential resources, they likely meet the current written standard. The Georgia IRP rules fail to effectively specify a mechanism by which a utility has to meet the requirements of their resource planning rule. For example, while the rules require description and consideration of external regions, the statute does not dictate that those external regions must be included in the optimization. Strategist has limited capability to reflect potential external energy sellers that Georgia might use, and thus the utility can model their own system footprint exclusively and may miss the potential opportunity to purchase power at a lower rate than required to maintain their existing set of resources. Overall, compared to other states, Georgia provides its utilities more freedom in choosing model software and settings, and the stakeholder involvement is relatively limited.

3.4. PNM (New Mexico)

3.4.1. Written IRP Rules

Major New Mexico utilities must file an IRP and accompanying action plan with the commission every three years. The stated purpose of New Mexico's IRP rule is to monitor the development of utility resource plans that identify the "most cost-effective portfolio of resources to supply the energy needs of customers," and when resources are cost-comparable to prefer those that minimize environmental impacts. Utilities must provide plans that look 20 years ahead.[32]

New Mexico Administrative Code defines the most cost-effective resource portfolio as that set of resources that "minimize the net present value of revenue requirements" proposed, in line with risk and reliability. This definition should force a stricter eventual selection of the resource portfolio. New Mexico's rule does also provide some direction regarding how the most cost-effective portfolio should be selected. The rule requires some balancing of risk and uncertainty and requests a life-cycle (or similar) analysis of resource costs.[33]

---

[32] "NM Administrative Code. 17.7.3."
[33] "NM Administrative Code. 17.7.3."

In August of 2017, the New Mexico Public Regulation Commission (NMPRC) amended the IRP rules to formally allow the consideration of energy storage resources in the plans, supported by all three New Mexico investor-owned utilities.[34] It is notable that they created a separate carve-out for energy storage rather than lumping it into existing rules around demand-side or supply-side resources. Storage resources effectively provide both demand and supply-side services, so it makes sense to regulate them separately. However, breaking them out may provide an opportunity to set restrictive modeling or input requirements, which could limit their success in the context of an optimization model. In a rule like New Mexico's, though, which provides little guidance and oversight on modeling assumptions, this is not an impending risk. However, in a state like Michigan, where the commission determines recommended model inputs and methodologies, separating storage from supply- or demand-side resources could at some point lead to unintended outcomes and disparate treatment of the technology.

Beyond the most cost-effective portfolio, the New Mexico IRP rules require the utility to model alternative portfolios but do little to define those scenarios beyond stating that there must be a "reasonable number of alternative portfolios" and that those may include alternate risk assumptions and "other parameters."[35] Compared to Michigan's pre-determined portfolios, there is little guidance on what adjustments can be made. The NMPRC does require a high-growth, low-growth, and uncertain load forecast, but there is no guidance on what "high" and "low" mean relative to past load.

The New Mexico rules defer heavily to the public advisory process, though in practice the utility controls the process. Indeed, the utility initiates, chairs, and develops the agenda for all public meetings. The language on further involvement is vague and deferential to the utility (e.g.,

[34] "New Mexico Commission to Allow Energy Storage in Integrated Resource Plans."
[35] "NM Administrative Code. 17.7.3."

participants may place items on the agenda of the public process meetings, but they must do so with “adequate notice to the utility,”[36] which is subjective and enables further utility control. Thus, the modeling software and methodologies used by the utility are potentially intractable and not easily subject to critique or change.

3.4.2. New Mexico Modeling and Intervenor Work

Here, I use Public Service Company of New Mexico’s (PNM) 2017 IRP to assess the influence of New Mexico’s IRP rules on modeling outcomes, then outline the modeling changes implemented for the 2020 IRP and describe their impact on the IRP results.

Like DTE and Georgia Power, PNM used Strategist for its 2017 capacity expansion modeling and AuroraXMP for its production-cost modeling.[37] At its initial public planning meeting PNM also discussed potential use of PROMOD, though that isn’t apparent in the body or technical appendices of its IRP filing.[38]

The issue raised above regarding deference to utilities during the public advisory process was repeatedly discussed by intervenors in the relevant docket. One intervenor, New Energy Economy expressed repeated concern that, while they “submitted timely requests for analysis using Strategist…these requests were not completed, nor included in the final IRP report.”[39] This anecdote reflects general dissatisfaction expressed across the docket about the ability of intervenors to have substantive input on modeling scenarios.

New Energy Economy also raised an issue with PNM’s published IRP specifically aimed at the written IRP rule. They asserted that PNM’s IRP did not actually identify a “most cost-effective

[36] “NM Administrative Code. 17.7.3.”
[37] Public Service Company of New Mexico, “PNM 2017-2036 Integrated Resource Plan.”
[38] O’Connell, “PNM 2017-2036 Integrated Resource Plan Analysis Tools and Plans.”
[39] New Energy Economy, “New Energy Economy’s Motion to Compel Discovery from PNM.”

portfolio" (MCEP). They further argued that the lack of battery storage resources in the (apparent) MCEP was the result of several assumptions "which unfairly disqualified them," including the lack of sub-hourly dispatch available in the Strategist model and that the capacity expansion portion of the model could not account for the avoided cost of curtailment unserved energy battery resources provide to the grid.[40] Different modeling software could easily solve the latter problem, while the debate around modeling transparency and preferred portfolio selection lies more squarely in the methodology category.

Another issue that New Energy Economy raised in this docket is a common thread in IRP dockets: the issue of "fixed" or "locked down" resources. As detailed above, most IRP rules necessitate some kind of least-cost or best-mix optimization exercise. For an integrated resource planning exercise, this rule implies, or explicitly states, that all resources will be subject to optimization. However, utilities occasionally force resources to stay online during dispatch, disallow economic retirements of certain resources, or hard-code specific new power units. There are many acceptable reasons to do this, such as contracted purchase commitments. However, New Energy Economy here contended that PNM admitted it "locked down" resources in the selection process unnecessarily, "thereby hyper-narrowing the choices Strategist could select." Also raised by intervenors in the DTE Energy IRP case, utilities often justify these lock downs via the limitations set by Strategist, and PNM uses that same defense here.[41] While locking down resources because of set contracts may be acceptable, the limitations of an outdated model obstruct a utility's ability to meet the stated goals of the written IRP rules.

Interestingly, following the passage of major clean energy legislation in New Mexico, the 2020 draft PNM IRP looks quite different from its predecessor. PNM's new document itself states:

---

[40] New Energy Economy, "New Energy Economy's Response Brief."
[41] New Energy Economy, "New Energy Economy's Post Hearing Brief."

> Older models are becoming inadequate for analysis of electricity systems with changing customer energy requirements, increasing penetrations of variable renewable resources, and the anticipated deployment of storage resources at scale."[42]

For its 2020 IRP, PNM utilized EnCompass, paired with SERVM to assess resource adequacy. PNM highlights the need for a chronological model to better capture renewable and demand-side resources, new cycling behaviors for thermal units, and storage charging and discharging. They also note the process efficiency that comes with a model that bundles capacity expansion and production cost simulation. PNM's 2020 IRP is still working through the commission approval and intervenor involvement process – ultimate approval is pending.

3.5. Duke Energy (North Carolina)

3.5.1. Written IRP Rules

North Carolina's IRP rules require each utility to file an integrated resource plan every two years forecasting their generation and operation for the following 15 years, in addition to an annual report. The rules require that each utility consider a set of resource options to "determine an integrated resource plan that offers the least cost combination (on a long-term basis) of reliable resource options…". The explicit use of "least cost" is important here, as was its absence from the rules covered in the preceding case studies. The state's rules lack specificity about resource type and ask for some description of analytical exercises but stop short of being prescriptive. Overall, these rules give the governed utility a relatively wide berth to perform their IRP analysis in regard to both modeling software and methodology.[43]

3.5.2. North Carolina Modeling and Intervenor Work

Unlike the three other utilities covered in this paper, Duke Energy, a major Carolinas utility, used System Optimizer for capacity expansion and PROSYM for production cost modeling for their

[42] PNM Resource Planning Team, "PNM 2020-2040 Integrated Resource Plan."
[43] "North Carolina Utilities Commission Rule R8-60."

2018 IRPs. These tools are more sophisticated than Strategist, as expressed by Applied Economics Clinic (AEC) in their testimony on behalf of the NRDC and other advocates, but Duke's modeling methodology failed to take advantage of them. While System Optimizer has the ability to model economic retirements of existing units, Duke chose to disallow economic retirements for its existing coal units. AEC argued that "the most important change to the Companies' analysis would be to allow for the capacity expansion model to retire existing units based on economics."[44] In a similar vein, the Attorney General's Office submitted initial comments questioning why Duke didn't choose the option to configure System Optimizer to allow for incremental energy efficiency measures to be selected.[45]

The North Carolina Utilities Commission approved Duke's proposed IRP but they included several requirements, including an order that the utility address this central theme of intervenor comments in its 2018 IRP, "The modeling exercise fails to consider whether existing resources can be cost effectively replaced with new resources. Therefore, Duke has not performed a least-cost analysis to design its recommended plans."[46] While the NCUC stopped short of denying Duke's IRP, intervenors were able to cite the stated purpose of the process (to determine a "least-cost" plan) to garner more attention for model misuse. Interestingly, Anchor Power Solutions, who developed the EnCompass model, recently announced that Duke is joining their client base.[47] Duke has yet to fully transition to the tool for its 2020 IRP, though they announced that the formal transition would occur in the fourth quarter of 2020.[48]

[44] Applied Economics Clinic, "SACE, Sierra Club and NRDC's Initial Comments - Public, Attachment 2: Review of Duke Energy's North Carolina Coal Fleet in the 2018 Integrated Resource Plans."
[45] Attorney General's Office, "Initial Comments on Duke's Integrated Resource Plan."
[46] North Carolina Utilities Commission, "Order Accepting Integrated Resource Plans and Reps Compliance Plans, Scheduling Oral Argument, and Requiring Additional Analyses."
[47] Anchor Power Solutions, "Duke Energy Impemented EnCompass Software."
[48] Duke Energy, "IRP Reference Information Portal."

3.6. Discussion

These four limited case studies indicate renewed attention to modeling software and methodologies and, subsequently, an eye toward the ways in which IRP rules dictate those choices. Utility commissions, public intervenors, and utilities themselves are demanding more from the economic modeling tools they employ, and software developers are rising to the challenge. However, without regulatory mechanisms to oversee these transitions, model misuse can become more pervasive and lead to less accuracy and legitimacy in resource planning. Transparency in modeling software and model assumption selection, as demonstrated in the DTE case, is a crucial first step toward establishing appropriate modeling standards.

Utilities and their governing commissions are looking ahead to substantial change in operation and in resource mix that will necessitate regulatory agility. Michigan's legislative-driven shift to explicitly defining modeling parameters is one potential pathway, while the story in New Mexico speaks to the power of public intervenors and state clean energy legislation. Georgia's IRP rules may prove too vague to force change in modeling methodology, so Georgia Power and state intervenors may need to find venues outside of the formal IRP process to assess modeling techniques. Each state demonstrates a different methodology and, as shown in both the Michigan and North Carolina cases, we might anticipate further shifts in IRP rule-making and modeling in reaction to an impending clean energy transition. **Table 3** (below) simplifies the key points discussed for each state's IRP rules as they relate to modeling software, and shows the current capacity expansion model used.

Table 3. Summary of IRP Rules & Current Modeling Software Across 4 Case Study Regions

State (Utility)	Stringency of IRP Rules & Related Policy	Current Capacity Expansion Model in Use
Michigan (DTE Energy)	▪ Standard IRP rule ▪ Commission-ordered process to develop detailed modeling parameters	▪ EnCompass
Georgia (Georgia Power)	▪ Detailed IRP rules, but few enforced/enforceable requirements	▪ Strategist
New Mexico (PNM)	▪ Most Cost-Effective Portfolio Requirement ▪ New carve-out for storage resources	▪ EnCompass
North Carolina (Duke)	▪ Non-specific rules ▪ Allow utilities wide berth	▪ System Optimizer ▪ EnCompass (pending)

4. Capacity Values

4.1. Introduction to Capacity Values

Capacity values, as a concept, have been widely used in relation to the U.S. electricity system since at least the mid-1960s. A capacity value quantitatively indicates the ability of any generating technology to contribute to electric demand.[49] A full rated capacity value indicates that the generating unit (1) has sufficient fuel and (2) is mechanically available. For example, a 400 MW natural gas combined cycle plant would typically have a capacity value representing its full installed 400 MW. Many renewable technologies, on the other hand, are only available intermittently and "hence, even a fully mechanically available unit might not be able to generate at rated capacity."[50] So, a 100 MW solar plant may be credited for only 60 percent of its installed nameplate capacity, or 60 MW. In some settings, the capacity value is referred to as the "capacity credit". Additionally, the proportion of the resource that is credited fully (take 60 MW of the 100 MW solar plant) is referred to as "firm capacity". These terms hold specific meanings in different fields but their use is generally interchangeable in the IRP context.

Capacity values are crucial to properly calculating the amount of available energy that an electric utility will have in the future, and thus the overall reliability of the system. The most traditional approach to valuing capacity is the effective load carrying capability, or ELCC. L.L. Garver's 1966 paper introduced the application of loss-of-load probability mathematics to estimate the ELCC of any power generating unit. His methodology, and subsequent refinements of it, allow analysts to compare units by their power rating and forced outage rate.[51]

---

[49] Dent, Keane, and Bialek, "Simplified Methods for Renewable Generation Capacity Credit Calculation."
[50] Garver, "Effective Load Carrying Capability of Generating Units."
[51] Garver.

Of course, as power systems have become more complex and operators have learned more about system operation, methods for determining true capacity value have improved in parallel. These methods range from simple to extraordinarily complex. The standard MISO (Midcontinent Independent System Operator) method for wind capacity crediting, for example, sits somewhere in the middle – it first utilizes an ELCC methodology followed by a deterministic approach that evaluates the historical output of each individual wind resource.[52] In a paper primarily focused on wind resources, Dent et. al. found a preference for simplified methods for valuing capacity in comparison to detailed risk calculations and laid out five major categories for simplified approaches to capacity valuation: (1) annual-peak-risk-based approaches, (2) the Garver approximation, which uses a time series risk calculation and probabilistic wind representation, (3) the z-method, which linearizes small additional generation capacities, (4) valuing capacity based on available generating capacity distribution, and (5) 'toy' models.[53] They also note that "the importance of the concept of capacity value lies in the transparency of the results."

IRP models are designed to determine the optimal system setup that both minimizes cost and maintains reliability. In order to simulate that reliability standard, IRP models use a reserve margin, which indicates the excess firm capacity a region has over its expected peak demand (the highest anticipated demand for any hour in a given year). The capacity value for a resource class can determine whether or not that resource is selected by the utility's optimization model, which can have real effects, such as that resource being undervalued in a subsequent RFP.

Of course, the capacity value chosen for each resource is only one example of a model assumption that can drive the output of IRP modeling. Many other technical and financial assumptions are just as crucial in driving the outcome. In Michigan's recent stakeholder input process, the MPSC

[52] Midcontinent Independent System Operator, Inc., "Planning Year 2021-2022 Wind & Solar Capacity Credit Draft Report."
[53] Dent, Keane, and Bialek, "Simplified Methods for Renewable Generation Capacity Credit Calculation."

identified 16 categories of such assumptions: (1) analysis period, (2) model region, (3) economic indicators & financial assumptions, (4) load forecast, (5) unit retirements, (6) natural gas price, (7) coal price, (8) fuel oil price, (9) energy waste reduction savings, (10) energy waste reduction (EE) costs, (11) demand response savings, (12) demand response costs, (13) renewable capacity factors, (14) renewable costs (capital + operation & maintenance), (15) other/emerging alternatives, and (16) wholesale electric prices.[54] The iterative process described in each state below, whereby utilities, commissions, and stakeholders determine the approach to capacity values, also occurs for each of those 16 assumptions.

Non-experts may dismiss capacity values as a purely technical assumptions, but these inputs embed non-technical judgements about the value of a given generating resource. Capacity values for intermittent resources (wind and solar) are generally calculated based on some historical operation, or expected future weather pattern, and discounted accordingly for times when the wind won't blow and the sun won't shine. Traditional fossil units, however, are rated at their optimal output with little consideration of past performance. Meanwhile, these resources are also subject to unexpected outages. During PJM's 2014 Polar Vortex natural gas units made up 47 percent of unavailable megawatts and coal units comprised 34 percent, due either to weather-related fuel interruptions or weather-inflicted plant operational issues.[55] During the February 2021 extreme weather event in Texas, the vast majority of units unavailable appear to have been coal- or gas-fired.[56] Analysts use many methods to represent weather-related outages in electricity systems models, but they are not always incorporated into the capacity expansion stage of modeling. Without a representation of true capacity value, on a daily, annual, and major storm basis, capacity expansion models will tend to overbuild fossil resources. And since integrated

[54] "Michigan Integrated Resource Planning Parameters: Pursuant to Public Act 341 of 2016, Section 6t."
[55] PJM Interconnection, "Analysis of Operational Events and Market Impacts During the January 2014 Cold Weather Events."
[56] ERCOT, "Update to April 6, 2021 Preliminary Report on Causes of Generator Outages and Derates During the February 2021 Extreme Cold Weather Event."

resource plans serve as a starting point for system planning and procurement in many jurisdictions, a fossil overbuild in the model may result in a fossil overbuild in the actual system.

4.2. DTE Energy (Michigan)

For its 2019 IRP, DTE set capacity values for all thermal resources at 100 percent and developed detailed assumptions for wind and solar resources. Most IRP inputs were set in stone between May and August of 2018 and were then re-assessed in February 2019, to check whether they had "changed materially since initial modeling." In its final report, DTE noted that parameters "included in the IRP optimization that drive the fundamental modeling" are more difficult to change mid-process "because those inputs are incorporated at the beginning of the process." Of 13 inputs considered for update in February 2019, only four were ultimately chosen, one of which was the wind ELCC. The ELCC for wind resources was initially set at 11.7 percent and then updated to 16 percent. DTE noted that a "30 percent increase is a material change" though neither the Wind ELCC adjustment nor the other input adjustments changed the result of the capacity optimization exercise. [57]

ELCC of solar was set at 50 percent, declining to 30 percent by 2033 in both the 2019 IRP and its predecessor. DTE stated that this 50 percent and declining trajectory was consistent with MISO standards, but it was contested by intervening parties. Witnesses representing the Michigan Environmental Council, NRDC, Sierra Club, and Environmental Law & Policy Center argued that this trajectory undervalued potential new solar resources, pointing to DTE's assessment of older fixed-tilt solar systems rather than newer tracking technologies. Administrative Law Judge Sally L. Wallace recommended a higher solar ELCC, set at 65.8 percent, "consistent with the company's built system."[58] Other intervenors commented that the 50 percent value demonstrated a disregard

[57] DTE Electric Company, "2019 Integrated Resource Plan."
[58] Michigan Public Service Commission, In the matter of the application of DTE ELECTRIC COMPANY for approval of its integrated resource plan pursuant to MCL 460.6t and for other relief.

for the company's treatment of existing solar resources, which DTE currently represents at a 60 percent ELCC. DTE reminded the intervening parties that, as more renewables are built (or their "penetration increases"), ELCCs are expected to drop.

Ultimately, the MPSC deferred the decision on solar ELCC, stating that, "the issue of the correct solar inputs is best addressed in the next round of updates to the MIRPP," which begins in July of 2022.[59] While this decision indicates movement toward a capacity crediting methodology that environmental advocates and consumer representatives prefer, it won't be formally incorporated into DTE's IRP process for several years, and then only because Michigan has a strong process in place to ensure stakeholder input into modeling parameters.

4.3. Georgia Power (Georgia)

Georgia Power's 2019 IRP redacts a large portion of the financial and operational assumptions for each of its modeled resources, including their chosen capacity values.[60] Redactions of proprietary operational and cost data is routine, but it does present an additional barrier to external actor participation in IRP processes. For this paper, I rely on the discussion around capacity valuation that remains open to the public via the integrated resource planning docket, which includes both intervenor testimony and utility rebuttal. Discussion around renewable capacity values in Georgia is primarily focused on new solar resources, given that the state has relatively low wind speeds and anticipates higher reliance on solar.

For its IRP, Georgia Power performed a Renewable Cost Benefit (RCB) analysis to assess the capacity value for renewable resources, among other assumptions. The utility uses a unique methodology to value renewable resources which compares the reliability of each potential renewable resource to a dispatchable combustion turbine (CT) resource. This method aims to

[59] Michigan Public Service Commission.
[60] Georgia Power Company, "2019 Integrated Resource Plan."

assess the value of reliability in every hour of the year, as opposed to a selecting a set of peak demand hours. Georgia Power justifies this approach, writing, "while the ELCC methodology is widely accepted industry practice, the Company's ICE Factor Methodology is the most appropriate method for the Southern Company System because it directly values the reliability benefit of the resource being evaluated."

As with capacity value methodologies proposed in IRP dockets across the U.S., intervenors in the Georgia Power (GPC) case disagree in some measure with that assessment. Michael Goggin, testifying on behalf of the Southern Renewable Energy Association (SREA), states that the capacity value for solar that GPC uses is the lowest estimate of which he is aware and adds that the utility failed to assess the value of new solar resources with tracking capacity.[61] Goggin claims that this low estimate stems from Georgia Power's incorrect analysis, which reduces capacity values for wind and solar in an attempt to "account for forecast error and frequency regulation needs." Further, Mark Detsky, testifying for both SREA and the Southern Alliance for Clean Energy (SACE), argues that the RCB Framework capacity values should allow the utility to compare renewable technologies to existing thermal resources.[62] GPC rebutted by drawing a line between capacity value and capacity firmness. They allow that renewable resources provide capacity value, but not in all hours of the day. "Firm" capacity, they argue, hinges on the alignment of "when the capacity is made available compared to when the system is most in need of the capacity."[63]

Ultimately, the determination of Georgia Power's capacity values for solar (or wind) don't have a major impact on the resulting IRP scenario. GPC doesn't allow the model to optimize solar build-

---

[61] Goggin, "Direct Testimony of Michael S. Goggin on Behalf of Southern Renewable Energy Association."
[62] Detsky, "Direct Testimony of Mark D. Detsky on Behalf of Southern Alliance for Clean Energy and Southern Renewable Energy Association."
[63] Grubb et al., "Rebuttal Testimony of the Panel of Jeffrey R. Grubb, Narin Smith, Michael A. Bush and Jeffrey B. Weathers."

out. They simply hard-code 1,000 MW of solar resources into the model and optimize portfolios around four thermal resource options.[64] The language of Georgia's Rule 515-3-4-.05, which governs integrated resource planning, is not sufficiently specific to propose that this lack of optimization doesn't meet commission requirements. However, the rule requests an IRP base case scenario that is "the most economic and reliable" portfolio of potential resources. The layering method that GPC uses here is not abnormal and is usually used as a solution to limited model capabilities. However, it is not clear that, even if solar resources were allowed to be optimized and were the ELCC calculated transparently, the modeling tool would select them.

4.4. PNM (New Mexico)

New Mexico passed a broad-reaching bill in 2019, the Energy Transition Act (ETA), that set a state renewable energy standard at 50 percent by 2030 and 80 percent by 2040, among other major provisions. It also outlined financial and administrative guidance for closing the San Juan Generating Station (SJGS) in 2022 and the Four Corners Power Plant in 2031.[65] This legislative mandate to retire legacy thermal resources and replace them with clean energy resources refocused attention on how those new renewable resources are valued in the IRP context.

In recent history, PNM credited renewables with considerably lower firm capacity than their fossil counterparts. In its 2017 IRP, PNM assigned wind a firm capacity credit of five percent and solar a credit between 20 and 71 percent, while all proposed gas units were credited a full hundred percent.[66] Thus, by PNM's standards, wind and solar developers would provide substantially less firm capacity than a comparable combined cycle plant.

[64] Georgia Power Company, "2019 Integrated Resource Plan."
[65] "Energy Transition Act of 2019, S.B. 489, 54th Legislature (NM)."
[66] Public Service Company of New Mexico, "PNM 2017-2036 Integrated Resource Plan."

In PNM's most recent IRP (2020), the utility uses a standard ELCC methodology to determine the capacity credit. As with other utilities, PNM relies on a declining ELCC methodology for wind, solar, and various storage resources that results in a declining value as renewable penetration increases. Rather than declining linearly in all scenarios, like Georgia Power's method, PNM's capacity values are dynamically adjusted within the model to reflect the actual installed MW of each resource in the portfolio modeled. PNM also downgrades the capacity credit for traditional fossil units to their UCAP, which is inclusive of planned forced outages. PNM writes that "derating each thermal plant by its forced outage rate better reflects the value that resource provides towards resource adequacy." This indicates that the utility is being more thoughtful about treating all resources on a comparable basis and allows them to better assess their resource adequacy needs.[67] The intervenor engagement for PNM's 2020 plan has only just begun, and there are no shareable findings at the time of this paper's writing.

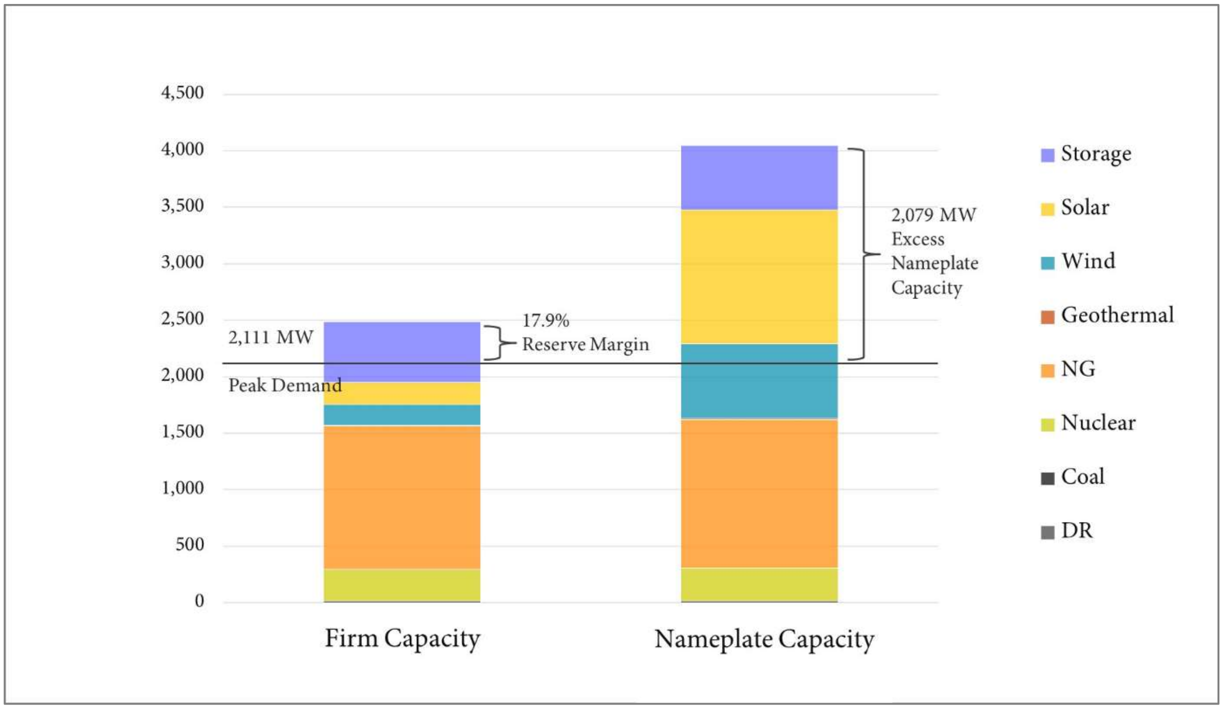
Given the new ETA-mandated renewable requirements, the capacity value methodology is particularly important in determining the least-cost scenario to meet the state's demand. If the capacity is overvalued, PNM may not build enough renewable resources to meet future demand. However, if capacity is undervalued, PNM could overbuild substantially.

Figure 2, below, provides an example of how the capacity value plays out in PNM's 2020 Integrated Resource Plan. The chart shows capacity by resource type in PNM's "Technology Neutral" optimized scenario in 2030. PNM's anticipated peak demand in 2030 is 2,111 MW and the utility requires a 17.9 percent reserve margin. The right column shows installed capacity, with substantial solar, wind, and storage capacity in addition to PNM's existing natural gas and nuclear resources (by this point in the scenario, coal resources are retired). The left column shows the firm capacity of that same set of resources. Nuclear and natural gas resources are credited with firm value for

[67] Public Service Company of New Mexico.

nearly all of their installed capacity. Wind and solar resources, on the other hand, contribute little to the firm capacity stack on the left. The model finds that wind and solar are low enough cost to build for capacity, even when their firm capacity value is low. The question here is whether the model has over- or under-built. Could New Mexico install less wind and solar and maintain system reliability? Or do the intermittent resources get too much credit here, and should the utility build even more excess capacity over peak demand?

Figure 2. PNM 2030 IRP Modeled Capacity by Resource (MW) | Technology Neutral Scenario



4.5. Duke Energy (North Carolina)

NC Rule R8-60, which governs the state's integrated resource planning process, requires:

> a comprehensive analysis of all resource options (supply-and demand-side) considered by the utility for satisfaction of native load requirements and other system obligations over the

planning period, including those resources chosen by the utility to provide reliable electric utility service at least cost over the planning period.[68]

For the 2018 IRP, Duke Energy retained consulting firm Astrapé to conduct both a resource adequacy and a solar capacity value study. The solar capacity value study assessed the incremental capacity values for both fixed-tilt and single-axis-tracking solar resources at five solar penetration levels across 13 regions in North and South Carolina. This study assessed substantially more resource options than those outlined in Georgia or Michigan.

While this assessment was comprehensive and transparent, it indicates disparate treatment between potential solar resources and potential thermal builds. The commission staff point to the capacity value of 100 percent for thermal resources "despite their not having guaranteed availability at the time of all High Risk Hours due to planned and forced outages" as a demonstration of this disparity.[69] The public staff recommended following PJM guidance for representing capacity values. Witnesses representing SACE, the state attorney general, and other intervenors agreed with this assessment and also stated a need for a more detailed capacity value of storage study. The Commission's final decision finds those arguments persuasive, and suggests improvements, but they ultimately accepted the 2018 IRP as written regarding capacity values.

Those suggestions appear in Duke's recent 2020 IRP draft. Capacity values receive considerably more attention. Duke has added full assessments of storage resources and paired solar-storage resources.[70] However, the values for standalone solar resources remain at the 2018 assessed levels (1 percent in the winter and 37 percent in the summer), an assumption that the utility does not address.[71]

---

[68] "North Carolina Utilities Commission Rule R8-60."

[69] North Carolina Utilities Commission, "Order Accepting Integrated Resource Plans and Reps Compliance Plans, Scheduling Oral Argument, and Requiring Additional Analyses."

[70] Duke Energy Carolinas, "North Carolina Integrated Resource Plan: 2020 Biennial Report."

[71] Duke Energy Carolinas, "North Carolina Integrated Resource Plan: Attachment II."

4.6. Discussion

Current and reasonable model input assumptions are integral to the success of the IRP process. It goes without saying that a model is only as good as its inputs, and in the IRP setting this is certainly true. The summaries of capacity values in sections 4.2-4.5 provide a very narrow but critical insight into one model assumption. In developing integrated resource plans, utilities necessarily have to make decisions about which assumptions to pursue, and how much bandwidth their team has to assess each potential option. Similarly, commission staffs, consumer advocates, and public intervenors must strategize about which inputs are most worth discussing in the commission context. Capacity values may go by the wayside when discussions about resource capital costs, demand forecasting, or fuel costs are more relevant, for example. That said, capacity values are a consistent feature in IRP dockets and, as demonstrated above, are becoming more central as the U.S. transitions to a grid less dependent on carbon-emitting fuels.

Table 4. Presence of Discussed Emerging Capacity Value Methodology in Most Recent IRP

State (Utility)	Value-Of Study	Attempt at Equal Consideration	Unforced Outages
Michigan (DTE Energy)	Reliant on MISO assessments	No	Yes
Georgia (Georgia Power)	Solar & Wind	No	Unable to determine
New Mexico (PNM)	Wind & Storage (via SERVM)	Yes	Yes
North Carolina (Duke)	Solar, Storage, & Paired Solar-Storage	No	Unable to determine

The four case studies above point to three major trends related to capacity value assumptions in integrated resource planning. First, separate value-of studies, which have become common for solar and wind resources, may also emerge for storage and paired renewable-storage resources. When capacity values can be represented dynamically within the existing capacity expansion software (for example, via the option to tie declining ELCCs to specific renewable penetrations), utilities could better represent intermittent resources and increase analytical efficiency. Secondly, if complex mechanisms are used to determine value for one type of resource, those same mechanisms should be applied to like resources. The same consideration should be applied to now standard renewable resources (e.g., wind and solar), novel energy technologies (e.g., long-duration storage), and legacy thermal units (e.g., coal and gas). Finally, and in the same vein, unforced outages for thermal units should be appropriately incorporated into IRP modeling, whether via a capacity value that reflects UCAP or some other modeling mechanism within the capacity expansion program.

Table 4 shows whether each of the four case studies discussed incorporates these three trends into their IRP modeling. Of course, the simple presence of an analysis does not necessarily indicate equal treatment – the scope and quality of the analysis may also include biases.

5. Incorporating Justice into Planning

5.1. Introduction to Energy Justice

Shalanda Baker's 2021 book *Revolutionary Power* highlights one of the key obstacles to centering equity in energy sector work. She writes:

> The technological and financial feasibility of bringing more clean energy onto the grid becomes the focus of most policy debates [rather than the social, the political, or the physical]. This overemphasis on technology and finance ignores the significant ways our energy system, created through a series of policy choices, shapes every single aspect of life, particularly for poor people and people of color.[72]

Baker's reminder is particularly salient when considering equity in such a deeply technical process as state integrated resource planning. The ultimate goal of public utilities, after all, is to serve the "public good".[73] Yet, in a world facing up to the massive challenge of climate change, the question of what best serves the public becomes even more contentious. Baker urges her readers to pursue a justice-first framework, rather than prioritizing climate first, leaving justice for later. Energy justice does not simply mean a recognition of the disparities rife within the system. Rather, energy justice should be a central focus of policymakers and other decisionmakers, built into the processes already in use.[74] As climate considerations are increasingly incorporated into technical decision-making processes that have always been dominated by cost-motivated metrics, so too should energy justice principles. In this paper, I ask how we can consider resource planning processes through a justice lens.

First, it is important to rely on the vast literature that exists on justice generally, environmental justice and, more recently, energy justice. The consensus across energy justice literature is that there are three or four modes of justice:

---

[72] Baker, *Revolutionary Power*.
[73] "Munn v. Illinois, 94 U.S. 113 (1876)"; Farnsworth, "Revisiting the Public Good, Part 2."
[74] Sovacool and Dworkin, *Global Energy Justice*; McHarg, *Energy Justice*.

(1) **Distributive Justice,** which concerns how impacts of and externalities from the energy system are distributed across society;
(2) **Procedural Justice,** which concerns the participation in, access to, and knowledge of major decision-making processes;
(3) **Recognitional Justice,** which concerns acknowledgement of differing needs within the energy system across different populations; and
(4) **Restorative Justice,** which concerns the duty of energy sector actors to rectify past injustices.

There are others modes of justice discussed within the literature, of course. Among them, Baker emphasizes the need to center marginalized voices and McHarg et. al. note the importance of inter-generational, global, and spatial justice.

In Shelly Welton and Joel Eisen's 2019 paper charting the emergence of clean energy justice from a legal perspective, they write that "as energy law scholars approaching issues of justice, [they] are distinctly attuned to the perils of losing or transforming the voices of affected communities as [they] channel their concerns into academic, analytical frames."[75] I, too, strive to be thoughtful in recognizing that a discussion of incorporating principles of justice into integrated resource planning processes from an academic perspective is inherently distant from the communities it most impacts.

Resource planning is one of several key steps in determining the lived experience of electrical service for millions of Americans. The ways that our electricity system impacts communities are diverse and individual and range from disproportionate burdens of legacy fossil-fuel infrastructure to a lack of access to opportunities in the emerging clean energy economy.[76] Integrated resource planning currently centers around cost metrics that aren't explicitly designed with disparate

---

[75] Welton and Eisen, "Clean Energy Justice."
[76] Carley and Konisky, "The Justice and Equity Implications of the Clean Energy Transition."

outcomes and justice in mind. In order to better serve the public interest, it may be necessary to reassess the existing set of success metrics. To that end, I discuss several mechanisms that can be revived or developed as justice moves closer to the center of these critical debates.

5.2. Current Processes & Potential Solutions

Welton and Eisen outline the difficulties of incorporating justice into deeply technical processes. Clean energy legislation is proliferating across the country, yet legislation often isn't sufficiently detailed to provide guidance to those people responsible for implementing the laws. Instead, questions of distribution, procedure, and recognition are handed to policymakers at the "sub-legislative level," most commonly in state utility commissions. Commission staff and commissioners are already tasked with ensuring the reliability and cost-effectiveness of the electricity grid – no small task. Energy justice considerations, when they do happen to appear in energy legislation, aren't often prioritized.[77]

Beyond the actual staff at utility commissions, electricity consumers generally have some form of representation. However, in many states, consumer advocates are consumers' sole mandated representative, and their responsibilities differ widely based on statute. Many are duty-bound to consider primarily how any energy policy will affect consumer cost, with a strong motivation to find the lowest possible cost solution to any issue brought to the commission. Public participation beyond consumer advocacy is limited. Daley and Reames find great promise in public participation's ability to promote justice concerns in the environmental sphere, but it is contingent on continued maintenance of the administrative mechanisms that support such public participation.[78]

[77] Welton and Eisen, "Clean Energy Justice."
[78] Daley and Reames, "Public Participation and Environmental Justice."

In the following sections, I address three methods for incorporating justice considerations into integrated resource planning process, from those which are already underway to the most incipient. I begin by outlining the current national conversation around intervenor compensation and detail how state and federal regulatory bodies diverge in compensating external intervenors for their participation in integrated resource and other planning processes. Section 5.4 discusses the potential to incorporate energy justice assessments into IRPs in the same way that environmental and health assessments are required by some jurisdictions. Finally, I discuss energy democratization and other methods that require a greater restructuring of utility regulation itself. For the purposes of this chapter, I do not return to the four state-level case studies, as justice considerations are not yet routine enough in each of the IRP states to provide a sufficient comparison between the four. Instead, I point to states which have particularly exemplary modes of incorporating equity into their existing processes. Ultimately, I aim to provide a template for commissions and other decisionmakers to consider appropriate options as more of their constituents demand assessments in the justice and equity space.

5.3. Intervenor Compensation

Intervenor compensation programs are common in regulatory bodies across the country. Simply put, regulators pay people or organizations who provide substantive input into the regulatory discussion for their time and effort toward that input. In his 1990 review of the California Public Utilities Commission's public participation programs, James Wheaton wrote, "the concept of intervenor funding is neither new nor difficult."[79]

In the first months of 2021, amidst the Biden Administration transition, the Federal Energy Regulatory Commission (FERC) renewed its conversation around equity and public participation.

---

[79] Wheaton, "Funding Consumer Representation."

FERC announced in March of 2021 that it would establish and operate a new Office of Public Participation, originally authorized in section 319 of the Federal Power Act (FPA).[80] FERC then hosted a set of workshops designed to receive input and feedback on how best to establish the new office, and to collect insight from state regulators intimately familiar with public participation processes. One of these meetings specifically related to intervenor compensation, and the presentations represent some of the most current conceptions of intervenor compensation programs and how regulators in 2021 should consider them.[81] At this meeting, Sharon Jacobs outlined the key features of existing state-level intervenor compensation programs and provided the agency with guiding questions for shaping such programs:

(1) **Compensation decision-makers** : attorneys within the general counsel's office, a board made up of internal or external officials, and/or agency staff
(2) **Funding eligibility:** How significant is the participant's work? Are they a regulated interest? Was their involvement similar to another stakeholder with similar interests?
(3) **Compensation Parameters:** What services are covered, at what rates, and when in the regulatory process?
(4) **Program Evaluation:** What internal reports are maintained? Is there an external monitor? Can regulators measure whether the intervenor program truly incentivizes participation from a broader range of stakeholders?

Several other presenters pointed to the complexities embodied in answering each of Jacobs' questions above. While outlining the existing intervenor compensation program in Michigan, Paul Iseley, the Interim Chair of Michigan's Utility Consumer Participation Board noted that their program only provides funding for a narrow set of intervenors, particularly those representing

---

[80] "16 U.S.C. § 825q–1"; Federal Energy Regulatory Commission, "Workshop Regarding the Creation of the Office of Public Participation | Docket No. AD21-9-000."
[81] Federal Energy Regulatory Commission, "Panel 5: Intervenor Funding, Bios and Testimony," 5.

residential consumers. While this allows for targeted intervention, it also excludes groups that would otherwise be interested in participation.

Mark Toney, the Executive Director of the Utility Reform Network (TURN) made six recommendations specifically aimed at bringing "diverse community voices, rich data, and innovative alternatives to FERC decision-making, all of which are inspired by existing state programs and can be applied to those that don't already have programs." His recommendations include setting clear requirements and standards, providing clear and limited timelines for funding turnaround, and providing clarity around compensation for parties with similar interests. [82]

Section 122 of the federal Public Utility Regulatory Policies Act (PURPA) provides specific guidance to states on intervenor funding. Given no existing consumer representation (such as a dedicated consumer advocate) PURPA directs that utilities are liable to compensate consumers for all fees and reasonable costs associated with participating in the proceeding. This compensation is contingent on "substantial" contribution from the intervenor. While Section 122 mandates intervenor compensation in the absence of a consumer advocate, there are jurisdictions that make use of both, to a positive effect.[83]

There is some indication that intervenor compensation may soon receive renewed attention at the state level. Currently, eight states include participant compensation in their statutes. (See Appendix 2 for a full list of state-level programs.) Intervenor compensation, of some kind, is included in three pairs of bills introduced in 2021 in the Illinois state legislature.[84] A proposal to

---

[82] Federal Energy Regulatory Commission, 5.
[83] "NH Rev Stat § 365:38-a (2019)."
[84] Buckner, Consumers & Climate First Act; Gillespie, Public Utilities Intervenor Compensation Act; Castro, Clean Energy Jobs Act.

reform the existing intervenor program in Minnesota was also recently introduced,[85] as was a proposal in Hawaii to add an intervenor compensation program in addition to the services already provided by the state consumer advocate.[86] These programs emerge thanks to a small group of advocates committed to ensuring access to regulatory proceedings across the country, and represent a promising trend toward public participation.[87]

5.4. Energy Justice Assessments

Of 30 reviewed IRP rules and regulations, I identified only three that included specific language related to justice, equity, or disparate impacts on communities. While this doesn't mean that these topics aren't built into the IRP process in other ways, there are only three states where justice and equity are explicitly referenced in the statute or in commission decisions regarding filed integrated resource plans. (See Appendix 1 for a list of referenced IRP rules and regulations.)

The State of Washington is the only state where "equity" or "justice" are explicitly referenced in the statute. Washington requires that utility IRP work plans must include "a proposed schedule of meetings for the utility's resource planning advisory group and equity advisory group" as outlined in the rules set for public participation. Washington's statute directs the utility to encourage the participation of "environmental justice and public health advocates, tribes, and representatives from highly impacted communities and vulnerable populations in addition to other relevant groups."[88] Puget Sound Energy (PSE) convened its inaugural Equity Advisory Group as required by statute in 2021. The group is scheduled to meet 10 times to advise on components of PSE's proposed Clean Energy Implementation Plan.[89]

---

[85] Frentz, Public Utilities Commission proceedings participant's compensation authorization.
[86] Gabbard, Chang, and Ruderman, Relating to the Public Utilities Commission.
[87] Slocum, "Energy Affordability: A National Perspective."
[88] "WAC 480-100-625."
[89] Puget Sound Energy, "Clean Energy Implementation Plan."

The California PUC's Decision 18-02-018[90] requires each LSE to address impacts on disadvantaged communities within their IRP. They encourage the LSEs to conduct outreach to communities ahead of their IRP analysis and set measurable evaluation criteria to assess their progress. This resulted in all LSEs including an analysis of "Local Air Pollutant Minimization and Disadvantaged Communities" in their most recent published plans.[91]

The Michigan Public Service Commission (MPSC) actually responded to requests to incorporate questions around environmental justice into planning proceedings in 2017 by finding that such issues are better addressed in CON proceedings (Certificate of Necessity proceedings for new builds or investments into power plants) rather than IRP processes.[92] They argued that CON proceedings, which deal with siting questions, are a more appropriate arena for the discussion. The implied assumption in this decision is that that justice and equity issues are limited only to questions of siting. While this kept equity and justice from the IRP conversation, in October 2020 Michigan Governor Gretchen Whitmer signed an executive order directing the MPSC to "include considerations of environmental justice and health impacts under the Michigan Environmental Protection Act" via the IRP process. Notably, the focus of Michigan's advocacy continues to be in the environmental justice realm, as opposed to energy justice explicitly. The results of the executive order are as of yet unknown.[93]

Each of these requirements demonstrates a different path for centering justice issues in utility resource plans, as outlined in **Table 5**. Neither the Washington nor Michigan policies have reached a point where we might appropriately assess their efficacy. The California requirement is the

---

[90] "Decision Setting Requirements for Load Serving Entities Filing Integrated Resource Plans."
[91] PG&E, "Integrated Resource Plan 2020"; The University of California, "Standard LSE Plan: The Regents of the University of California 2020 Integrated Resource Plan"; San Jose Clean Energy, "Standard LSE Plan: San Jose Clean Energy 2020 Integrated Resource Plan."
[92] "In the Matter, on the Commission's Own Motion, to Implement the Provisions of Section 6s of 2016 PA 341."
[93] "Executive Directive No. 2020-10."

longest-standing, but without a comparable program it is difficult to place its success in the context of other potential state action.

Table 5. State Policies Related to Equity & Justice in Integrated and their Procedural Effect

State	Policy	Procedural Effect
California	CPUC Decision 18-02-018	Each California LSE includes an analysis of "local air pollutant minimization and disadvantaged communities" in their IRP.
Washington	WAC 480-100-655	The IRP process convenes an Equity Advisory Group to advise on issues related to equity in the context of utility clean energy implementation plans.
Michigan	Executive Directive 2020-10	Advisory decisions from the MPSC related to utility IRPs must include considerations of environmental justice and health impacts.

The existence of policies that require assessments of energy and environmental justice are the very first but essential step in setting standards for including justice in these highly technical resource planning processes. Advocacy organizations often outline best practices for achieving energy justice pursuits. The NAACP, for example, provides specific guidance on advocacy around renewable portfolio standards, energy efficiency standards, net metering standards, distributed generation, and community renewable energy.[94] The next step in this process is to develop research and specific recommendations for the inclusion of energy justice topics in integrated resource planning processes for traditionally-regulated utilities.

5.5. Emerging Trends in Utility Democratization & Public Power

In her essay in *All We Can Save*, Mary Ann Hitt details the ways that the Sierra Club's Beyond Coal campaign has been successful. One of her central recommendations is that advocates must

[94] NAACP Environmental and Climate Justice Program (ECJP), "Just Energy Policies: Model Energy Policies Guide."

understand economics because, so often, economic arguments drive change in utility proceedings. She also points to the importance of centering environmental justice when pursing change.[95] Economic arguments are indeed a critical method for moving the needle on long-term energy planning. Sections 3 and 4 of this paper illustrate some of the complex decision-making processes that surround economic questions in IRP proceedings. There are economic arguments to make that also benefit disadvantaged communities. However, those economic arguments do not comprise all impacts or outcomes. While funding intervenors and ensuring routine assessments of equity in IRPs will ensure progress toward recognition of issues of equity and distribution, those methods are still rooted in the cost-benefit assessment model that undergirds long-term resource planning. Discussion is increasing around methods for planning that diverge from the existing regulatory model. The question is: do those methods serve communities better than those that already exist?

Shalanda Baker describes the perverse set of incentives for investor-owned utilities (IOUs) that drive questions around publicly- or cooperatively-owned power. She describes IOUs as "ultimately accountable to shareholders or, in the case of a utility in a bankruptcy proceeding, the utility's creditors." Meanwhile, she writes, "cooperatives take the concept of public power literally" – members with an ownership stake elect their leaders.[96] Utilities, however, are stuck between two types of oversight: their shareholders and the public they serve. The notion of what is in the "public interest" has transformed over time. As the public interest in utility regulation is increasingly decoupled from growth in the form of major capital investments and power is further decentralized (spurred by community and distributed solar and other renewable programs), the IOU model will need to evolve.[97]

[95] Hitt, "Beyond Coal."
[96] Baker, *Revolutionary Power*.
[97] Peskoe, "Unjust, Unreasonable, and Unduly Discriminatory."

A segment of the progressive left has repeatedly called for a "democratization" of power, or shifting the system to some proportion of public ownership. This is not a novel idea, but it has reached a notable level of visibility in the public discourse. Vermont Senator Bernie Sanders even included a proposal to transition all utilities to public ownership, to be overseen by four regional power market administrators (plus DOE support for community choice aggregation and other publicly-owned programs), in his presidential campaign platform.[98] But would a full shift to public power really transform the system for the betterment of community outcomes, or would a government-run utility fall prey to the same modes of injustice as the existing system? While Baker advocates for community energy policy as a better pathway to an equitable and just future, she also notes that some forms of community power ownership simply mirror the White supremacist patterns that already exist in those communities.[99]

Far more research is needed on the topic of regulatory reform toward public ownership. I propose several guiding questions for that work, with integrated resource planning in mind:

- What metrics, both qualitative and quantitative, should policymakers use to assess the success of public utility regulation? How do those metrics change as the electricity is (1) more reliant on clean technology and/or (2) increasingly decentralized?
- Is a least-cost optimization standard still an appropriate core feature of integrated resource planning? Can distributive issues be appropriately valued and incorporated into a cost-based assessment?
- Who regulates the system, and why? What is the role for stakeholders without technical expertise? Furthermore, how can regulators leverage the vast pool of utility expertise?
- What does direct outreach to communities look like under a new regulatory structure? What is the role of education, assessment and dialogue?

---

[98] "The Green New Deal."
[99] Baker, *Revolutionary Power*.

6. Conclusion

This paper is not aimed at determining which modeling software, what capacity value, or what energy justice mechanism will lead to the optimal integrated resource plan. Instead, it aims to identify similarities in IRP rule- and decision-making that spur effective stakeholder processes. The energy sector in the United States has transformed within decades before and, as recognition of the global challenge of climate change incites a wave of clean energy innovation and activism, we can expect that another transition is in progress. State regulatory structures are as strong as they are adaptable. Integrated resource planning processes provide a potential stage for important discussion about the rapid energy transition, but can only provide that platform as long as these processes remain nimble and become increasingly inclusive of new technologies and actors. Ultimately, commissions must continually re-assess IRPs to ensure they serve the core purpose of a regulated utility: the public good.

Economic modeling software must be well selected and correctly used in order to best represent a shifting energy landscape. IRP structures that invite feedback, like those mandated by the state of Michigan for DTE Energy, encourage consistent consideration of the models in use. They invite both technical and non-technical actors to understand how those tools will represent the state's energy future and influence investment decisions. States that don't invite such feedback or mandate model oversight, like Georgia, risk falling behind on modeling software and incorrectly assessing the value of their systems. That is not to say that utilities are not making smart decisions about model software, or that advocates hold the best knowledge on the subject. Simply, a commission-led process ensures that models and methodologies are routinely assessed in an industry that is constantly transforming.

Capacity values are just one model input. This paper aims to illuminate the detailed iterative consideration by utilities, their regulators, and intervenors, on finding the best inputs to represent the current system. This paper suggests three areas to watch regarding capacity values: (1) the expanded presence of value-of studies for all resources, (2) the application of apples-to-apples capacity value comparisons, and (3) an assurance that unforced outages of traditional baseload plants are reflected. Each of the thousands of input assumptions in IRP modeling must be reinvestigated as often as a utility undergoes the planning process; and where advocates and commissions can provide guidance on national trends, they will increase model accuracy and process efficiency. Where utilities ultimately hold the most knowledge about their own technical and financial operations, sharing their methodologies transparently may provide benefits beyond their service territories.

Finally, there is a true and urgent need to consider how equity and justice are present (or, more accurately, *not* present) in IRP and similar utility proceedings. Intervenor funding is a well-known mechanism that might be revamped across many states to incentivize greater community participation. Energy justice assessments could follow the same path as environmental assessments, and more research is needed on how best to incorporate that work into IRP. And where it is appropriate, utilities, their regulators, and the communities they serve must reckon with how community and public ownership of power may transform the electricity system in the decades to come.

Through these case studies, this paper explored three avenues for reforming IRP processes: (1) written IRP rules, (2) commission procedures and orders, and (3) internal utility processes. Major barriers to change exist for all three, and thus they are slow to adapt to a rapidly changing energy system. By promoting transparency and access, policymakers could spur necessary transformation that would deeply strengthen planning processes. As clean energy legislation flourishes, IRP rules should be reexamined both by industry experts and the communities they affect. Commission procedures designed to solicit feedback and use qualitative metrics for success could have a profound impact. Finally, utility processes should involve commission staff and external stakeholders early and often. While mechanisms for change differ across jurisdictions, setting standard principles for transparency and access will only strengthen the technical modeling outcomes of IRP processes and provide an opportunity for true consideration of equity and justice.

Appendix 1. IRP Rules & Regulations [100]

Arizona: Decision No. 71722, in Docket No. RE-00000A-09-0249. June 3, 2010

Arkansas: Docket 06-028-R

California: R1602007, Decision 1802018

Colorado: Colorado PUC. 4 CCR 723-3, Part 3603: Rules Regulating Electric Utilities.

Connecticut: Public Act 11-80

Delaware: 26 Del. C. § 1007 HB 6, the Delaware Electric Utility Retail Customer Supply Act of 2006

Florida: Fl Code 25-22.071

Georgia: Georgia Public Service Commission. General Rules. Integrated Resource Planning 515-3-4

Hawaii: Docket No. 2009 0108

Idaho: Order No. 22299, in Case No. U-1500-165.

Indiana: Indiana Code § 8-1-8.5-3(e)(2)

Kentucky: 807 KY Administrative Regulation 5:058.

Louisiana: Louisiana Public Service Commission Corrected General Order. Docket No. R-30021.

Michigan: Case No. U-18461, 2017 PA 341, 2008 PA 286

Minnesota: MN Administrative Rules 7843.0300

Missouri: 4 CSR 240.22

Montana: Administrative Rules of Montana 38.5.2001-2016. Administrative Rules of Montana 38.5.8201-8227.

Nebraska: 10 CFR Part 905

Nevada: NRS 704.741 and 704.7316

New Hampshire: Title XXXIV Public Utilities, Chapter 378: Rates and Charges, Section 38: Least Cost Energy Planning

New Mexico: New Mexico Administrative Code Title 17, Chapter 7, Part 3

North Carolina: North Carolina Utilities Commission Rule R8-60

North Dakota: North Dakota PSC Order issued on January 27, 1987 in Case No. 10,799. Amended in Case No. PU-399-91-689.xxii

Ohio: Ohio Rev. Code §4901:5-3-01

Oklahoma: OAC 165:35-37-4.

Oregon: Oregon PUC Order No. 07-002,

Pennsylvania: 66 Pa. Stat. § 524

South Carolina: Code of Laws of South Carolina, Chapter 37, Section 58-37-40

South Dakota: South Dakota SL 1977, Ch 390, § 23. Chapter 49-41B-3

Utah: Docket No. 90-2035-01

Vermont: 30 V.S.A. § 218c

Virginia: Code of Virginia § 56-599

Washington: WAC 480-100-238 (4)

West Virginia: WV Docket: GO 184.35

Wyoming: Wyoming Public Service Commission Rule 253

[100] I used Advanced Energy Economy's PowerSuite tool extensively, which makes gathering regulatory information immeasurably easier. I also relied heavily on Wilson & Biewald's *Best Practices in Integrated Resource Planning.*

Appendix 2. State Intervenor Compensation Programs [101]

California: California Public Utilities Code § 1801-1812
Colorado: Colorado Revised Statues § 40-6.5-105
Idaho: Idaho Public Utility Regulation Title 61 § 61-617A
Maine: Maine Public Utilities § 1310
Michigan: Public Act 3 of 1939 MCLA 460.6(1)
New Hampshire: New Hampshire Statute § 365:38-A
Oregon: Oregon UM 1929
Wisconsin: Wisconsin Statute § 196.31

[101] Slocum, "DECIPHERING ISO-NE, NEPOOL & FERC: THE ACRONYMS DRIVING NEW ENGLAND ENERGY + CLIMATE POLICY"; Low-Income Solar Policy Guide, "State Intervenor Compensation."

References

16 U.S.C. § 825q–1

170 Indiana Administrative Code § 4-7

2018 Biennial Integrated Resource Plans and Related 2018 REPS Compliance Plans, No. E-100 Sub 157.

Allison, Avi. "Direct Testimony of Avi Allison on Behalf of Michigan Environmental Council, Natural Resources Defense Council, and Sierra Club." Michigan Public Service Commission, August 21, 2019. https://mi-psc.force.com/s/filing/a00t000000DjXSXAA3/u204710339.

Anchor Power. "DTE Electric Company Selects EnCompass Software." *Anchor Power Solutions* (blog), November 30, 2020. https://anchor-power.com/news/dte-electric-company-selects-encompass-software/.

Anchor Power Solutions. "Duke Energy Impemented EnCompass Software." *News* (blog), May 7, 2020. anchor-power.com/news/duke-energy-implemented-econompass-software.

Applied Economics Clinic. "SACE, Sierra Club and NRDC's Initial Comments - Public, Attachment 2: Review of Duke Energy's North Carolina Coal Fleet in the 2018 Integrated Resource Plans." North Carolina Utilities Commission, March 7, 2019. https://starw1.ncuc.net/NCUC/PSC/PSCDocumentDetailsPageNCUC.aspx?DocumentId=8e114351-42c5-4f8b-bfa6-49edb6f6b7c7&Class=Filing.

Attorney General's Office. "Initial Comments on Duke's Integrated Resource Plan." North Carolina Utilities Commission, March 7, 2019. https://starw1.ncuc.net/NCUC/PSC/PSCDocumentDetailsPageNCUC.aspx?DocumentId=dff7027d-4fee-4037-9a3a-3f0a68dedda2&Class=Filing.

Baker, Shalanda. *Revolutionary Power: An Activist's Guide to the Energy Transition*. Island Press, 2021.

Branson, Estella. "DTE Electric Company's Official Exhibits A-1 through A-32." Michigan Public Service Commission, October 10, 2019. https://mi-psc.force.com/s/filing/a00t000000DXcOeAAL/u204710494.

Buckner, Kambium. Consumers & Climate First Act, Pub. L. No. HB4074 (2021).

CAL. PUB. UTIL. CODE § 202

Carley, Sanya, and David M. Konisky. "The Justice and Equity Implications of the Clean Energy Transition." *Nature Energy* 5, no. 8 (August 2020): 569–77. https://doi.org/10.1038/s41560-020-0641-6.

Carvallo, J. P., P. H. Larsen, A. H. Sanstad, and C. A. Goldman. "Long Term Load Forecasting Accuracy in Electric Utility Integrated Resource Planning." *Energy Policy* 119, no. Q. Rev. Econ. Bus. 1977 (August 1, 2018): 410–22. https://doi.org/10.1016/j.enpol.2018.04.060.

Castro, Cristina. Clean Energy Jobs Act, Pub. L. No. SB 1718 (2021).

Daley, Dorothy M., and Tony G. Reames. "Public Participation and Environmental Justice: Access to Federal Decision Making." In *Failed Promises: Evaluating the Federal Government's Response to Environmental Justice*, 143–71. The MIT Press, 2015. http://direct.mit.edu/books/book/2249/chapter/59136/Public-Participation-and-Environmental-Justice.

"Decision Setting Requirements for Load Serving Entities Filing Integrated Resource Plans." Public Utilities Commission of the State of California, February 13, 2018. https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M209/K771/209771632.PDF.

Dent, C.J., A. Keane, and J.W. Bialek. "Simplified Methods for Renewable Generation Capacity Credit Calculation: A Critical Review." In *IEEE PES General Meeting*, 1–8, 2010. https://doi.org/10.1109/PES.2010.5589606.

Detsky, Mark D. "Direct Testimony of Mark D. Detsky on Behalf of Southern Alliance for Clean Energy and Southern Renewable Energy Association." Georgia Public Service Commission, April 25, 2019. https://psc.ga.gov/search/facts-document/?documentId=176693.

DTE Electric Company. "2019 Integrated Resource Plan." Michigan Public Service Commission, October 10, 2019. https://mi-psc.force.com/s/filing/a00t000000DXcOeAAL/u204710494.

———. "DTE Electric's Integrated Resource Plan (IRP) | Modeling Software Collaborative Summary Report." Michigan Public Service Commission, June 18, 2020. https://mi-psc.force.com/sfc/servlet.shepherd/version/download/068t000000CIEbLAAX.

Duane, Timothy P. "Regulation's Rationale: Learning from the California Energy Crisis." *Yale Journal on Regulation* 19, no. 2 (Summer 2002): 471–540.

Duke Energy. "IRP Reference Information Portal." Duke Energy. *Carolinas Integrated Resource Planning* (blog), duke-energy.com/Our-Company/IRP.

Duke Energy Carolinas. "North Carolina Integrated Resource Plan: 2020 Biennial Report," December 2020.

———. "North Carolina Integrated Resource Plan: Attachment II," September 1, 2020.

Energy Transition Act of 2019, S.B. 489, 54th Legislature (NM).

ERCOT. "Update to April 6, 2021 Preliminary Report on Causes of Generator Outages and Derates During the February 2021 Extreme Cold Weather Event." April 27, 2021. http://www.ercot.com/content/wcm/lists/226521/ERCOT_Winter_Storm_Generator_Outages_By_Cause_Updated_Report_4.27.21.pdf.

"Executive Directive No. 2020-10." The State of Michigan, September 23, 2020. https://www.michigan.gov/whitmer/0,9309,7-387-90499_90704-540278--,00.html.

Farnsworth, David. "Revisiting the Public Good, Part 2: What Do We Mean by 'Good'?" *Regulatory Assistance Project* (blog), October 26, 2020. http://www.raponline.org/blog/revisiting-the-public-good-part-2-what-do-we-mean-by-good/.

Federal Energy Regulatory Commission. "Energy Primer: A Handbook for Energy Market Basics," April 2020. https://www.ferc.gov/sites/default/files/2020-06/energy-primer-2020_Final.pdf.

———. "Panel 5: Intervenor Funding, Bios and Testimony." Presented at the Workshop Regarding the Creation of the Office of Public Participation, April 16, 2021. https://www.ferc.gov/media/opp-panel-5-bios-and-testimony.

———. "Workshop Regarding the Creation of the Office of Public Participation | Docket No. AD21-9-000," March 2021. https://www.ferc.gov/news-events/events/workshop-regarding-creation-office-public-participation-04162021.

Frentz, Nick. Public Utilities Commission proceedings participant's compensation authorization, Pub. L. No. SF1621 (2021).

Ga. Comp. R. & Regs. 515-3-4-.01

Gabbard, Mike, Stanley Chang, and Russell Ruderman. Relating to the Public Utilities Commission, Pub. L. No. SB2733 (2020).

Garver, L. L. "Effective Load Carrying Capability of Generating Units." *IEEE Transactions on Power Apparatus and Systems* PAS-85, no. 8 (August 1966): 910–19. https://doi.org/10.1109/TPAS.1966.291652.

Georgia Power Company. "2019 Integrated Resource Plan." Georgia Public Service Commission, January 31, 2019. https://psc.ga.gov/search/facts-document/?documentId=175473.

Gillespie, Ann. Public Utilities Intervenor Compensation Act, Pub. L. No. SB2295 (2021).

Girouard, Coley. "Understanding IRPs: How Utilities Plan for the Future." *Advanced Energy Perspectives* (blog), May 2020. https://blog.aee.net/understanding-irps-how-utilities-plan-for-the-future.

Goggin, Michael S. "Direct Testimony of Michael S. Goggin on Behalf of Southern Renewable Energy Association." Georgia Public Service Commission, April 25, 2019. https://psc.ga.gov/search/facts-document/?documentId=176695.

Grubb, Jeffrey R., Narin Smith, Michael A. Bush, and Jeffrey B. Weathers. "Rebuttal Testimony of the Panel of Jeffrey R. Grubb, Narin Smith, Michael A. Bush and Jeffrey B. Weathers."

Georgia Public Service Commission, April 25, 2019. https://psc.ga.gov/search/facts-document/?documentId=177179.

Harvard Environmental & Energy Law. "Ari Peskoe Speaks with Leah Stokes about Interest Groups, Utilities, and Clean Energy Policy." CleanLaw. https://eelp.law.harvard.edu/2020/06/cleanlaw-ari-peskoe-speaks-with-leah-stokes-about-state-clean-energy-policies/.

Hirst, Eric. "What Constitutes a Good Integrated Resource Plan?" *Utilities Policy* 4, no. 2 (1994): 141–53.

Hitt, Mary Anne. "Beyond Coal." In *All We Can Save: Truth, Courage, and Solutions for the Climate Crisis*, edited by Ayana Elizabeth Johnson and Katharine K. Wilkinson, 61–73. One World, 2020.

"In the Matter, on the Commission's Own Motion, to Implement the Provisions of Section 6s of 2016 PA 341." Michigan Public Service Commission, November 21, 2017. https://mi-psc.force.com/s/filing/a00t0000005pV0LAAU/u184180065.

Knee, Jeremy. "Rational Electricity Regulation: Environmental Impacts and the Public Interest." *West Virginia Law Review* 113, no. 3 (2011 2010): 739–90.

Low-Income Solar Policy Guide. "State Intervenor Compensation," December 2020. https://www.lowincomesolar.org/wp-content/uploads/2020/12/State-Intervenor-Compensation.pdf.

Maggie Thomas. "The Politics of Policy." In *All We Can Save: Truth, Courage, and Solutions for the Climate Crisis*, edited by Ayana Elizabeth Johnson and Katharine K. Wilkinson. One World, 2020.

McHarg, Aileen. *Energy Justice: Understanding the 'Ethical Turn' in Energy Law and Policy*. *Energy Justice and Energy Law*. Oxford University Press. https://oxford.universitypressscholarship.com/view/10.1093/oso/9780198860754.001.0001/oso-9780198860754-chapter-2.

Michigan Compiled Laws § 460.6g

Michigan Compiled Laws § 460.6t

"Michigan Integrated Resource Planning Parameters: Pursuant to Public Act 341 of 2016, Section 6t." Michigan Public Service Commission, November 21, 2017. https://www.michigan.gov/documents/mpsc/11-21-2017_MIRPP_Final_606706_7.pdf.

Michigan Public Service Commission. In the matter of the application of DTE ELECTRIC COMPANY for approval of its integrated resource plan pursuant to MCL 460.6t and for other relief. (2020).

———. “Order Recommending Changes to the Filed Integrated Resource Plan.” Michigan Public Service Commission, February 20, 2020. https://mi-psc.force.com/s/filing/a00t000000F9LQwAAN/u204710730.

Midcontinent Independent System Operator, Inc. “Planning Year 2021-2022 Wind & Solar Capacity Credit Draft Report,” January 26, 2020. https://cdn.misoenergy.org/2021%20Wind%20&%20Solar%20Capacity%20Credit%20Report503411.pdf.

Munn v. Illinois, 94 U.S. 113 (1876)

NAACP Environmental and Climate Justice Program (ECJP). “Just Energy Policies: Model Energy Policies Guide.” Baltimore, MD: National Association for the Advancement of Colored People, 2017. https://www.naacp.org/wp-content/uploads/2014/03/Just-Energy-Policies_Model-Energy-Policies-Guide_NAACP.pdf.

New Energy Economy. “New Energy Economy’s Motion to Compel Discovery from PNM.” New Mexico Public Regulation Commission, May 31, 2018.

———. “New Energy Economy’s Post Hearing Brief.” New Mexico Public Regulation Commission, June 24, 2018.

———. “New Energy Economy’s Response Brief.” New Mexico Public Regulation Commission, July 31, 2018.

Daily Energy Insider. “New Mexico Commission to Allow Energy Storage in Integrated Resource Plans,” August 10, 2017. https://dailyenergyinsider.com/news/7112-new-mexico-commission-allow-energy-storage-integrated-resource-plans/.

NH Rev Stat § 365:38-a (2019)

NM Administrative Code. 17.7.3

North Carolina Utilities Commission. “Order Accepting Integrated Resource Plans and Reps Compliance Plans, Scheduling Oral Argument, and Requiring Additional Analyses.” North Carolina Utilities Commission, August 27, 2019. https://starw1.ncuc.net/NCUC/PSC/PSCDocumentDetailsPageNCUC.aspx?DocumentId=4affabb5-d070-4395-adf6-07cadd282ead&Class=Order.

North Carolina Utilities Commission Rule R8-60

O’Connell, Pat. “PNM 2017-2036 Integrated Resource Plan Analysis Tools and Plans.” November 10, 2016. https://www.pnm.com/2017-irp-meetings.

Peskoe, Ari. “Unjust, Unreasonable, and Unduly Discriminatory: Electric Utility Rates and the Campaign Against Rooftop Solar.” SSRN Scholarly Paper. Rochester, NY: Social Science Research Network, February 1, 2016. https://papers.ssrn.com/abstract=2735789.

PG&E. "Integrated Resource Plan 2020," September 1, 2020. https://www.pge.com/pge_global/common/pdfs/for-our-business-partners/energy-supply/integrated-resource-planning/2020-PGE-Integrated-Resource-Plan.pdf.

Pielke, R. "The Role of Models in Prediction for Decision," 2003. /paper/The-Role-of-Models-in-Prediction-for-Decision-Pielke/cea4c38f5285f90d6e953e65374f3f6e7c021ce7.

PJM Interconnection. "Analysis of Operational Events and Market Impacts During the January 2014 Cold Weather Events," May 8, 2014. https://www.hydro.org/wp-content/uploads/2017/08/PJM-January-2014-report.pdf.

PNM Resource Planning Team. "PNM 2020-2040 Integrated Resource Plan," January 29, 2021. https://www.pnmforwardtogether.com/assets/uploads/PNM-2020-IRP-FULL-PLAN-NEW-COVER.pdf.

Public Service Company of New Mexico. "PNM 2017-2036 Integrated Resource Plan," July 3, 2017. https://www.pnm.com/documents/396023/396193/pnm+2017+irp+final.pdf/eae4efd7-3de5-47b4-b686-1ab37641b4ed.

Puget Sound Energy. "Clean Energy Implementation Plan." Puget Sound Energy, April 2021. https://www.cleanenergyplan.pse.com/.

San Jose Clean Energy. "Standard LSE Plan: San Jose Clean Energy 2020 Integrated Resource Plan," September 1, 2020. https://sanjosecleanenergy.org/wp-content/uploads/2020/09/San-Jose-Clean-Energy-2020-Integrated-Resources-Plan-Public-Version.pdf.

Slocum, Tyson. "DECIPHERING ISO-NE, NEPOOL & FERC: THE ACRONYMS DRIVING NEW ENGLAND ENERGY + CLIMATE POLICY." Presented at the Association of Energy Engineers 2019 Conference, Boston, MA, March 21, 2019. https://mkus3lurbh3lbztg254fzode-wpengine.netdna-ssl.com/wp-content/uploads/AEEboston2019.pdf.

———. "Energy Affordability: A National Perspective." Presented at the NYSERDA 2018 Low-Income Forum on Energy, May 23, 2018. https://www.nyserda.ny.gov/-/media/Files/EDPPP/LIFE/Conferences/2018/3-Plenary.pdf.

Sommer, Anna. "Direct Testimony on Behalf of the Environmental Law & Policy Center, the Ecology Center, the Solar Energy Industries Association, the Union of Concerned Scientists, and Vote Solar, and on Behalf of MiEIBC." Michigan Public Service Commission, August 21, 2019. https://mi-psc.force.com/s/filing/a00t000000DjXJaAAN/u204710338.

Sovacool, Benjamin K., and Michael H. Dworkin. *Global Energy Justice: Problems, Principles, and Practices*. Cambridge University Press, 2014.

Bernie Sanders Official Website. "The Green New Deal," May 2021. https://berniesanders.com/issues/green-new-deal/.

The University of California. "Standard LSE Plan: The Regents of the University of California 2020 Integrated Resource Plan," September 1, 2020. https://www.ucop.edu/energy-services/_files/ucop_v1_public.pdf.

WAC 480-100-625

Welton, Shelley, and Joel B. Eisen. "Clean Energy Justice: Charting an Emerging Agenda." SSRN Scholarly Paper. Rochester, NY: Social Science Research Network, September 28, 2018. https://papers.ssrn.com/abstract=3256819.

Wheaton, James R. "Funding Consumer Representation: Failed Models and Fresh Approaches." *California Regulatory Law Reporter* 10, no. 1 (1990): 1–11.

Wilson, Rachel. "Direct Testimony of Rachel Wilson on Behalf of Sierra Club." Georgia Public Service Commission, April 25, 2019. https://psc.ga.gov/search/facts-document/?documentId=176702.

Wilson, Rachel, and Bruce Biewald. "Best Practices in Electric Utility Integrated Resource Planning." The Regulatory Assistance Project, June 21, 2013. https://www.raponline.org/knowledge-center/best-practices-in-electric-utility-integrated-resource-planning/.