DOE/EE-2276

SEE Action

STATE & LOCAL ENERGY EFFICIENCY ACTION NETWORK

Combined Heat and Power in Integrated Resource Planning: Examples and Planning Considerations

Industrial Energy Efficiency and Combined Heat and Power Working Group

November 2020

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The work described in this study was funded by the U.S. Department of Energy's (DOE) Advanced Manufacturing Office, Office of Energy Efficiency and Renewable Energy, under Lawrence Berkeley National Laboratory Contract No. DE-AC02-05CH11231.

This study was prepared under DOE's authority to encourage and facilitate the exchange of information among State and local governments with respect to energy conservation and energy efficiency, and provide technical assistance on such matters. This study was specifically prepared for the use and dissemination of the State & Local Energy Efficiency Network (SEE Action), a DOE program that DOE and the U.S. Environmental Protection Agency facilitates, to offer resources and technical assistance to state and local decision makers as they provide low-cost, reliable energy to their communities through energy efficiency. The purpose of SEE Action is not to provide advice or recommendations to DOE or the Federal government.

This document was final as of November 4, 2020.

If this document is referenced, it should be cited as:

Meegan Kelly and Jamie Scripps. 2020. *Combined Heat and Power in Integrated Resource Planning: Examples and Planning Considerations*. Prepared by ICF for the State and Local Energy Efficiency Action Network.

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Acknowledgments

This report was prepared by Meegan Kelly and Jamie Scripps of ICF. The authors gratefully acknowledge external reviewers, internal reviewers, colleagues, and sponsors who supported this report. Tarla Toomer, Johanna Zetterberg, Sandy Glatt, Jay Wrobel, David Meyer, and Bob Gemmer of DOE, and Vestal Tutterow and Paul Sheaffer with Lawrence Berkeley National Laboratory, provided project guidance. We thank the following individuals for reviewing a draft of this report: Todd Currier of Washington State University, Nick Dreher and Greg Ehrendreich of the Midwest Energy Efficiency Alliance, Natalie Mims Frick and Lisa Schwartz of Lawrence Berkeley National Laboratory, David Gardiner and Lynn Kirshbaum of the CHP Alliance, Joan Kowal of Emory University, Dana Levy of the New York State Energy Research and Development Authority, Neeharika Naik-Dhungel and Gary McNeil of the EPA CHP Partnership, Ed Rightor of the American Council for an Energy-Efficient Economy, Ken Duvall of Sterling Energy Group, Richard Sweetser of Exergy Partners, Chris Villareal on behalf of the National Association of Regulatory Utility Commissioners, and Kirsten Verclas and Rodney Sobin of National Association of State Energy Officials. The authors also gratefully acknowledge assistance from Trent Blomberg, Bruce Hedman, Ethan Rogers, and R. Neal Elliott.

All opinions, errors and omissions remain the responsibility of the authors. All reference URLs were accurate as of the date of publication.

Acronyms

ACEEE	American Council for an Energy-Efficient Economy
AEP	American Electric Power
BTMG	Behind-the-meter-generation
CC	Combined cycle
CHP	Combined heat and power
CT	Combustion turbine
DER	Distributed energy resource
DR	Demand response
DOE	Department of Energy
EE	Energy efficiency
HRSG	Heat recovery steam generator
I&M	Indiana Michigan Power
IPL	Indiana Power & Light Company
IRP	Integrated resource plan
LCOE	Levelized cost of electricity
MDE	Missouri Division of Energy
MW	Megawatt
MWh	Megawatt hour
O&M	Operations and maintenance
PSC	Public service commission
PV	Photovoltaic
RFP	Request for Proposals
SCR	Selective catalytic reduction
TAP	Technical Assistance Partnership
WHP	Waste heat to power

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Executive Summary

As states, local governments, and utilities gain experience with new planning approaches that account for the full range of benefits of distributed energy resources (DERs), there is increased interest in the consideration of combined heat and power (CHP) as both a supply-side and demand-side resource in utility integrated resource plans (IRPs). The purpose of this report is to assist state-level policy makers, state energy offices, utility commissions, and utility system planners in exploring the role of CHP in integrated resource planning.

Significant potential exists for increasing CHP installations across the U.S. While about 81 GW of CHP capacity is in operation today, an estimated 149 GW of technically viable capacity remains to be developed. As states and utilities explore scenarios to meet energy-related goals, CHP can continue to provide value and help balance key priorities, including: 1) providing efficient and reliable electricity and thermal energy to the U.S. industrial sector; 2) increasing our power system's resilience to support our nation's critical infrastructure; 3) supporting grid integration of wind, solar, and energy storage technologies; and 4) helping the U.S. maintain its global leadership position in reducing carbon dioxide and other emissions while keeping electricity prices affordable.

An integrated resource plan (IRP) is a utility plan for meeting forecasted annual peak and energy demand through a combination of supply-side and demand-side resources over a specified future period. When developing plans for future resource options, utilities can gain value from evaluating CHP as a grid resource on the supply side, as an energy efficiency resource on the demand side, or as an overall resource solution. A handful of recent state policy activities have encouraged the consideration of CHP in utility resource plans. Policymakers in some states have updated statutory requirements or other rules to explicitly require consideration of CHP in future integrated resource plans; in other states, stakeholders have intervened in utility commission proceedings to discuss consideration of CHP and ensure utilities conduct an adequate review of CHP as a resource.

Examples of utility consideration of CHP in IRPs show that some utilities indicate a preference for owning CHP assets, while others do not take a position on ownership in their consideration of the costs and benefits of CHP. Modeling assumptions needed to characterize CHP in an IRP include: 1) resource potential; 2) customer thermal loads; and 3) CHP system characteristics. Traditionally, utilities have compared the cost-effectiveness of CHP to other resources through reference to levelized cost of electricity (LCOE). However, many features of CHP, such as increased resilience, lower emissions, or state economic development are more challenging to value in traditional cost-benefit frameworks. New planning frameworks that consider the full range of CHP attributes may indicate that CHP can be a useful solution that minimizes system costs and maximizes customer benefits.

With an understanding of the role CHP can play in future resource planning, states and local governments can benefit from actions that: 1) evaluate how CHP is treated in state planning rules; 2) explore the role of CHP in electric utility planning; 3) provide guidance on utility ownership of CHP as a component of the rate base; 4) revise IRP rules to ensure inclusion of CHP; 5) issue guidance on modeling frameworks that value the benefits of CHP; 6) encourage collaboration across state agencies; and 7) require utilities to solicit stakeholder input in developing resource plans. Similarly, utilities may consider moves to: 1) identify CHP potential in their service territory; 2) assess CHP interest in their service territory; 3) conduct feasibility assessments; 4) issue a Request for Proposals (RFPs) for CHP projects; 5) develop a project priority pipeline; and 6) measure CHP's long-term benefits in integrated resource planning.

Introduction

Combined heat and power (CHP) has not traditionally been viewed as a utility resource like other generation resources. Instead, many electric utility companies view CHP as a customer resource that results in a loss of load, because customers that generate their own power purchase less electricity from their utility. However, the situation is changing as states and utilities increasingly look to energy efficiency and demand response as resource solutions and not just as reductions in demand. As decisionmakers explore and gain experience with new capacity planning approaches and business models there may be increased opportunities for realizing the benefits of CHP to utilities and customers.[1]

Within these evolving frameworks, state leaders and utilities can include an assessment of the full range of benefits of CHP as both a supply-side distributed energy resource (DER) on the utility side of the meter, and as a demand-side DER on the customer side of the meter. In both approaches, CHP can bring more affordable, secure, reliable and clean power to customers with large continuous thermal loads and all users of the electric grid through addition of DER located near or at critical customer loads.

Utilities are demonstrating interest in deploying more CHP. In the last 10 years, more than 20 utilities across the country piloted and implemented CHP programs for their customers in at least 12 states in the U.S. (Kelly and Hampson 2018). In a more recent survey of American utility executives, while most had no current or planned investments in owning CHP, 34% of utilities expected an overall moderate increase and 4% expected a significant increase in CHP deployment in their service territory (Bade 2019). For utilities that are interested in exploring the benefits of CHP for their customers and the grid, this report may offer useful information.

The purpose of this report is to assist state-level policy makers, state energy offices, utility commissions, and utility system planners in exploring the role of CHP in integrated resource planning.[2] This first section summarizes current trends, benefits, and potential for CHP deployment. The second section provides an overview of integrated resource planning and how CHP is treated, including descriptions of recent state-level activity related to CHP in integrated resource planning. The third section provides three specific examples of utilities that have considered CHP in an IRP process, and highlights how CHP was analyzed. The fourth section describes technical considerations for modeling CHP as an alternative to traditional utility investments. The final section previews considerations and next steps states and utilities could take to further explore CHP in integrated resource planning.

1. Benefits, Potential, and Current Trends for CHP

CHP is an energy-efficient method of generating electric power and useful thermal energy from a single fuel source at the point of use, replacing or supplementing electricity provided through a utility's distribution system and fuel burned in an on-site boiler or furnace. When electricity and thermal energy are provided separately, overall fuel use energy efficiency ranges from 45–55%. While efficiencies vary for CHP installations based on site-specific parameters, a properly designed CHP system will typically operate with an overall fuel use efficiency of 65–85% (DOE 2017).

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[1] *See* U.S. Department of Energy, Oak Ridge National Laboratory, Combined Heat and Power: Effective Energy Solutions for a Sustainable Future (December 2008), *available at* https://www.energy.gov/sites/prod/files/2013/11/f4/chp_report_12-08.pdf; U.S. Department and Energy and U.S. Environmental Protection Agency, Combined Heat and Power: A Clean Energy Solution (August 2012) *available at* https://www.energy.gov/sites/prod/files/2013/11/f4/chp_clean_energy_solution.pdf.

[2] Consumer-owned utilities and the agencies that oversee them can also benefit from considerations in this report, although the report is focused on integrated resource planning by investor-owned utilities. Consumer-owned utilities serve around 25 percent of the nation's population, including cities and many large rural areas. These include municipal utilities, co-ops, and public power districts, and are often distribution-only entities. In most states, regulation and oversight of consumer-owned utilities is left to local governmental bodies and elected utility boards. *See* Lazar, J. (2016). Electricity Regulation in the US: A Guide. Second Edition.
Montpelier, VT: The Regulatory Assistance Project, p. 12, *available at* http://www.raponline.org/wp-content/uploads/2016/07/rap-lazar-electricity-regulation-US-june-2016.pdf.

For end users, CHP also results in decreased energy costs, enhanced energy resilience, reduced risk from uncertain energy commodity prices, and increased economic competitiveness. Local, regional and national benefits of CHP include increased use of domestic fuel sources including renewable natural gas, increased energy resilience of critical infrastructure and operations, enhanced electric grid reliability, and enhanced local economic growth and development.[3]

1.1. CHP Potential and Integrated Resource Planning

CHP is currently installed at nearly 4,600 sites around the country and the number of systems continues to increase, with 120 new installations that came online in 2018 (DOE 2018a). Significant potential exists for increasing CHP installations in the U.S. While about 81 GW of CHP capacity is in operation today, almost double that amount – an estimated 149 GW of technically viable capacity spread across more than 290,000 commercial and industrial facilities – remains to be developed. In Figure 1, existing capacity and technical CHP potential in the industrial sector are illustrated on the left, with existing capacity and technical potential in the commercial sector illustrated on the right (DOE 2016).[4]

All states and the District of Columbia have technical potential for CHP, including both on-site CHP (where system output is consumed at the host facility) and export potential (where all electricity in excess of what can be used by the host facility is sold to the electric grid). A utility's IRP can identify the portion of the CHP potential in their service territory that is optimal under various scenarios and in the context of the utility's complete resource portfolio.

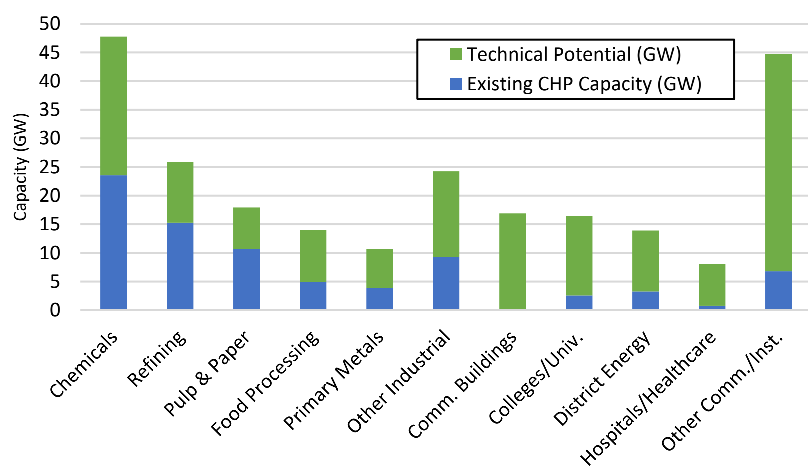


Figure 1. Existing CHP Compared to On-Site Technical Potential by Sector. (Source: DOE 2019a, DOE 2016)

New installations are trending toward "packaged" CHP systems, which are standardized and pre-engineered systems that reduce both the time and expense involved in installing CHP compared to systems that involve custom engineering and design.[5] The rise in packaged CHP corresponds with continued growth in installations in the commercial and institutional sectors, including systems at multi-family buildings, hotels, retail sites, hospitals, and wastewater treatment plants. In integrated resource planning, utilities can assess a range of CHP technologies

[3] *Ibid.*
[4] 149 GW is the additional, within the fence (i.e., no export of power to the grid) technical potential for CHP at existing industrial, commercial and institutional facilities; the technical potential for additional CHP including export (i.e., CHP system sized to site thermal and any excess power generated above site demand is exported to grid) is 241 GW (DOE 2016). This 92 GW of export potential can provide energy to the utility grid at locations or during times when it is needed most to address capacity constraints and increase grid resilience.
[5] For more information about packaged CHP, visit the DOE Packaged CHP Accelerator: https://betterbuildingsinitiative.energy.gov/accelerators/packaged-chp, and the CHP eCatalog: https://chp.ecatalog.lbl.gov/.

and applications, and model the potential energy and cost savings that could be derived from incorporating different types and sizes of CHP into its future resource mix. Figure 2 shows technical potential for packaged CHP systems less than 500 kW in commercial and institutional sectors by market segment.

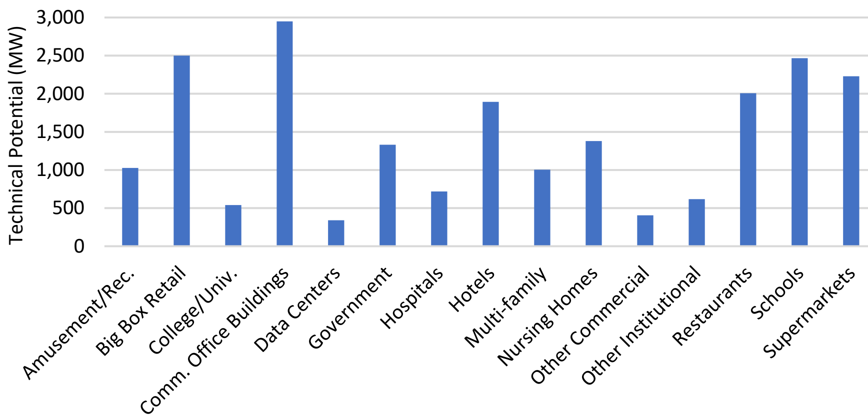
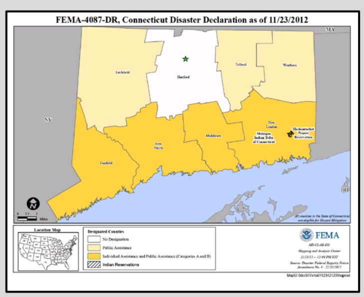


Figure 2. Technical Potential for Packaged CHP Systems <500 kW in the Commercial and Institutional Sectors. (Source: DOE 2016)

CHP MICROGRIDS DELIVERY RESILIENT POWER TO CRITICAL FACILITIES



After Fairfield, Connecticut suffered significant energy outages during Superstorm Sandy, the town invested in a CHP-based microgrid supporting its critical facilities.

Credit: FEMA, Connecticut Hurricane Sandy (DR-4087), available at https://www.fema.gov/disaster/4087

The microgrid features a 300 kW natural gas-fired generator, 47 kW of solar PV, and a 60 kW natural gas-fired CHP reciprocating engine as the microgrid anchor. It serves the fire station, police station, an emergency communications center, a public shelter, and a cell phone tower.

Source: U.S. Department of Energy - Better Buildings Initiative, Distributed Generation (DG) for Resilience Planning Guide (January 2019).

1.2. Current Trends in CHP

Looking forward, as states and utilities explore pathways to a low carbon future, CHP can continue to provide value and help balance key priorities.[6] Some examples of high-value applications for CHP today and in the future include (1) providing efficient and reliable electricity and thermal energy to the U.S. industrial sector, (2) delivering resilient power to our nation's critical infrastructure, (3) supporting the integration of renewable energy, and (4) providing an affordable, energy-efficient pathway to a low/no carbon energy supply. Heightened awareness of these benefits of CHP, along with evolving utility planning frameworks and state policy actions to encourage evaluation of CHP, are key drivers in increasing consideration of CHP in integrated resource planning.

Providing Efficient Electricity and Thermal Energy to the U.S. Industrial Sector

The industrial sector consumes nearly one-third of all total energy consumption in the United States (EIA 2019a). For industrial customers with large continuous thermal loads and complex process integration, CHP is the most energy-efficient method of producing electricity and high-temperature steam that is required to drive many manufacturing processes. Support for CHP at industrial sites is often an important economic development tool for states and utilities to retain industrial companies and attract new manufacturers, while also supporting companies in achieving their resilience and sustainability goals.

Increasing Energy Resilience of the Nation's Critical Infrastructure

Critical infrastructure refers to systems and assets so vital to the United States that the incapacity or destruction of these assets would have a debilitating impact on national security, national economic security, or national public health or safety.

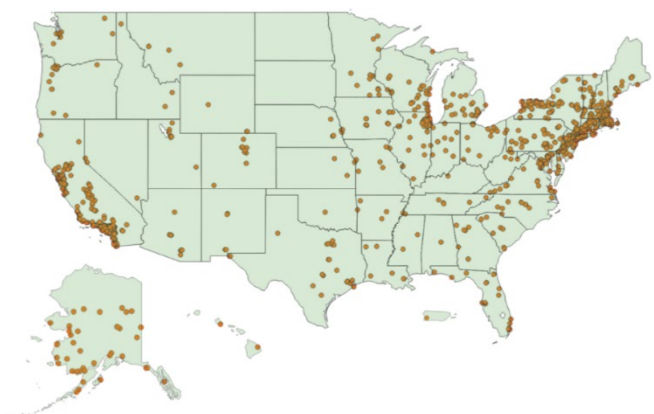


Figure 3. CHP Installations at Critical Infrastructure Facilities throughout the U.S. (Source: DOE 2019b)

Civilian critical infrastructure applications can include hospitals, water and wastewater treatment facilities, financial institutions, police and security services, and areas of refuge.[7] CHP provides resilient power capable of withstanding long, multi-day grid outages to protect and keep communities habitable and safe in disasters or other emergencies. Multifamily housing and campuses with CHP microgrids can reduce stress on shelters and emergency services by permitting shelter-in-place. Policymakers and planners are increasingly aware of the need to protect and reduce stress on critical infrastructure, and CHP systems can be configured to allow operations and delivery of essential services to continue uninterrupted at critical facilities, even during unexpected grid outages. More than

[6] *See* U.S. Department of Energy (DOE) and U.S. Environmental Protection Agency (EPA), State and Local Energy Efficiency Action (SEE Action) Network, Guide to the Successful Implementation of State Combined Heat and Power Policies (March 2013), *available at* https://www4.eere.energy.gov/seeaction/system/files/documents/see_action_chp_policies_guide.pdf

[7] Critical infrastructures protection, 42 U.S.C.§ 5195c (2011). https://www.law.cornell.edu/uscode/text/42/5195c

15 GW of CHP is currently installed at over 2,000 sites identified as critical infrastructure, shown in Figure 3 (DOE 2018b).

Defense applications can include any military installations where both thermal and electric loads are needed. For example, the U.S. Army sees opportunities for CHP deployment at large barracks, dining halls, hospitals, hangars, labs, manufacturing and maintenance facilities. The Army recognizes benefits of CHP systems – such as black start capability – as mission-sustaining technologies that can help the military improve resilience and reduce vulnerability to potential power disruptions caused by cyber and physical attacks, and severe weather events. A key need is to ensure the availability, reliability and quality of power (and water) to continuously sustain all missions.

In pursuit of energy security and energy resilience as required by the 2018 National Defense Authorization Act, the Army's Energy Security and Sustainability Strategy, and the Installation Energy and Water Security Policy (Army Directive 2017-07), which requires the capability of providing necessary energy and water to installations for a minimum of 14 days, the Army Office of Energy Initiatives is reviewing opportunities for installations across the enterprise to have assured energy – specifically, through islandable capabilities, sufficient on-site generation, energy storage and energy controls to allow generating assets to provide a direct power feed to the installation in the event of an extended grid disruption. A wide range of technology solutions, including CHP and microgrids, are undergoing feasibility assessments and several projects are already in operation. For example, a 2 MW CHP system recently began operation in 2017 at Picatinny Arsenal, a military research and ammunition manufacturing facility located in New Jersey. In another example, a 4 MW CHP system is planned at Fort Huachuca, home to intelligence and technology command units and a major installation in Arizona.[8]

Supporting the Integration of Variable Renewable Energy

Growing markets for CHP include hybrid installations and microgrids that integrate CHP with other distributed energy resources, including solar and storage. In these configurations, CHP can ramp up and down[9] to balance variable generation as part of an on-site microgrid or in support of the local distribution grid, increasing the capacity to accommodate more renewable energy. CHP installations can also be powered by renewable fuels, with approximately 23% of today's CHP sites using waste, wood, and biomass fuels, with potential for expanded use of renewable fuels in the future (DOE 2018a).

RENEWABLE-FUELED CHP AT WASTEWATER MANAGEMENT FACILITY

CHP installations can be powered by natural gas as well as renewable fuels; today, roughly 23% of existing CHP sites use waste, wood, and biomass fuels. For example, the McAlpine Creek Wastewater Management Facility in Charlotte, NC uses anaerobic digester gas to power a 1 MW CHP system. Advances in alternative fuels, including renewable natural gas and hydrogen, may in the future allow customers to benefit from a zero carbon source of electricity and thermal energy from CHP.

McAlpine Creek Wastewater Management Facility CHP System. Photo credit: US DOE Southeast CHP Technical Assistance Partnership

[8] https://www.army.mil/article/212756/the_us_armys_pivot_to_energy_and_water_resilience

[9] CHP systems designed for flexible operation or paired with thermal storage can avoid efficiency losses that might otherwise occur due to ramping.

PRINCETON UNIVERSITY INTEGRATES CHP, SOLAR PV, AND THERMAL STORAGE TO PROVIDE GRID SERVICES

In hybrid installations and microgrids that integrate CHP with other distributed energy resources, CHP can ramp up and down to balance variable generation as part of an on-site microgrid or in support of the local distribution grid. For example, Princeton University's CHP-based district energy system integrates 15 MW of CHP, a 4.5 MW solar array, and a large thermal energy storage system. The university operates its assets as dispatchable resources, responsive to market prices as well as onsite needs.

Princeton University CHP-based district energy system with solar array. Photo credit: Princeton University

Providing an Affordable, Energy-Efficient Pathway to a Low/No Carbon Future

Utilities use integrated resource planning as a framework for evaluating the reliability, costs and environmental impacts of future energy investment scenarios needed to meet system-wide energy capacity objectives. Comparing the levelized cost of electricity and the emissions profiles of CHP with the cost and emissions of other resource options in the plan, including new central station natural gas plants, can be a useful exercise, as conventional CHP inherently provides system-wide energy and emissions savings over state-of-the-art natural gas combined cycle or simple cycle peaking plants.

2. The Role of CHP in Utility Resource Planning

To determine if CHP is a cost-effective alternative to a traditional investment, utility system planners must have a method for evaluating and comparing it to other investment options. This exercise is undertaken through an integrated resource plan (IRP). An IRP is a utility plan for meeting forecasted annual peak and energy demand, including some established reserve margin, through a combination of supply-side and demand-side resources over a specified future period (Wilson and Biewald 2013).[10]

Integrated resource planning is primarily used by utilities in vertically integrated states where utilities own generation assets and are the entity responsible for planning for and developing future resource needs. In these types of plans, a utility may evaluate CHP as a resource on both the supply-side and the demand-side as an alternative to an investment in a more traditional generating resource. Therefore, the scope of this report focuses in on integrated resource planning undertaken by electric utilities in vertically integrated markets.[11]

States can evaluate CHP in these procurements plans and other utility planning efforts that are separate from traditional integrated resource planning. Utilities may use other planning approaches such as long-term procurement plans that cover shorter planning horizons and evaluate purchases of capacity and energy in wholesale markets, as well as energy efficiency and other demand-side management resources. For example,

[10] Wilson and Biewald 2013 provides a detailed summary of how utility resource planning efforts have evolved and describes best practices in IRP processes. This section relies on their description for much of the background included.

[11] While CHP is relevant in both electric and gas utility planning, utilities tend to plan for the provision of gas and electric services separately. By contrast, many state energy offices undertake more comprehensive planning efforts that may encourage consideration of CHP. According to the EPA CHP Policies and Incentives Database, 29 states reference CHP as a strategy for achieving objectives laid out in state energy plans (EPA 2020). Interestingly, the energy office in Connecticut -- Connecticut Department of Energy and Environmental Protection (DEEP) – also prepares a statewide IRP, and the 2014 plan highlighted CHP as a key resource strategy: "The Department estimates that there is another 170 MW of cost-effective CHP potential in the state. DEEP proposes to revitalize incentive programs to help deploy this CHP potential, recognizing that CHP systems can provide special value in locations where it can power microgrids and/or avoid costly upgrades to the utilities' electric distribution systems" (Connecticut DEEP 2014).

investments in CHP can be evaluated in transmission or distribution system planning (*e.g.,* CHP as a non-wires solutions, also called non-wires alternative), as part of grid modernization plans, energy efficiency plans, resilience plans, state energy plans, or other state planning processes.

While these other planning processes are beyond the scope of this report,[12] insights gained from other types of utility planning, such as distribution system planning, can help capture the full range of benefits of CHP. Data on the locational benefits of specific CHP projects are immediately relevant to distribution system planning, and can also help assess the potential value of CHP as both a supply-side and demand-side resource in integrated resource planning. Similarly, rate design approaches can impact the use of CHP, which in turn impacts the consideration of CHP in a utility's various planning processes. Some leading states are developing more comprehensive approaches to planning that allow these separate processes to inform one another, and these efforts can result in valuable data to inform future integrated resource planning.[13]

According to Synapse Energy Economics, 34 states have or are developing an IRP rule and/or filing requirement, as shown in Figure 4 (Wilson 2018). In recent years, some states have updated their IRP rules to ensure utilities give consideration to specific resources with benefits in addition to cost-effective service, such as renewable energy and energy efficiency.[14] While most utilities do not yet have experience including CHP in resource plans, rules in the following states either require or at least mention CHP as an option to consider in a plan: Connecticut, Georgia, Iowa, Indiana, Kentucky, Nebraska, Nevada, New Mexico, Oregon, Massachusetts, Minnesota, Utah, Washington, and most recently, Michigan and Virginia (NASEO 2013). However, the majority of these rules do not provide detailed guidance about how utilities should evaluate CHP in their IRPs.

[12] Distribution system planning has emerged to help utilities plan for integrating more DERs on the grid and to address aging infrastructure and utility investments. Because CHP is a highly flexible grid asset, it can play a pivotal role in helping utilities balance the grid, especially with greater penetrations of variable resources. Utilities that prepare these types of plans could apply their cost-benefit frameworks to CHP to evaluate its ability to meet specific needs on the distribution system. An analysis of the treatment of CHP in distribution system planning is an area for further research that could reveal useful models for estimating the value of CHP to the system.
[13] *See* National Association of Regulatory Commissioners (NARUC) Task Force on Comprehensive Electricity Planning, encouraging greater alignment of resource and distribution system planning, *available at* https://www.naruc.org/taskforce/."
[14] *See* Frick, N., T. Eckman, A. Sanstad, G. Leventis, P. Peterson, J. Kallay and A. Hopkins. 2019. Treating Energy Efficiency as a Resource in Electricity System Planning. Berkeley Lab.

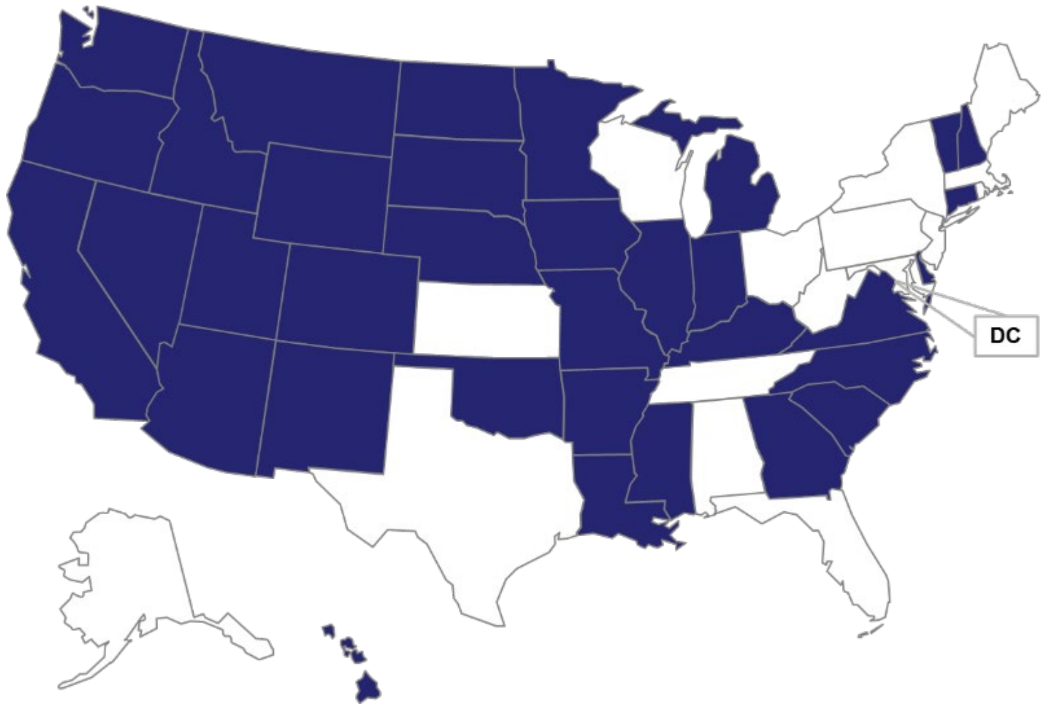


Figure 4. States with (or developing) an IRP rule and/or filing requirement. (Source: Wilson 2018)

As state policymakers and utilities explore options for building a more modern grid, several have recently recognized the value of evaluating CHP as a resource for achieving broad planning objectives. When developing plans for future resource options, utilities can gain value from evaluating CHP as a grid resource on the supply side, or as an energy efficiency resource on the demand side. On the supply side, CHP is often a least-cost resource compared to other generation options, and CHP plants can be deployed at strategic locations and in a shorter timeframe than large utility power plants. On the demand side, CHP delivers significant electric and thermal savings that utilities need to meet energy efficiency targets or other demand management needs. Whether CHP is considered as a supply-side or demand-side resource or an overall resource solution, consistent thermal energy demand is essential to reaching optimal economic efficiencies in resource planning.

2.1. Key State Policy Activity Related to CHP in Integrated Resource Planning

A handful of recent state policy activities encouraging the consideration of CHP in utility IRPs may also contribute to a growing role of CHP in utility planning. For example, policymakers in some states have updated statutory requirements or other rules to explicitly require consideration of CHP in future integrated resource plans. In other states, stakeholders have intervened in utility commission proceedings to discuss consideration of CHP and ensure utilities conduct an adequate review of CHP as a resource.

Updates to Integrated Resource Planning Rules Related to CHP

While the concept of integrated resource planning is not new, state requirements for utility IRPs are constantly evolving. This section describes recent examples from three states – Michigan, Virginia, and Mississippi – where policymakers have updated rules or are considering updates to rules related to CHP in integrated resource planning. Experience in these states demonstrates a range of ways in which state policymakers and regulators can ensure that CHP is evaluated alongside other potential resources in utility planning.

Michigan

In 2016, the Michigan Legislature passed PA 341, which requires all rate-regulated utilities to file IRPs with the Michigan Public Service Commission (PSC). The law also sets criteria for utilities to consider in their IRP filing. Among other requirements, an IRP must include the projected energy and capacity purchased or produced by the utility from a CHP resource (Michigan 2016).

In implementing PA 341, the Michigan PSC clarified how CHP should be taken into account during the IRP modeling process: "Prior to and during the modeling process, the utilities shall take into account resources that include, but are not limited to: small qualifying facilities (20 MW and under), renewable energy independent power producers, large combined heat and power plants, and self-generation facilities such as behind-the-meter-generation (BTMG)."(Michigan 2016; Michigan 2017).

IS CHP A SUPPLY SIDE OR DEMAND SIDE RESOURCE?

On the **supply side** (or "utility side of the meter"), the electric and thermal generation from CHP can contribute to a utility's supply-side portfolio, adding to the company's generation resource mix. Utilities may plan for increased use of CHP as a utility-owned, regulated asset, or through other competitive procurement strategies.

On the **demand side** (or "customer side of the meter"), CHP lowers demand and increases flexibility by providing energy efficiency and load management services. Utilities may plan for increased use of CHP as a demand resource via customer-focused programs, including energy efficiency portfolios.

As energy efficiency and demand response are increasingly treated as resource solutions rather than merely reductions in demand, the importance of the distinction between supply side and demand side resources in utility planning may eventually diminish, which could further enable utilities in the consideration of the full benefits of CHP in resource planning. This approach aligns with the increasing prevalence of all-source solicitation, in which a utility considers all resources (*i.e.*, demand and supply are bid together) in response to an RFP.

Virginia

A 2018 law in the Commonwealth of Virginia requires consideration of a specific CHP deployment scenario as part of the IRP process. Senate Bill 966 directs Dominion Energy to consider the deployment of 200 MW of CHP or waste heat to power (WHP) by 2024 in its next IRP (Virginia 2018). According to the 2018 Virginia Energy Plan, "a number of stakeholders recommended that increasing Virginia's focus on CHP to even a fraction of Virginia's 4,308 MW potential could position the Commonwealth to effectively achieve other public-policy strategies such as energy efficiency and resiliency."

Mississippi

In late 2019, the Mississippi PSC finalized a rule amendment requiring evaluation of CHP and other distributed energy resources as either a supply side resource a demand side resource: “For incremental capacity additions, reasonably useful, commercially-proven, and economic supply-side and demand-side resources that may be available to an electric utility should be considered, including but not limited to energy efficiency, demand response, and distributed energy resources (DER).” The amended rule defines DER to include both supply side and demand side resources:

> Examples of different types of DER include solar photovoltaic (PV), wind, combined heat and power (CHP), energy storage, demand response (DR), electric vehicles, microgrids, and energy efficiency (EE). For purposes of this Rule, DER also includes utility-owned or controlled equipment (i.e. physical assets) used to generate, adjust, store, or sometimes deliver energy performed by a variety of devices at the distribution system-level. (Mississippi 2019)

The amended rule also requires utilities to identify, evaluate and discuss in their IRPs all existing supply-side resources, including but not limited to cogeneration (Mississippi 2019).

Interventions in Integrated Resource Planning Proceedings Related to CHP

This section describes recent examples from three states – Georgia, Missouri, and Michigan – where parties have intervened in IRP proceedings to request improved consideration of CHP. In some states, participants that aim to encourage consideration of CHP in utility resource plans may initially participate in utility-sponsored stakeholder engagement opportunities offered during the IRP development phase. Some utilities are encouraged by regulators to host workshops with interested participants to seek input, share information, and discuss assumptions, scenarios, and sensitivities used in the company’s IRP modeling. After a utility has filed its IRP, parties may consider more formal intervention in IRP proceedings at state regulatory commissions.

Georgia

In response to Georgia Power’s proposed 2019 IRP, Emory University intervened in support of a CHP-based microgrid that could provide ratepayers with a generation source at a lower cost than traditional utility resources (Maloney 2019). In addition to highlighting the benefits of CHP, Emory University’s testimony pointed to other utilities, including Duke Energy, DTE Energy, AEP, and Florida Public Utilities that demonstrated supply-side or utility-owned CHP generation was “more beneficial to rate payers than having a large load leaving the utility’s system by developing CHP behind their meter” (Kowal 2019).[15] While the proposed microgrid was ultimately not approved in the IRP settlement, the intervention initiated a dialogue between the utility, a large customer, and state regulators on the role of CHP in IRP and allowed for a future review and approval by the commission if the economics show no additional cost to Georgia Power’s ratepayers (Georgia 2019).

Missouri

When Ameren Missouri filed its 2017 IRP before the Missouri PSC, the Missouri Division of Energy intervened and filed testimony in response to the company’s filing.[16] The Division argued, among other things, that “Ameren Missouri should fully consider facilitating CHP deployment as an element of providing safe and adequate service and based on the state policy of pursuing all cost-effective demand-side savings” (Missouri 2018a). This concern was resolved in a settlement in which Ameren Missouri indicated it was “willing to work with interested stakeholders to develop an agreeable cost effectiveness model of CHP that reflects using CHP as a load management and/or demand response resource…” according to the Missouri Energy Efficiency Investment Act

[15] See Kowal 2019, p.5. To view live testimony about the proposed project at Emory University before the Georgia Public Service Commission, visit https://youtu.be/Twl2DD3HCkA.
[16] Missouri’s Division of Energy is the state’s energy office.

(MEEIA), and specified that "symmetric treatment of costs and benefits will be explicitly discussed during the development of the cost effectiveness model." (Missouri 2018b).

Michigan

In Michigan, there was active interest in response to DTE Energy's proposed 2019 IRP, both during the utility's stakeholder engagement efforts prior to filing and during the more formal regulatory proceeding before the Michigan Public Service Commission. Some intervenors expressed a desire for the utility to consider CHP more thoroughly in its resource plan (Michigan 2019). Participants highlighted the ability of CHP to protect customers from a grid failure, which provides continuity of critical services and frees up power restoration efforts to focus on other facilities during emergencies, resulting in electricity cost savings, reduced losses due to power outages, and increased reliability.

3. Examples of Evaluation of CHP as a Resource in IRPs

In the previous section, discussion of experience gained in Michigan, Virginia, Mississippi, Georgia and Missouri demonstrates a range of ways in which state leaders and other interested parties can encourage the consideration of CHP in integrated resource planning. Historically, evaluation of CHP in integrated resource planning has not been widespread. According to a review of IRPs conducted by the American Council for an Energy-Efficient Economy (ACEEE) in 2017, the vast majority of plans at that time had no meaningful discussion of CHP.[17] While some plans defined or mentioned CHP, its benefits as a resource were not commonly evaluated.[18] CHP was considered in only a handful of utility IRPs reviewed, including examples from utilities operating in three states – North Carolina, South Carolina, and Indiana – that explicitly evaluate CHP as a supply resource option in their plans. A brief discussion of Idaho Power's evaluation of CHP in its 2017 IRP is also included below. Some of the utilities that evaluated CHP in their plans indicated a preference for owning the assets themselves, such as Duke Energy, but others do not take a position on ownership and simply consider the costs and benefits of CHP in the context of their resource needs.

The following section provides three examples from utilities that included CHP in their planning exercises and selected a clearly defined amount of installed capacity (MW) to pursue during the period covered by the plan. The case studies describe how Duke Energy Carolinas, Duke Energy Indiana, and Indiana Michigan Power approach CHP in their IRP. They are listed in Table 1 and summarized below. Some additional noteworthy examples of plans that did not select a defined amount of CHP but offer useful insights on approaches for pursuing CHP as a resource, are also discussed at the end of the section.

Table 1. Utility plans that select CHP as a resource

	Amount of CHP Included (MW)	Installed by (Year)
Duke Energy Carolinas	44	2021
Duke Energy Indiana	15*	2020
I&M	27	2035

*Duke Energy Indiana selected 29 MW in 2016-2020 and 15 MW in 2021-2025, for a total of 44 MW in its no-carbon regulation portfolio. 15 MW were selected in its carbon tax scenario and in the recommended plan for 2015 – 2035. Sources: Duke Energy Carolinas 2018; Duke Energy Indiana 2015; I&M 2015.

[17] ACEEE reviewed a sample of 29 publicly-available IRPs or similar planning documents published between 2014 and 2017 to see whether and how utilities evaluate CHP as a resource. See Appendix A, "ACEEE Review of Integrated Resource Plans," for more information.
[18] Some of these plans may include a forecast of customer-adoption of CHP for the purpose of adjusting future demand curves, without evaluating CHP as a resource option on the supply-side.

3.1. Duke Energy Carolinas

Duke Energy serves 3.3 million electric customers in North Carolina and 740,000 customers in South Carolina. The company began evaluating the interest of its customers in hosting utility-owned CHP in 2015 and included projections for 44 MW of CHP as a capacity and energy resource in its 2018 IRP (Duke Energy Carolinas 2018). These 44 MW are also included in the company's Short-Term Action Plan, which identifies actions to be taken over the next five years.

The company identified numerous potential customer sites with continuous steam loads in its service territory and is currently constructing a 15 MW system at Clemson University. Using the base plan scenario in the IRP, the Clemson University CHP project is a cost competitive generation resource addition compared to traditional generation.[19]

3.2. Duke Energy Indiana

Duke Energy Indiana serves 840,000 electric customers. In its 2018 IRP, Duke Energy Indiana modeled as a baseload resource a 16 MW combustion turbine CHP installation.[20] The company selected the Moderate Transition Portfolio, which was designed to gradually diversify the resource mix without steeply increasing cost to customers over a short period. The Moderate Transition Portfolio accelerated coal unit retirements, replacing that coal capacity with a mix of resources summarized in Table 2, including 56 MW of CHP added between 2021 and 2026.[21]

[19] In integrated resource planning modeling, the base plan scenario is the expected scenario, determined by using assumptions that the utility considers most likely to occur. For further reading, see Regulatory Assistance Project, Best Practices in Electric Utility Integrated Resource Planning (June 2013), *available at* https://www.raponline.org/wp-content/uploads/2016/05/rapsynapse-wilsonbiewald-bestpracticesinirp-2013-jun-21.pdf

[20] Duke Energy Indiana 2018 IRP (Vol. 1) , p. 130.

[21] Ibid.

Table 2. Capacity Nameplate Additions (MW) for Moderate Transition Portfolio (2018 IRP)

	Net Additions (MW)*							
Year	CC	CT	Solar	Wind	Cogen	Storage	DR	EE
2018	0	0	0	0	0	0	74	5
2019	0	(8)	6	0	0	10	13	26
2020	0	0	2	0	0	5	28	22
2021	0	0	0	0	16	0	23	24
2022	0	50	0	0	0	0	22	24
2023	0	0	100	0	0	0	21	24
2024	0	0	150	50	20	0	(1)	27
2025	0	0	150	50	0	0	0	29
2026	0	0	150	50	20	0	1	23
2027	0	0	100	50	0	0	0	26
2028	1240	0	100	(50)	0	0	0	19
2029	0	0	100	50	0	0	0	15
2030	0	0	100	50	0	0	0	6
2031	0	0	100	50	0	0	1	1
2032	0	0	100	50	0	0	0	7
2033	0	0	100	50	0	0	0	8
2034	1240	0	100	50	0	0	0	1
2035	0	0	100	50	0	0	1	(5)
2036	0	0	79	50	0	0	0	(4)
2037	0	0	100	50	0	0	0	(2)

Source: Duke Energy Indiana 2018 IRP

3.3. Indiana Michigan Power (I&M)

Indiana Michigan Power (I&M) is a unit of American Electric Power (AEP) serving approximately 587,000 customers in Indiana and Michigan. In its 2015 IRP, CHP was not originally included as a resource option, but I&M began modeling it after receiving stakeholder input. Ultimately, 27 MW of CHP at two customer sites were included over the planning period of the Preferred Portfolio. I&M indicated the locations of the two projects were unknown at the time, but planned to work with customers to identify a good fit (I&M 2015).

In its 2018 IRP, I&M again included CHP in its resource evaluation, modeling CHP as a 15 MW facility utilizing a natural gas fired combustion turbine, Heat Recovery Steam Generator (HRSG) and selective catalytic reduction (SCR) to control NOx emissions, assuming all of the steam was taken by the host and the efficiency of the modeled CHP resource was credited for the value of the steam provided to the host. The overnight installed cost was estimated to be $2,300/kW and the assumed modeled full load heat rate was approximately 4,800 Btu/kWh, and the assumed capacity factor was 90%.[22] I&M's 2015 and 2018 IRPs stand out for the transparency of their assumptions, all of which are documented in the plans.

3.4. Other Noteworthy Examples

Other utilities conducted meaningful exercises to evaluate or consider CHP, but did not set an explicit target for acquiring a defined amount of CHP or clearly define an approach for pursuing CHP as a resource. These noteworthy examples are summarized below.

Indianapolis Power & Light Company (IPL)

IPL provides retail electric service to 480,000 customers in Indianapolis and other central Indiana communities. IPL commissioned the engineering firm Burns & McDonnell to prepare a report detailing cost and performance assumptions for CHP in their 2016 IRP.[23] These parameters had not been included in previous planning studies.

IPL modeling, summarized below in Table 3, "reflects attributes of these resource[s] regardless of ownership" and selected CHP in two of four scenarios. 225 MW is included in the Distributed Generation Portfolio, which reflects high customer adoption of DERs, and in the Hybrid Preferred Resource Portfolio, which reflects public pressure to reduce emissions, customer adoption of DERs, additional environmental costs, and the possibility that technology costs decline more quickly than modeled.[24] Ultimately, IPL described the Hybrid Preferred Resource Portfolio as "the right mix of resource types that minimizes cost and risk for the customer, allows for flexibility in the response to future market changes, and provides balance to the portfolio in terms of cost, environmental impact, and risk."

Table 3. IPL Summary of Resources in MW (Cumulative changes 2017-2036)

	Final base case	Strengthened environmental	Distributed generation	Hybrid
Coal	1,078	0	1,078	1,078
Natural gas	1,565	2,732	1,565	1,565
Petroleum	11	11	11	0
DSM and DR	208	218	208	212
Solar	196	645	352	398
Wind with ES*	1,300	4,400	2,830	1,300
Battery	500	0	50	283
CHP	0	0	225	225
Totals	4,858	8,006	6,319	5,060

Source: IPL 2016. *Energy storage

Vectren

Vectren Energy Delivery of Indiana, Inc. (Vectren) provides natural gas and electricity to customers in Indiana, with 144,000 electricity customers in a 7-county region. According to Vectren's 2016 IRP, "CHP technical and operating

[22] A power plant's capacity factor is the ratio of its actual output over a period of time, usually a year, to its output if it were to operate at full nameplate capacity continuously over the same period of time.
[23] As of November 2019, IPL's 2019 IRP stakeholder process was still ongoing, with an IRP expected to be filed at the conclusion of public advisory meetings scheduled through December 2019.
[24] See IPL 2016, p. 208.

considerations should include the following: customer electric load and thermal requirements inclusive of a detailed engineering and feasibility review. The matching of high load factor thermal load is key to CHP success." The company also indicated it was monitoring developments in customer-owned CHP and including CHP as a supply-side resource option.

For its cost-effectiveness screening, Vectren modeled several different size CHP systems (1 MW, 3 MW, 5 MW, 10 MW, 15 MW) and assumed it would own the facility. The technical and operating assumptions used for the screening are published in the plan.[25] Of the different size CHP systems modeled, only the largest – a generic 15 MW CHP system – emerged as a cost-effective alternative to construction of new conventional generation resources. The company also conducted a review of potential CHP host sites and identified a market potential for customer-sited CHP of approximately 30 MW in the Vectren South service territory.

As of November 2019, the stakeholder process for Vectren's 2019 integrated resource planning process was ongoing, with public meetings scheduled through May 2020. During the second stakeholder meeting held in October 2019, Vectren provided examples of candidate CHP gas generation to be modeled in its 2019 IRP, as shown in Table 4.[26]

Table 4. Candidate Gas CHP Generation to be modeled in Vectren 2019 IRP

Gas Combined Heat and Power*	2 x 10 MW Recip Engines	20 MW Combustion Turbine
Net Plant Electrical Output (MW)	17.9 MW	21.7 MW
Fixed O & M (2019 $/kW-yr)	$42	$35
Total Project Costs (2019 $/kW)	~$2,800	~$4,600

**Utility owned and sited at a customer facility*

3.4.1. Idaho Power

Idaho Power, headquartered in Boise, Idaho, serves more than 560,000 customers in a 24,000 square mile service territory. In its 2017 IRP, Idaho Power modeled CHP using a capital cost of $2,213 per kW and a 40-year levelized cost of energy of $71 per MWh, assuming an annual capacity factor of 80% (Idaho Power 2017). The company recognized the actual cost of a CHP resource varies and noted that CHP can be challenging to model in an IRP setting, although the company "is committed to working with individual customers to design operating schemes that allow power to be produced when it is most valuable, while still meeting the needs of the steam host's production process."

4. Characterizing CHP as a Resource Option

Utilities with experience evaluating distributed generation should already be well-positioned to include CHP in their planning exercises from a technical perspective. No additional analytic tools are needed. It can be useful to collect some basic data as a starting point for modeling and conducting cost-effectiveness screenings. The following section reviews the assumptions needed to characterize CHP in an IRP and provides specific examples of how two utilities compared the cost-effectiveness of CHP to other resources. It concludes with a brief discussion of additional benefits of CHP that could be included in cost screenings, but are not currently captured well by traditional frameworks.

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[25] See Vectren 2016, Figure 5.7.
[26] Vectren 2019 IRP, Vectren Stakeholder Meeting #2 (PDF), p. 80, *available at* https://www.vectren.com/assets/downloads/planning/irp/IRP-2019-Vectren-Stakeholder-Meeting-2.pdf

4.1. Modeling Parameters and Other Assumptions

The modeling parameters and assumptions described in this section are inputs that would be a good starting point for including CHP in modeling used for IRPs.

Resource Potential

A CHP potential study could help estimate how much CHP capacity (MW) would be reasonable to model in a planning scenario. One initial step is to review the state-specific estimates of CHP technical potential in the 2016 DOE study (DOE 2016). Note that the projections of potential can vary significantly by service territory, depending on the availability of customer sites with consistent thermal loads. Sites that usually have consistent thermal loads are manufacturing facilities, hospitals, campuses and universities, hotels and casinos, and large commercial or multifamily buildings.

Customer Thermal Loads

Significant, and consistent thermal energy demand is essential to reaching the economic efficiencies that utilities can achieve by incorporating CHP in IRPs. CHP provides maximum benefits when a system is sized to meet all of the thermal demand of a given facility. In this way, the thermal load at the customer site influences the size of the system, and in order to maximize both energy efficiency and economic efficiency, the CHP system should be designed for high annual operating hours and maximum use of the thermal output and operated accordingly.

CHP System Characteristics

Additional assumptions about the performance, operating and cost characteristics of CHP systems are also needed. Planners can obtain cost and performance data for various types of CHP technologies of different size ranges from sources such as the US Department of Energy's (DOE's) CHP technology Fact Sheets (DOE n.d.), the EPA Combined Heat and Power Partnership (EPA n.d.) and the DOE CHP Technical Assistance Partnerships (TAPs). DOE's Technology Fact Sheets include typical CHP system cost and performance characteristics by technology (i.e., reciprocating engines, microturbines, gas turbines, fuel cells and steam turbines) and by size that can be the basis for IRP modeling parameters. For example, when the Michigan Energy Office completed its IRP modeling for the CHP Roadmap for Michigan using the open-source STEER Model, it "incorporated CHP technologies for inclusion in Michigan's generation portfolio based on the performance characteristics and costs published by EPA with potential deployment numbers and capacities published by DOE." (MEO 2018)

States may also work with their affiliated DOE CHP TAP or private consultants to develop state-specific estimates of market potential and CHP operating characteristics, and make other assumptions needed to compare the cost of generating electricity from CHP with other resources.

4.2. Comparing Cost-Effectiveness of CHP with Other Resources

Because of the substantially increased fuel efficiency and high capacity factor of most CHP, well-sited and properly designed systems can be a least cost resource compared to other baseload resource options available.[27] Many of the additional, unique features of CHP are more challenging to capture and value in a traditional cost-benefit framework, such as increased reliability and energy resilience including on a locational basis, lower emissions, or state economic development. CHP provides additional reliability because it does not rely on transmission lines, and is more efficient in light of lower transmission losses. States and utilities that develop planning frameworks

[27] For utility-owned CHP on the supply-side, utilities may apply the revenue from steam sales by the CHP system back to the cost of fuel for generating electricity. Crediting steam sales from CHP back to fuel costs covered by all customers is an important part of the equation for evaluating CHP as a least-cost generating option.

that carefully consider these beneficial attributes of CHP are likely to find CHP can be a useful solution that minimizes system costs and maximizes customer benefits.

Levelized cost of electricity (LCOE) is a common metric for comparing the utility's cost of different generating resources. It represents the cost per kWh of building and operating a plant over its expected lifetime. Key inputs to calculating LCOE include capital costs, fuel costs, fixed and variable operations and maintenance (O&M) costs, financing costs, and an assumed utilization rate (or capacity factor) for each plant type. However, note that LCOE does not include avoided transmission and distribution costs. Because of the substantially increased fuel efficiency and high capacity factor of most CHP projects, well-sited and properly designed systems can be more cost-effective than other baseload resource options available. The following graphs, excerpted from IRPs prepared by Duke Energy Indiana and I&M in 2015, demonstrate actual cost comparisons that account for these factors.

Figure 5 shows Duke Energy Indiana's baseload screening analysis from its 2015 IRP, which evaluates a range of baseload technologies using different fuels including CHP under a variety of scenarios. The scenario shown in Figure 5 is the core "no carbon regulation" scenario that assumes no carbon regulation or renewable energy portfolio standard and rewards low capital cost portfolios.[28] The screening indicates that CHP (the purple line) is competitive with combined cycle generation as a least-cost resource throughout the capacity range and is lower cost than combined cycle at capacity factors above 50%. Note that the Energy Information Administration estimates that the national average capacity factor for natural gas combined cycle power plants in 2017 was 51.3% (EIA 2019b).

[28] For more information on scenario assumptions, see Duke Energy Indiana 2015 p. 136 – 137.

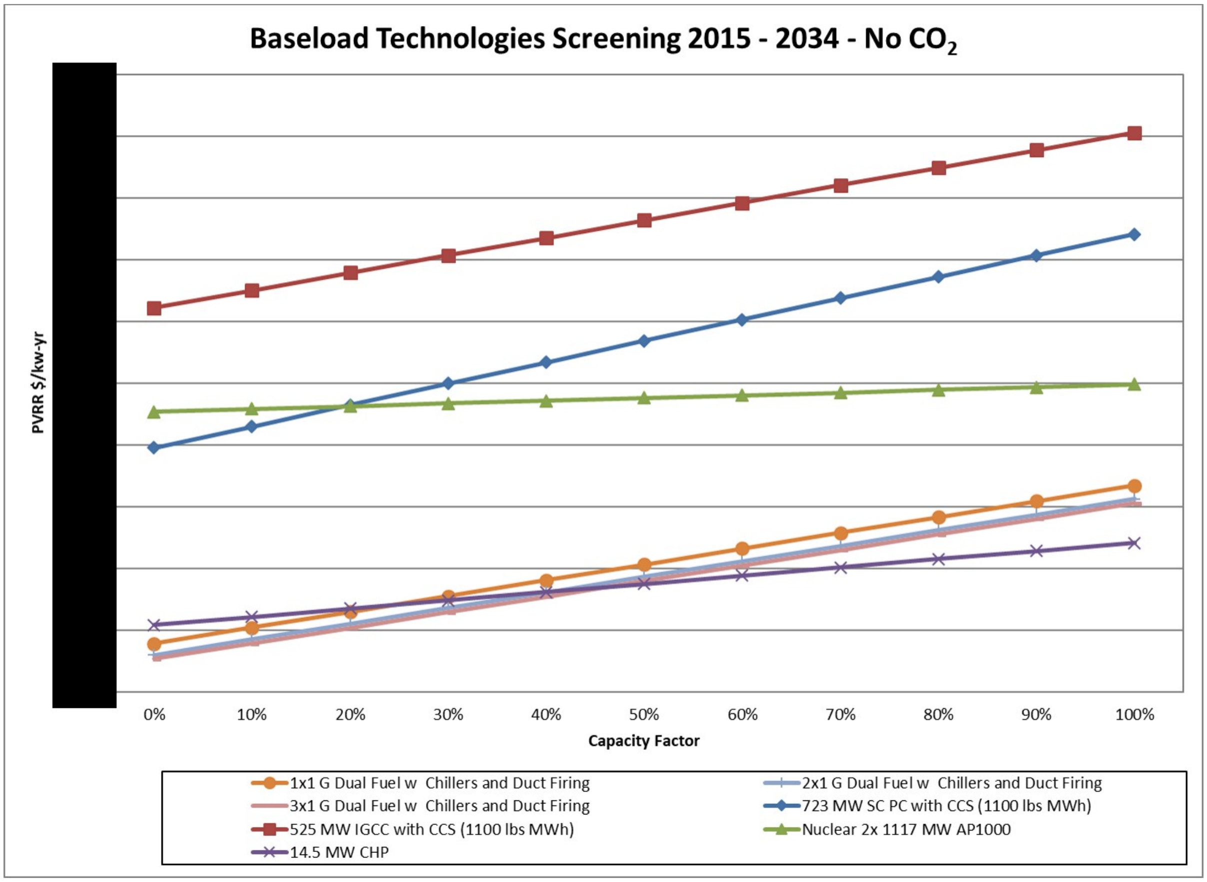

Figure 5. Duke Energy Indiana's supply-side resource screening analysis. (Source: Duke Energy Indiana 2015)

Figure 6 shows Indiana Michigan Power Company's (I&M) comparison of the cost of CHP with other natural gas-based resource options, relative to capacity factor, in its 2015 IRP (I&M 2015). I&M estimates that CHP operating at a capacity factor of about 65% or higher has a lower LCOE than a combustion turbine (CT) but higher LCOE than a combined cycle (CC) until the costs converge at around 95% capacity factor.

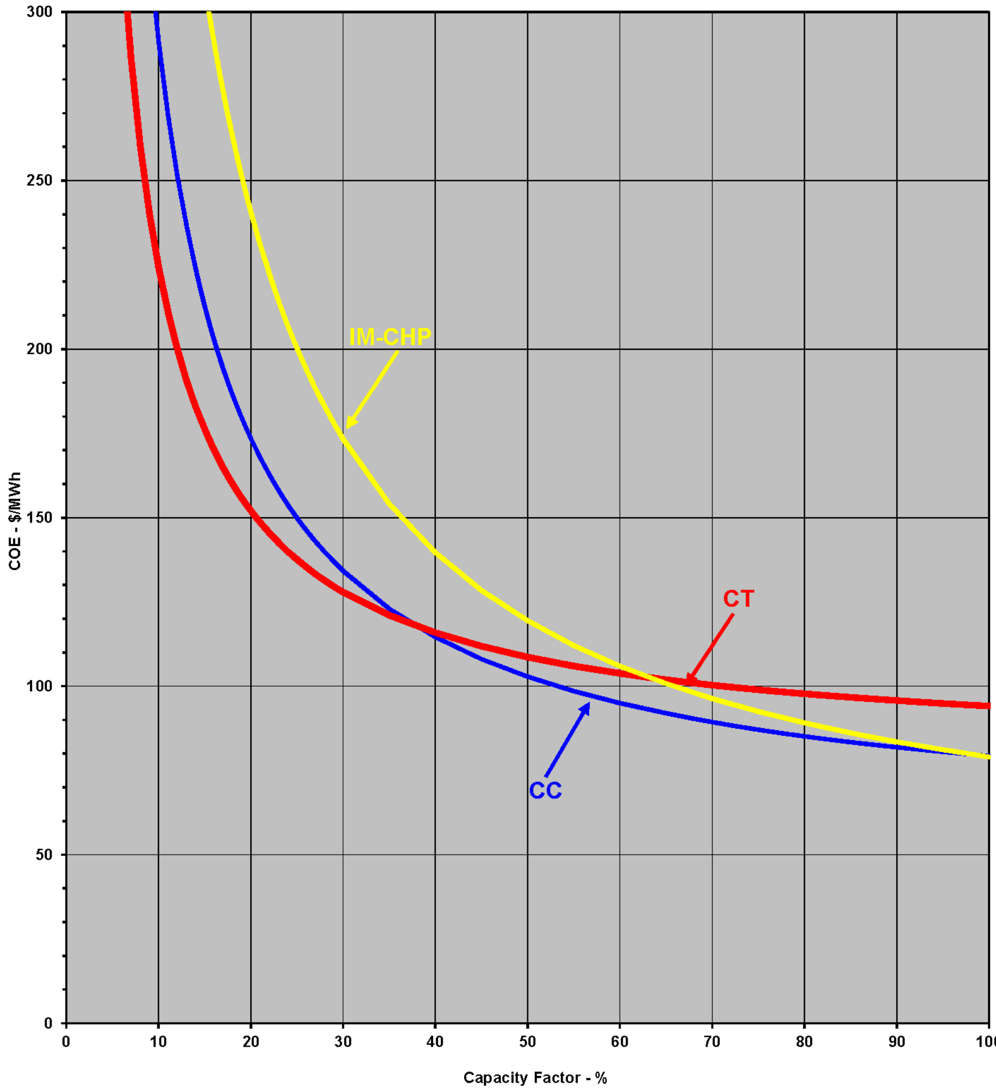

Figure 6. CHP cost of electricity ($/MWh) vs. capacity factor (%). (Source: I&M 2015)

The above examples are two variations on comparing CHP systems with other types of supply side resources within a utility resource portfolio. One consideration for such comparisons is whether the CHP system(s) in multiple configurations are compared on an equal basis on a cost per MW basis with comparative inputs as the other resource options within a resource plan.

4.3. Additional Benefits of CHP to Consider

In addition to the cost of capital, operations and maintenance (O&M), and fuel, which are commonly used, well-known variables that are relatively simple to evaluate, there are additional benefits of CHP to consider in utility resource planning.

The locational value of CHP is another important feature to consider, since the benefits can be greater depending on where CHP is located and how it is deployed. CHP is often thought about as providing baseload capacity, generating electricity and thermal energy consistently throughout the day. In addition to providing an always-on source of power, modern CHP systems are capable of acting as a more flexible resource, offering key grid-supporting services needed to maintain operations and help balance the distribution system. CHP's ability to defer or avoid the need for substation or switchgear investments, provide back-up power, deliver black start capability, or offer other ancillary services are additional features that are not usually factored in to these cost screenings.

As a growing number of states and utilities contemplate the benefits and costs of distributed energy resources, new approaches to benefit cost analyses will be needed to optimize value from ratepayer investments.[29] Supplemental types of plans, such as the distribution system plans, could play an important role in augmenting or becoming integrated with existing IRP and IRP-like activities. Some states are using this time of profound change within the electric industry to reassess what their energy resource planning and cost-effectiveness tests are accomplishing.

5. Considerations and Next Steps for States and Utilities

With an understanding of the role CHP can play in future resource planning and how it can support a least-cost utility resource portfolio, states and utilities may benefit from the following considerations to further explore the integration of CHP in their planning processes.

5.1. Considerations for States

Evaluate and Clarify How CHP is Treated in State Planning Rules

The interplay between a state's energy laws can be confusing and uncertainty may prevent a utility from trying something new, such as CHP, in its integrated resource plan. For example, in Ameren Missouri's 2017 IRP proceeding, uncertainty over how CHP may be classified as an eligible measure for energy efficiency programs complicated efforts by a utility to consider the benefits of CHP in its IRP process, either as a demand-side or supply-side resource (Missouri 2018a, 2-3). Clarifying the eligibility of CHP in these programs while encouraging the meaningful and comprehensive consideration of CHP in integrated resource planning could help to keep all options on the table.

Explore and Study the Role of CHP in Electric Utility Planning

Utility commissions can initiate efforts such as technical workshops, opportunities for stakeholder input, or studies to explore the role of CHP in the IRPs of their regulated electric utilities. See, for example, the Washington Utilities and Transportation Commission's policy statement on the role of energy storage in utility planning, which provides a good example of procedural activities and policy guidance that could similarly be undertaken for CHP (Washington 2017).

Provide Guidance on Utility Ownership of CHP as a Component of the Rate Base

In most states, existing guidance does not discuss how the utility commission views utility-ownership of CHP. Commissions could add guidance to clarify an approach for considering proposals for utility-owned, customer-sited CHP as a component of the rate base. Such guidance would provide utilities with more certainty in seeking regulatory approval.[30]

[29] For example, the National Standard Practice Manual, a publication of the National Efficiency Screening Project coordinated by E4TheFuture, provides a comprehensive framework for cost-effectiveness assessment of energy resources, with a focus on energy efficiency. The Project is developing an expansion to include other DERs.

[30] Regulators may also consider whether to adopt rules to prevent cross-subsidization and preferential treatment between a utility's regulated and unregulated arms, including the utility's affiliated entities that may be providing CHP. For example, in 2018 the Michigan Public Service Commission adopted updated code of conduct rules, including affiliate transaction guidelines, for all utilities and alternative electric suppliers. *See* Michigan Public Service Commission, Case No. U-18361, Order dated December 20, 2018.

Revise IRP Rules to Ensure Inclusion of CHP

Regulatory commissions can review existing resource planning rules to ensure they reflect current state priorities and initiate rulemaking procedures to revise them if not. In order to optimize and enable non-utility solutions, states may consider whether to require consideration of customer-owned CHP in integrated resource planning. In recent years, several states have amended IRP rules to require utilities to specifically address certain technologies. In 2018, more than 15 states considered changes to the integrated resource planning process, with an emphasis on ensuring that complete consideration of all the costs and benefits of alternative resources are being evaluated (NC CETC 2018). Recent state policy actions in Michigan (Michigan 2016) and Virginia (Virginia 2018, 34) show that CHP is an important consideration in integrated resource planning in those states, while other states consider similar actions (Mississippi 2019a, 4-5).

Issue Guidance and Support Modeling Frameworks that Value the Benefits of CHP

Provide input in the IRP or other planning process to help set modeling parameters and assist with assumptions for utility system planners. This can include resilience benefits when serving critical facilities or critical areas of the distribution system, avoided investment costs when CHP systems are targeted to areas of the grid that need immediate capacity increases, and the value of ancillary services a CHP system may be able to provide.

Encourage Collaboration and Inclusion Across State Agencies

State leaders in various agencies may have expertise and valuable perspectives to contribute to discussions on the role of CHP in resource planning. For example, a state energy office may participate in regulatory discussions, including IRP proceedings. Missouri's state energy office, the Missouri Division of Energy (MDE), has participated in utility rate cases and IRP dockets before the Missouri Public Service Commission, and in 2017 requested more robust consideration of CHP in Ameren's IRP proceeding (Missouri 2018a, 2-3).

Require Utilities to Perform Outreach and Solicit Stakeholder Input in Developing Resource Plans

Effective stakeholder engagement increases accessibility and transparency, can build trust, and enhance cooperation and collaboration. Two-way knowledge sharing throughout the development of an IRP, from forecasting to modeling to the issuance of requests for proposals (RFPs), benefits all parties. By requiring, or strongly encouraging utilities to seek stakeholder input, state leaders can help to ensure a rigorous process with stakeholder buy-in. For example, under Indiana Code § 8-1-8.5-3(e)(2), electric utilities are required to submit IRPs every three years, with the plans subject to a rigorous stakeholder process.[31]

5.2. Considerations for Utilities

Identify Potential for CHP to Meet System Energy and Reliability Needs in Service Areas

Before launching a new CHP acquisition strategy, it is important to know whether there is the technical potential for CHP to provide the electricity needs of a service territory. Utilities and their key account representatives are aware of their largest electricity customers and can identify users that also have a demand for thermal energy as potential candidates for CHP. A rough-cut analysis of technical potential for CHP can be compared to known electric system needs and constraints to identify whether there are areas of the system that might be well-suited to CHP. The DOE CHP Technical Assistance Partnerships (TAPs) are also available to assist utilities in identifying CHP potential in their service area.

[31] *See* Indiana Utility Regulatory Commission, Integrated Resource Plans, *available at* https://www.in.gov/iurc/2630.htm

Evaluate Customer Hosts/Assess Interest in Service Territory

Through key account managers and energy efficiency program staff, it may be possible to understand where if any customer/host interest in CHP is present in a service territory. Key account managers and others with intimate knowledge of larger customers' energy needs and future growth plans are well-equipped to identify specific locations where a large thermal demand may coincide with a need for near term equipment upgrades, concerns about reliability or other conditions that lend themselves well to CHP. Surveying customers ahead of the development of an IRP can help provide appropriate projections for deployed CHP in utility plans.

PUTTING IRPS INTO ACTION: DUKE ENERGY PLANS FOR NEW CHP AT UNIVERSITIES

Duke Energy Carolinas began evaluating the interest of its customers in hosting utility-owned CHP in 2015 and incorporated projections for 44 MW of CHP in its 2018 IRP, including a new CHP plant at Clemson University to be owned and operated by Duke. The system is currently under construction and expected to be operational in 2020. It will provide the university with 15 MW of electricity and 100,000 pounds/hour of steam, allowing the university to island from the grid to keep critical loads operational.

Conceptual rendering of Clemson University CHP System. Source: Burns & McDonnell

Similarly, Duke Energy Indiana included in its 2018 IRP a plan to build, own and operate a new 16 MW CHP project with planned completion in 2021. The proposed system CHP facility would serve as a baseload steam supply resource for Purdue University and baseload electricity supply for Duke Energy Indiana customers. It would consist of a natural gas fired turbine generator with a single heat recovery steam generator and a duct burner, capable of providing additional steam at Purdue's discretion.

For more information see, Duke Energy Indiana's petition to the IURC for the project (IURC 2019).

Conduct Feasibility Assessments

Once potential locations are identified, a simple feasibility assessment can take into account facility energy use patterns and evaluate whether it makes sense to move forward with a more detailed investment-grade analysis of a CHP system. This is also an opportunity to identify whether a given facility already has dedicated staff onsite who might help move the project forward internally within the host company. The DOE CHP Technical Assistance Partnerships (TAPs) are available to provide high-level screenings to help assess feasibility for CHP.[32]

Issue a Request for Proposals (RFPs) for CHP Projects

An RFP for CHP projects can initiate partnerships between CHP developers and potential customers that can present concrete proposals to a utility. These proposals, in turn, can be evaluated in a utility's IRP modeling. For example, as part of its 2019 integrated resource planning process, Vectren issued an all-source RFP targeting 10 to 700 MW of capacity and unit-contingent energy, stating that "[m]arket information gathered from this RFP will be utilized within the IRP to inform the outcome of the 2019/2020 IRP."[33]

[32] For more information about the CHP Technical Assistance Partnerships (CHP TAPS), visit https://betterbuildingssolutioncenter.energy.gov/chp/chp-taps
[33] *See* Vectren, Integrated Resource Plan, All-Source RFP, *available at* https://www.vectren.com/irp

Develop Project Priority Pipeline

Once feasibility assessments are conducted, the potential projects can be prioritized based on known timelines (e.g. when a boiler replacement is planned) or distribution infrastructure needs. These potential projects can be evaluated in IRPs.

Measure Long-Term Benefits

Because there are so few utility-owned CHP systems sited at customer sites, there is little information on how contractual arrangements are updated, how and when major retrofits take place, and how CHP system features are affected when stakeholder interests change. By continuing to measure and evaluate the benefits and costs that were included in the original cost-benefit framework, utilities and other stakeholders can have a much clearer view of how CHP can fit into their resource landscape in the future.

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Appendix 1. ACEEE Review of Integrated Resource Plans

A sample of 30 publicly-available IRPs or similar planning documents were reviewed to see whether and how utilities evaluate CHP as a resource.[34] The selection includes plans that were most readily available and covers almost half of the US states.[35] These plans are the most recent of their kind from each utility and were published between 2014 and 2017. Table 5 provides a list of utilities, states, and the year the planning study was conducted. With limited exceptions, the focus of this research by ACEEE was on IOUs; further research may be warranted with regard to resource planning by consumer-owned utilities.

Table 5. List of utilities, states, and year of planning studies reviewed

Utility	State	Year
Alabama Power	AL	2016
Ameren	MO	2016
Appalachian Power	VA	2016
Arizona Public Service Company	AZ	2017
Cleco Power	LA	2015
Dominion	VA, NC	2016
Duke Energy Carolinas	NC, SC	2018
Duke Energy Indiana	IN	2015
Entergy Arkansas	AR	2015
Entergy Louisiana	LA	2015
Eversource	NH	2015
Georgia Power	GA	2016
Idaho Power	ID	2017
Indiana Michigan Power Company (I&M)	IN, MI	2015
Indianapolis Power & Light Company (IPL)	IN	2016
Los Angeles Department of Water & Power (LADWP)	CA	2016
Northern Indiana Public Service Company (NIPSCO)	IN	2016
NV Energy	NV	2016
Oklahoma Gas & Electric Company (OG&E)	OK	2014
Pacificorp	OR, ID, WY, CA, UT	2017

[34] ACEEE reviewed a sample of 29 publicly-available IRPs or similar planning documents published between 2014 and 2017 to see whether and how utilities evaluate CHP as a resource. Idaho Power's 2017 IRP was subsequently added to this summary.
[35] Note some states do not have requirements for utilities to file IRPs. See earlier discussion.

Portland General Electric (PGE)	OR	2016
Puget Sound Energy (PSE)	WA	2015
Salt River Project (SRP)	AZ	2014
South Carolina Electric & Gas Company (SCE&G)	SC	2016
Southwestern Electric Power Company (SWEPCO)	LA	2015
Southwestern Public Service Company (SPS)	NM	2015
Tennessee Valley Authority (TVA)	TN, AL, GA, KY, MS, NC, VA	2015
Tucson Electric Power (TEP)	AZ	2017
Wisconsin Power & Light (WPL)	WI	2014
Vectren	IN	2016

5.3. Analysis of Treatment of CHP

Utilities typically analyze multiple scenarios within integrated resource planning, each with a different mix of resources and different assumptions about load forecast; fuel prices; capital costs of generation, transmission, and distribution equipment; future regulation, and other anticipated conditions. In this assessment, the review first looked for any discussion of CHP in a plan. Second, if CHP was included, the review evaluated how utility planners treated CHP in general, and specifically looked for whether it was characterized as a resource option. Third, the review looked for the inclusion of CHP in the mix of resources modeled and reviewed how it was treated in cost-effectiveness screenings.

Utilities were grouped into four categories related to treatment of CHP in their IRP: no mention, little discussion, some treatment, or substantial treatment. Of the plans reviewed, six had no mention of CHP at all. Table 6 provides an overview of how plans were grouped in the assessment.

Table 6. Overview of treatment of CHP in resource planning

Category	Resource plan
No mention	Ameren Missouri, Eversource, NV Energy, OG&E, SRP, SPS
Little discussion	Appalachian Power, APS, Cleco Power, Dominion, Entergy Louisiana, Entergy Arkansas, Georgia Power, PacifiCorp, PSE, SCG&E, SWEPCO, TEP, TVA, WPL
Some analysis	Alabama Power, PGE
Explicit evaluation	Duke Energy Carolinas, Duke Energy Indiana, Idaho Power, I&M, LADWP, IPL, NIPSCO, Vectren

Fourteen plans had little discussion of CHP, meaning CHP is defined or mentioned in some way, but its benefits as a resource are not carefully evaluated. This category also includes those plans that forecast customer-adoption of CHP for the purpose of adjusting future demand, without evaluating CHP as a resource option on the supply-side.

Two plans had some progress toward treating CHP as a resource, meaning they indicate some interest in CHP as a supply-side resource or include a discussion of the adoption of utility-owned distributed generation technologies. For example, Portland General Electric's (PGE's) 2016 IRP included a study assessing CHP potential in Oregon, which showed 90.4 MW of CHP potential with a payback of less than 10 years. PGE suggests it will further evaluate

CHP in future IRPs and includes a discussion about the general benefits of utility resource ownership.[36] PGE explicitly does not add CHP to portfolios evaluated in the plan, though it does include a study of non-solar distributed generation. The study evaluated fuel cells and microturbines, but does not consider the configuration of these technologies in CHP operation; it evaluates them in electricity-only mode.

Eight plans offered more substantial treatment, meaning they explicitly evaluate CHP as a supply resource option in the plan. They were Duke Energy Carolinas, four utilities in Indiana (Duke Energy Indiana, I&M, IPL, NIPSCO, and Vectren), Idaho Power, and LADWP.

[36] See Section 7.7 of PGE 2016 for discussion on utility-ownership.

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