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Model Guidance to Address Barriers to Combined Heat and Power and Waste Heat to Power

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Buildings and Transportation Science Division

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

ACEEE	American Council for an Energy-Efficient Economy
API	American Petroleum Institute
CHP	combined heat and power
ComEd	Commonwealth Edison Company
ConEd	Consolidated Edison
dCHPP	Database of Combined Heat and Power Policies and Incentives
DER	distributed energy resource
DERA	distributed energy resource aggregation
DERS	Distributed Energy Resource Services
DOE	US Department of Energy
DTT	direct transfer trip
ELCON	Electricity Consumers Resource Council
EPA	US Environmental Protection Agency
EPAct	Energy Policy Act
EPCA	Energy Policy and Conservation Act
EPS	electric power system
ES	Engineered Systems
FERC	Federal Energy Regulatory Commission
GHG	greenhouse gas
IEEE	Institute of Electrical and Electronics Engineers
IEPR	Integrated Energy Policy Report
IIJA	Infrastructure Investment and Jobs Act
IOU	investor-owned utility
IREC	Interstate Renewable Energy Council
ISO	independent system operator
LBNL	Lawrence Berkeley National Laboratory
LEO	legally enforceable obligation
LGIA	*Large Generator Interconnection Agreement*
LGIP	*Large Generator Interconnection Procedures*
MIP	*Model Interconnection Procedures*
NARUC	National Association of Regulatory Utility Commissioners
NERC	North American Electric Reliability Corporation
NOPR	Notice of Proposed Rulemaking
NREL	National Renewable Energy Laboratory
OEPI	FERC Office of Energy Policy and Innovation
ORNL	Oak Ridge National Laboratory
PACE	property assessed clean energy
PEPCO	Potomac Electric Power Company
PG&E	Pacific Gas and Electric
PURPA	Public Utility Regulatory Policies Act
QF	qualifying facility
RAP	Regulatory Assistance Project
RTO	regional transmission organization
SGIA	*Small Generator Interconnection Agreement*
SGIP	*Small Generator Interconnection Procedures*
SMECO	Southern Maryland Electric Cooperative

UL	Underwriters Laboratories
USEA	United States Energy Association
WHP	waste heat to power

GLOSSARY

Barriers to the deployment of CHP systems	Impediments to the interconnection of CHP systems, including impediments to demonstrating project feasibility and to obtaining funding to interconnect and operate the systems.
Bulk power system	"Facilities and control systems necessary for operating an interconnected electric energy transmission network (or any portion thereof) [and] electric energy from generating facilities needed to maintain transmission system reliability." [1] The term does not include facilities used in the local distribution of electric energy.
Clean peak standard	A standard that establishes clean energy requirements for peak demand periods. Provides clean energy–generation certificates to eligible clean energy resources delivering electricity at peaking hours.
Cogeneration	See combined heat and power (CHP). Also known as combined heat and power (CHP), a term that is inclusive of waste heat to power in this report.
Combined heat and power (CHP)	A technology that (1) simultaneously and efficiently produces useful thermal energy and electricity and (2) recovers not less than 60% of the energy value in the fuel (on a higher-heating-value basis) in the form of useful thermal energy and electricity.[2] Also known as cogeneration. *CHP* in this report is inclusive of waste heat to power.
Commercial property assessed clean energy (PACE)	"Commercial property assessed clean energy (PACE) programs allow building owners to receive financing for eligible energy-saving measures (which can include CHP), repaid as a property-tied loan assessment." [3] [4]
Direct transfer trip (DTT)	Communicated signal transmitted when the substation circuit breaker is open, signaling the DER to disconnect from the utility grid.

[1] Federal Energy Regulatory Commission, *Essential Reliability Services and the Evolving Bulk-Power System—Primary Frequency Response*, Docket No. RM16-6-000, 2016, ferc.gov/sites/default/files/2020-06/RM16-6-000.pdf.
[2] Infrastructure Investment and Jobs Act (IIJA), Public Law 117–58, §40556, 2021, congress.gov/117/plaws/publ58/PLAW-117publ58.pdf.
[3] "Glossary – dCHPP," US Environmental Protection Agency, epa.gov/sites/default/files/2015-07/documents/glossary_-_dchpp_chp_policies_and_incentives_database.pdf.
[4] Also may be repaid as a property loan assessment that transfers with the property. This generally allows long-term low-interest loans based on municipal bond underwriting for the issuing banks (Richard Sweetser, Exergy Partner Corp.).

Distributed energy resource (DER)	"Distributed energy resources, or DERs, are small-scale electricity supply or demand resources that are interconnected to the electric grid. They are power generation resources and are usually located close to load centers, and can be used individually or in aggregate to provide value to the grid." [5]
Electric storage, bulk energy storage (BES)	A transmission resource 100 kV or higher that receives electric energy from the grid or another energy source and stores it for later grid use or to serve another load source.
Feed-in tariff	Payments to distributed generators for electricity exported to the grid.
Grant/rebate	"Payments to support CHP projects or activities. Payments may be made in advance, after installation, [or during system operation] depending on the program." [6]
Induction generator	Induction generators or asynchronous generators operate by mechanically turning their rotors faster than synchronous speed. Induction generators require external power sources to operate (i.e., the grid provides the source of excitation). They are typically used in smaller distributed generation systems and are often preferred by utilities because no power can be fed into a downed grid, ensuring the safety and integrity of the grid and utility service personnel. However, induction generators do not enhance electrical power reliability to the user.
Interconnection standard	Technical requirements for safe interconnection of distributed energy resources with the electric power system. The recognized, recommended standard developed by IEEE pertaining to interconnecting generation is IEEE 1547.
Inverter-based resources	A generation source that can be interconnected to the utility grid using a power electronic inverter, which converts direct current power to alternating current power. Examples of inverter-based resources include those energized by solar PV, wind turbines, or battery storage resources.
Large Generator Interconnection Procedures (LGIP)	Pro forma interconnection procedures set forth by the Federal Energy Regulatory Commission for adoption by transmission providers to apply to generating facilities exceeding 20 MW.
Micro-CHP	CHP systems that are generally no larger than 50 kW.[7]

[5] Cummins Inc., "What are Distributed Energy Resources and How Do They Work?" cummins.com/news/2021/11/04/what-are-distributed-energy-resources-and-how-do-they-work.
[6] "Glossary – dCHPP," US Environmental Protection Agency, epa.gov/sites/default/files/2015-07/documents/glossary_-_dchpp_chp_policies_and_incentives_database.pdf.
[7] David Landolfi, "Micro-CHP: Unleashing the Benefits of Cogeneration in the Residential Sector," CHP Alliance, chpalliance.org/micro-chp-unleashing-the-benefits-of-cogeneration-in-the-residential-sector/.

Model guidance	Guidance "for consideration by State regulatory authorities and nonregulated electric utilities [to] encourage the deployment of combined heat and power systems" and which reflects current best practices per Subsection (c)2 in consideration of the factors listed in Subsection (c)3 of IIJA Section 40556.[8] Provides recommended, but not mandatory, means for encouraging CHP interconnection.
Nameplate capacity	The maximum rated output of an electric generator under specific conditions designated by the manufacturer.
Net-metering policy	"State policies on how utilities compensate customers for excess electricity generated by customer-sited distributed generators such as CHP. Key criteria commonly addressed are system capacity limits, eligible system and customer types, and treatment of excess generation."[9] These policies are typically used for the adoption of certain technologies promoted by state governments.
Packaged Combined Heat and Power (CHP) Catalog (eCatalog)	The Packaged CHP eCatalog is a public-private partnership designed to increase deployment of CHP in commercial, institutional, and multifamily buildings and manufacturing plants. It is a web-based, searchable platform that hosts DOE-recognized packaged CHP systems with features designed to reduce economic and performance risks for designers, developers, owners, and facility operators interested in installing CHP.
Portfolio standard, renewable portfolio standard	State regulations that require utilities to obtain a certain amount of the electricity they sell from specified sources and/or achieve specified reductions in electricity consumption.[10]
Prime mover	"The engine, turbine, water wheel, or similar machine that drives an electric generator; or, for reporting purposes, a device that converts energy to electricity directly (e.g., PV solar and fuel cells.)"[11]
Production incentive	"Payments that support generators based on kWh produced."[12] Production incentives are generally part of a grant or rebate program.

[8] IIJA, Public Law 117–58, §40556, 2021, congress.gov/117/plaws/publ58/PLAW-117publ58.pdf.
[9] "Glossary – dCHPP," US Environmental Protection Agency, epa.gov/sites/default/files/2015-07/documents/glossary_-_dchpp_chp_policies_and_incentives_database.pdf.
[10] Ibid.
[11] "Glossary," US Energy Information Administration, eia.gov/tools/glossary/index.php?id=Prime%20mover#:~:text=Prime%20mover%3A%20The%20engine%2C%20turbine,photovoltaic%20solar%20and%20fuel%20cells).
[12] "Glossary – dCHPP," US Environmental Protection Agency, epa.gov/sites/default/files/2015-07/documents/glossary_-_dchpp_chp_policies_and_incentives_database.pdf.

Public benefits fund	"Public benefits funds are pools of resources typically created by levying a charge on customers' electricity bills and used by states to support energy efficiency and renewable energy."[13]
Qualifying facility (QF)	A cogeneration facility or a small power-production facility that is a qualifying facility under Subpart B of 18 CFR §292.[14] [15]
Rachet demand charge	"A common feature of industrial electricity rate structures whereby a minimum billed demand is set based on a percentage of the previous 12 months' maximum demand." [16]
Recoverable waste energy	Waste energy from which electricity or useful thermal energy can be recovered through modification of an existing facility or addition of a new facility.
Reservation charge	"Charge to compensate the utility for the capacity that the utility must have available to serve a customer during an unscheduled outage of the customers own generation unit."[17] Also known as a *capacity reservation charge.*
Small Generator Interconnection Procedures (SGIP)	Pro forma interconnection procedures set forth by FERC for adoption by transmission providers to apply to generating facilities 20 MW or less.
Standalone CHP	A CHP system serving a site that is isolated from the electric grid.
Standby rates	Charges assessed to generation customers that cover additional costs incurred by the electric utility to supply backup power when requested or required.
State climate change plan	"A climate change action plan lays out a strategy, including specific policy recommendations, that a state or local government will use to address climate change and reduce greenhouse gas emissions." [18]
Supplemental power	A component of standby power service; refers to the power supplied by an electric utility to a customer that has on-site generation that does not fully meet their energy needs.

[13] Ibid.
[14] 18 CFR 292, Subpart B, 2023, "Qualifying Cogeneration and Small Power Production Facilities," *Code of Federal Regulations*, Title 18, *Conservation of Power and Water Resources*.
[15] 18 CFR §292.202(e), 2023, "Regulations under Sections 201 and 210 of the Public Utility Regulatory Policies Act of 1978 with Regard to Small Power Production and Cogeneration," *Code of Federal Regulations*, Title 18, *Conservation of Power and Water Resources*.
[16] https://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/BP%20Understanding%20your%20Utility%20Bill%20-%20Electricity_FINAL.pdf
[17] Exergy Partners Corp and Entropy Research, LLC, *Standby/Capacity Reservation Charge Best Practices and Review*, Prepared for Pennsylvania Public Utility Commission CHP Working Group, 2018. puc.pa.gov/Electric/pdf/CHPWG/Standby_Cap_Res_Best_Practices_Review-071618.pdf
[18] "Glossary – dCHPP," US Environmental Protection Agency, epa.gov/sites/default/files/2015-07/documents/glossary_-_dchpp_chp_policies_and_incentives_database.pdf

Synchronous generator	Synchronous generators convert mechanical power from a prime mover into AC power. A synchronous generator is internally (self) excited and produces electricity that is synchronized to the electric grid. It does not require the electrical grid to provide the source of excitation and can thus be started when the grid is down. Synchronous generators are preferred by CHP owners because the CHP system has the potential to continue to produce power through grid brownouts and blackouts.
Tax credits	"State or federal tax credits or favorable tax treatment that supports CHP projects or activities." [19]
Topping-cycle CHP	A CHP system where fuel is used in a prime mover such as a gas turbine or reciprocating engine that generates electricity or mechanical power. The generated electricity may be used on-site or exported to the power grid. The prime mover's waste heat is recovered and used to provide process heat, hot water, or space heating/cooling for the site. [20]
Waste heat to power (WHP)	A system that generates electricity through the recovery of waste energy. The term *CHP* used in this report is inclusive of WHP.

[19] Ibid.

[20] 18 CFR §292.202(e), 2023, "Regulations under Sections 201 and 210 of the Public Utility Regulatory Policies Act of 1978 with Regard to Small Power Production and Cogeneration," *Code of Federal Regulations*, Title 18, *Conservation of Power and Water Resources*.

EXECUTIVE SUMMARY

BACKGROUND

Congress directed[21] that the US Department of Energy (DOE) initiate a review of interconnection rules to identify barriers to interconnection and ways to better integrate combined heat and power (CHP) and waste heat to power (WHP)[22] in the electric grid. Oak Ridge National Laboratory (ORNL) supports DOE by providing technical assistance for CHP. DOE tasked ORNL with the interconnection review and development of model guidance to enable developers and CHP owners to interconnect more CHP.

This report summarizes the work that DOE initiated in response to the congressional request. The work included two phases:

i. **Identify barriers to deployment.** The initial phase included a review of existing rules and procedures pertaining to interconnection and additional services up to 150 MW to identify barriers to deploying CHP systems.[23]

ii. **Issue model guidance.** Congress directed the secretary of energy to issue model guidance in consultation with the Federal Energy Regulatory Commission (FERC) and other appropriate entities. The legislation states that the model guidance shall reflect current best practices,[24] and the model guidance presented in this report was developed considering the following:

- Relevant current standards developed by the Institute of Electrical and Electronic Engineers and model codes and rules adopted by states or associations of state regulatory agencies
- The appropriateness of using standards or procedures for interconnection service that vary based on unit size, fuel type, or other relevant characteristics
- The appropriateness of establishing fast-track procedures for interconnection service
- The value of consistency with federal interconnection rules established by FERC
- The best practices used to model outage assumptions and contingencies to determine fees or rates for additional services
- The appropriate duration, magnitude, or usage of demand charge ratchets
- Potential alternative arrangements with respect to the procurement of additional services, including the following:
    - Contracts tailored to individual electric consumers for additional services
    - Procurement of additional services by an electric utility from a competitive market
    - Waivers of fees or rates for additional services for small electric consumers

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[21] Infrastructure Investment and Jobs Act (IIJA), Public Law 117–58, §40556, 2021, congress.gov/117/plaws/publ58/PLAW-117publ58.pdf.
[22] The term *CHP* used in this report is inclusive of WHP.
[23] Per IIJA, "The term 'additional services' means the provision of supplementary power, backup or standby power, maintenance power, or interruptible power to an electric consumer by an electric utility."
[24] In this report, *current best practices* means *baseline industry recommended practice*, and this latter term is used in this report. Over the years, working groups comprising industry experts have been developing standards, such as Institute of Electrical and Electronic Engineers (IEEE) 1547,* to enable safe interconnection of all generation to the electric grid related to distributed energy resources, including CHP. Together, existing interconnection model rules such as those developed by organizations such as FERC, the National Association of Regulatory Utility Commissioners, and the Interstate Renewable Energy Council and standards such as IEEE 1547 should be considered as baseline industry recommended practices.
*IEEE Standards Coordinating Committee 21, IEEE Std 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*, 2018.

- Outcomes such as increased electric reliability, fuel diversification, enhanced power quality, and reduced electric losses that may result from increased use of CHP systems and WHP systems

This study is organized as follows:

- Executive summary
- Section 1, "Introduction"
- Section 2, "Combined Heat and Power and Interconnection"
- Section 3, "Approach"
- Section 4, "Findings"
- Section 5, "CHP Interconnection Model Guidance"
- Appendices

The CHP interconnection barriers and model guidance addressed in this study fall into three categories: interconnection, interconnection tariffs, and regulatory and policy.

PARAMETERS AND DEFINITIONS

This study uses the parameters and definitions in the Infrastructure Investment and Jobs Act (IIJA) where available as outlined below.

Terms Defined in IIJA

IIJA defines terms related to CHP systems to mean the following.[25]

Combined heat and power system means a technology that

- simultaneously and efficiently produces useful thermal energy and electricity and
- recovers not less than 60% of the energy value in the fuel (on a higher-heating-value basis) in the form of useful thermal energy and electricity.

Recoverable waste energy means waste energy from which electricity or useful thermal energy can be recovered through modification of an existing facility or addition of a new facility.

Waste heat to power means "a system that generates electricity through the recovery of waste energy."[26]

Terms Not Defined in IIJA

For the purpose of this study, *barriers to the deployment of CHP systems* are impediments to the interconnection of CHP systems, including impediments to demonstrating project feasibility and obtaining funding to interconnect and operate the systems.

For the purpose of this study, *model guidance* means guidance "for consideration by State regulatory authorities and nonregulated electric utilities [to] encourage the deployment of combined heat and power systems" and that reflects current best practices per Subsection (c)2 in consideration of the factors listed

[25] 42 U.S.C. 6341, §6371, Energy Policy and Conservation Act.
[26] Further, *waste energy* means the following:
(A) Exhaust heat or flared gas from any industrial process
(B) Waste gas or industrial tail gas that would otherwise be flared, incinerated, or vented
(C) A pressure drop in any gas, excluding any pressure drop to a condenser that subsequently vents the resulting heat

in Subsection (c)3 of IIJA Section 40556. Model guidance establishes minimum requirements for interconnection-related rules and regulations which encourage CHP interconnection. Further, model guidance provides for uniformity, which to some extent relieves authorities of the burden of starting from the beginning when adapting the model guidance for their own jurisdictions.

STUDY METHODOLOGY

Figure ES-1-1 shows the methodology used to identify CHP barriers. The research team performed a literature review, including a review of interconnection rules from a variety of utilities across the United States. The research team interviewed stakeholders, including developers, FERC, and DOE CHP Technical Assistance Partnerships, in open discussions. Guiding questions included potential difficulties faced by developers in the CHP system interconnection process due to nameplate capacity, distribution or transmission system interconnection requirements, and current FERC proceedings that could affect CHP system interconnection.

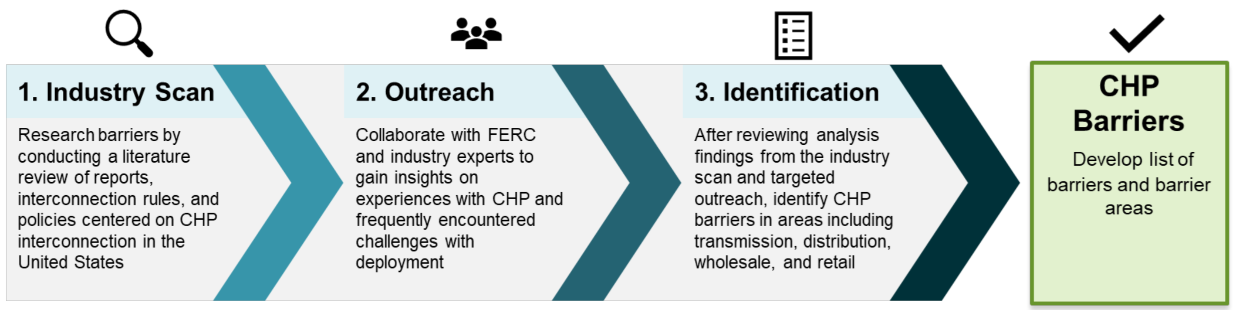

Figure ES-1-1. CHP barrier identification methodology overview.

The research team developed the model guidance in this study in consultation with over 20 stakeholder organizations, including utilities, vendors and developers, and research organizations (including FERC and DOE). Contributions from stakeholders significantly improved the depth and breadth of the study. Figure ES-1-2 shows the methodology for developing the model guidance.

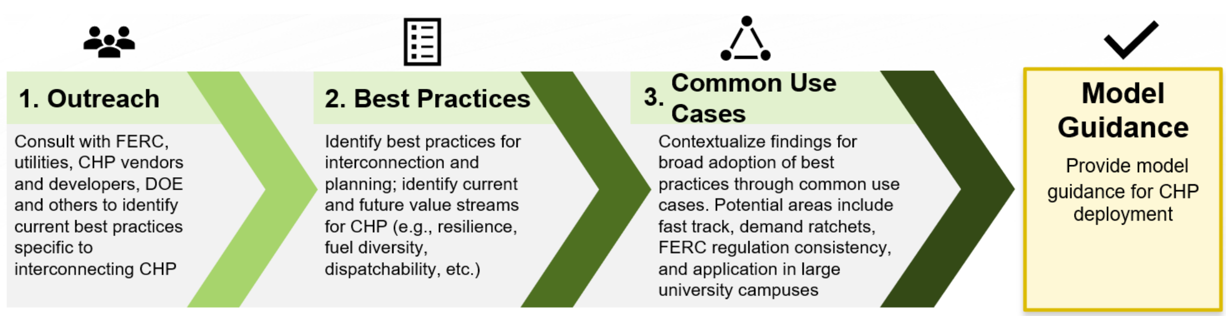

Figure ES-1-2. Model guidance methodology overview.

BARRIERS AND MODEL GUIDANCE

The initial rules review and outreach activities identified barriers that are potentially limiting the interconnection of CHP. Table ES-1-1 provides a summary list of 11 subject areas for barriers identified in three categories pertaining to CHP interconnection: interconnection, interconnection tariffs, and regulatory and policy.

The third column in Table ES-1-1 contains references to the relevant sections of IIJA Section 40556[27] for easy reference to clarify how each barrier addresses the items in the legislation.

Table ES-1-1. CHP interconnection barrier categories and subject areas

Category	Subject area	IIJA reference
Interconnection	Interconnection rules and processes	(c)2A, (c)2B, (c)3A, (c)3B
	Requirements for monitoring, metering, and protection of CHP systems	(c)2A, (c)2B, (c)3A
	Timely interconnection-related upgrade cost guide information and hosting capacity maps	(c)2A, (c)2B, (c)3A
Interconnection tariffs	Standby rates for CHP systems assessed by utilities	(b)2A, (c)3D, (c)3E, (c)3F
	Departing load charges	(b)2A, (c)3F
	Reservation charge design for CHP	(b)2A, (c)3F
	Tariffs for generation export	(b)2A, (c)3F, (c)3G
Regulatory and policy	CHP-specific tracks in regulatory policy documents	(c)2B, (c)3C, (b)2A, (c)3A, (c)3F, (c)3G
	CHP grid support value	(b)2A, (c)3A, (c)3F, (c)3G
	CHP inclusion in grid-forward planning	(b)2B, (c)2B, (c)3F, (c)3G
	Queue reform/design inclusive of CHP	(b)2B, (c)3C

Table ES-1-2 summarizes the key findings pertaining to the interconnection process for each subject area in the three categories. Further details can be found in Section 4 of this report.

Table ES-1-2. Summary of common barriers and impacts for CHP interconnection barrier categories and subject areas

Category	Subject area	Common barriers and impacts
Interconnection	Interconnection rules and processes	Interconnection processes are inconsistent across states and utilities; this makes it challenging for CHP developers to plan projects effectively and obtain project approval from utilities. In 2020, DOE examined state interconnection polices that apply to CHP and found that there were significant dissimilarities across the 50 states. The research conducted for this effort confirmed that interconnection processes remain inconsistent across states and utilities. This research also found that a lack of transparency in how interconnection rules and business processes apply to CHP projects makes it challenging for CHP developers to understand the costs and overall viability of a CHP project in a timely manner. CHP developers and end users said these factors significantly contribute to delays in obtaining funding approvals. Some utilities interviewed for this project said that incomplete applications and timelines for nonutility approvals are primary reasons for interconnection delays, including for CHP projects.

[27] IIJA, Public Law 117–58, §40556, 2021, congress.gov/117/plaws/publ58/PLAW-117publ58.pdf.

Table ES-1-2. Summary of common barriers and impacts for CHP interconnection barrier categories and subject areas (continued)

Category	Subject area	Common barriers and impacts
Interconnection	Requirements for monitoring, metering, and protection of CHP systems	One of the primary responsibilities of electric utilities and regional transmission organizations / independent system operators is to ensure reliability and safety of electric grid operation. Based on the type of generator (i.e., synchronous, induction, or inverter based) and the size of the generator (i.e., 1, 10, or 100 MW), the utility may include monitoring, metering, and protection requirements which could go beyond what is required by the host customer connected to the generator. Such information is unforeseeable by the CHP developer, and thus funding decisions are negatively affected when the requirements become known. For instance, the utility may require a utility-provided relay where the manufacturer has already included a utility-acceptable relay within the CHP technology or may require a type of metering appropriate for export when the technology is not planned for export. The utility specifies these requirements after completing its interconnection review and system impact studies if they are deemed necessary, which can take several weeks. When monitoring, metering, and protection costs for CHP projects are unknown during the early stages of the interconnection process, CHP project investment costs may increase, and project completion may be delayed.
	Timely interconnection-related upgrade cost guide information and hosting capacity maps	Public access to interconnection-related upgrade cost[28] and hosting capacity information is a key factor for the installation of CHP because the cost of interconnection has been growing, and utilities are faced with a growing number of resource interconnection requests.[29] All utilities interviewed stated they do not treat CHP interconnections differently from other types of generation. However, they may have opaque interconnection processes without clear timelines available to CHP developers and owners (e.g., information that could be provided by hosting capacity maps), which may compromise funding of a CHP project. Delayed feasibility studies or funding decisions result when CHP developers do not have timely access to information needed to understand the costs (e.g., reconductoring) and overall viability of a specific CHP project location. Although all interconnection customers face this barrier, not just CHP owners, the lack of essential information is compounded for CHP projects because CHP project nameplate capacities and overall project costs are expected to be larger than for other types of generation such as solar.

[28] For example, in the form of unit cost guides that specify cost per mile of reconductoring
[29] Such as for solar PV, energy storage, and electric vehicle–charging infrastructure

Table ES-1-2. Summary of common barriers and impacts for CHP interconnection barrier categories and subject areas (continued)

Category	Subject area	Common barriers and impacts
Interconnection	Timely interconnection-related upgrade cost guide information and hosting capacity maps (continued)	Many utilities use fast-track or preapplication interconnection processes to expedite access to information for developers, particularly for smaller inverter-based generator interconnection projects (generally solar PV projects). As the volume of PV generator interconnection applications has increased, fast-track screening processes in interconnection rules have allowed utilities to accommodate timely interconnection[30] of an increasingly large number of solar PV generators. Fast-track application screening processes developed by state regulatory agencies and utilities have therefore become focused on smaller-capacity inverter-based projects. Because the number of CHP interconnection projects (typically synchronous or induction generators installed without inverters) is small, there is often no market-driven reason for utilities and state regulatory agencies to consider how synchronous or induction-based CHP projects could safely be fast-tracked, so information is not available to CHP developers in a timely manner.
Interconnection tariffs	Standby rates for CHP systems assessed by utilities	CHP developers report that utility levies of some standby rates can significantly erode energy cost savings for CHP projects and are often based on worst-case scenarios that would not actually occur during CHP system operation.
	Departing load charges	Departing load charges, sometimes called stranded cost or exit fees,[31] can negatively affect the financial viability and economics of CHP projects. These charges increase the cost of producing electricity on-site with CHP systems. Although only a few states use departing load charges, the financial burden these charges create for CHP developers is a key factor to why CHP projects do not move forward. Departing load charges, when combined with standby charges, can result in developers determining that the investment decision of moving forward with CHP is not financially viable. Utilities typically establish departing load charges within utility rate tariffs, and the process for setting the charges may not include the perspective of CHP developers.
	Reservation charge design for CHP	Reservation charges, if not justifiable, create a financial barrier for CHP projects by charging customers a fixed per-kilowatt fee regardless of whether the CHP sites use the full capacities of the CHP systems. CHP developers report that utility assessments of reservation fees may be too high and/or based on worst-case scenarios that would not occur during CHP system operation. Without accounting for the reliability of the CHP system, and by not fully considering how the CHP system owners design, operate, and maintain the systems using the latest and most reliable technology, reservation charge designs may create a substantial financial barrier to interconnecting more CHP.

[30] In some states, interconnection timelines are required by the state-adopted interconnection process and enforced by the regulator. Utilities in these states must meet the timelines specified.
[31] ACEEE, August 2009

Table ES-1-2. Summary of common barriers and impacts for CHP interconnection barrier categories and subject areas (continued)

Category	Subject area	Common barriers and impacts
Interconnection tariffs	Tariffs for generation export	Most states do not include CHP in net-metering tariffs even when CHP may offer a more valuable source of power. For instance, when considering CHP's higher capacity factor, CHP may have a higher value than solar in some cases.[32] CHP developers lose the opportunity to use excess energy generation to improve the economics of a CHP project. Other barriers to exporting power for CHP facilities include more complex and lengthy interconnection review processes, interconnection-related upgrade costs, and transactional costs to reach wholesale markets.
Regulatory and policy	CHP-specific tracks in regulatory documents	CHP developers and owners need a well-defined regulatory policy addressing the specific challenges, logistical requirements, and timelines for CHP projects. CHP projects can be complex, involving multiple fuel types, contracts, and agreements that may require coordination across multiple agencies and different departments within utilities. Therefore, the lack of an explicit CHP track in regulatory documents can result in lost opportunity to secure funding and complete projects.
	CHP grid support value	Not including CHP when valuing distributed energy resource (DER) grid assets ignores its value in integrated resource plans or other grid planning,[33] [34] which affects CHP project financial feasibility. Advances in CHP such as expanding inverter-based systems and R&D efforts underway at DOE for flexible CHP systems that decouple power and thermal output will further enhance the potential value of CHP in supporting the grid. However, if state regulatory authorities and utilities do not value CHP alongside other DERs in supporting grid operations (e.g., as a firm dispatchable baseload or source of volt-amp reactive) when developing policies with the potential to drive the market value of CHP, CHP developers cannot include the associated financial benefits in their business plans.

[32] US Department of Energy and Environmental Protection Agency, *A Clean Energy Solution: Combined Heat and Power*, 2012.

[33] California study of CHP supporting grid found that dispatchable CHP reduced overall grid operating costs including energy, capacity, and grid stress.
E. Chartan et al., *Modeling the Impact of Flexible CHP on California's Future Electric Grid*, US Department of Energy, 2018

[34] Study by ICF developed for SEE Action states, "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."
SEE Action, *Combined Heat and Power in Integrated Resource Planning: Examples and Planning Considerations,* 2020, energy.gov/sites/default/files/2022-03/see-action-chpirp-fy22.pdf.

Table ES-1-2. Summary of common barriers and impacts for CHP interconnection barrier categories and subject areas (continued)

Category	Subject area	Common barriers and impacts
Regulatory and policy	CHP inclusion in grid-forward planning	State regulatory authorities overlook CHP technology as a resource that can be utilized for carbon reduction on a forward-planning basis. Statewide grid-forward and integrated resource planning, which does not mention or include CHP explicitly,[35] causes CHP to be left out of the dialogue when planning and funding[36] grid modernizations to accommodate more DERs. In addition, the cost of upgrading the utility system to accommodate a single CHP project could be shared among other DER project interconnections to reduce project capital costs.
	Queue reform/design inclusive of CHP	State regulatory agencies may not explicitly consider CHP when designing queue reforms. The interconnection-queue cost-allocation methodology discussion (i.e., cost allocation of required interconnection-related upgrades needed to interconnect a new generator safely)[37] normally does not consider potential benefits of CHP to other customers on the circuit. This results in a lost opportunity to reduce barriers to interconnecting more CHP through innovative queue reform strategies such as cluster- and milestone-based cost-allocation approaches.[38]

Table ES-1-3 summarizes the model guidance developed in this study to encourage CHP interconnection in consideration of the barriers found, current industry best practices, and other factors for consideration identified in IIJA Section 40556.

Table ES-1-3. Summary of model guidance to encourage CHP interconnection

Subject area	Model guidance
Interconnection	
Interconnection rules and processes	State regulatory agencies and utilities should • adopt the use of standards (e.g., IEEE 1547-2018, UL 1741) that simplify interconnection, • develop fast-track programs[39] to reduce longer-timeline activities such as modeling and studies where possible while maintaining grid safety and reliability, and • revise interconnection rules to allow for consideration of cost-effective alternatives to interconnection requirements.

[35] Exceptions include New York (e.g., coned.com/-/media/files/coned/documents/our-energy-future/our-energy-projects/distributed-system-implementation-plan.pdf) and California (e.g., cpuc.ca.gov/industries-and-topics/electrical-energy/electric-power-procurement/combined-heat-and-power-program-overview).
[36] Funding includes cost recovery strategies for utilities.
[37] Cost-allocation approaches range from cost-causer pays to prorated strategies and rate decoupling schemes, depending on the state.
[38] A cluster-based approach in which queued new resource projects are evaluated in multiproject cohorts by the utility might allow for CHP to be evaluated alongside existing operational facilities and other DERs in the queue, reducing or deferring interconnection-related upgrade costs for all customers on a circuit. A milestone-based approach adopts a first-ready first-through approach, allowing projects that are ready to move ahead of projects that are not ready.
[39] While fast-track procedures are already in use by many utilities and are generally considered beneficial, it is worth noting that FERC has included them in *Small Generator Interconnection Procedures* for utilities to use as model guidance.

Table ES-1-3. Summary of model guidance to encourage CHP interconnection (continued)

Subject area	Model guidance
Interconnection	
Requirements for monitoring, metering, and protection of CHP systems	State regulatory agencies and utilities should • align interconnection rules to be consistent with IEEE 1547-2018 to ensure grid safety and reliability and • consider whether electric metering of CHP could justifiably seek utility rate-base treatment. Utilities should also provide clear timelines for processing CHP interconnection applications to support realistic project schedules for developers.
Timely interconnection-related upgrade cost guide information and hosting capacity maps	State regulatory agencies and utilities should ensure interconnection rules require transparent, publicly available interconnection-related upgrade unit cost guides and hosting capacity information.
Interconnection tariffs	
Standby rates for CHP systems assessed by utilities	State regulatory agencies and utilities should reduce complexity and improve transparency of standby rates and tariffs. Utilities should update and modernize rate structures and demand charges to ensure equitable rates.
Departing load charges	State regulatory agencies and utilities should periodically investigate the approach, assumptions, and data used to justify departing load charges.
Reservation charge design for CHP	Utilities should review and update the methodologies used to determine reservation charges periodically to ensure they remain justifiable.[40]
Tariffs for generation export	State regulatory agencies and utilities could develop pathways for additional revenue generation for CHP. Furthermore, they should review and evaluate interconnection regulations and tariffs that may discourage CHP deployment.
Regulatory and policy	
CHP-specific tracks in regulatory policy documents	State regulatory agencies and utilities should collaborate and evaluate tracking of CHP policies in regulatory documents to encourage more interconnection. Interconnection standards should clearly outline requirements for smaller-capacity induction- or synchronous-generator CHP.
CHP grid support value	State regulatory agencies and utilities should establish processes to assess CHP value streams and create pathways to incentivize CHP grid support.
CHP inclusion in grid-forward planning	State regulatory agencies and utilities should collaborate to include CHP in grid planning.[41]
Queue reform/design inclusive of CHP	State regulatory agencies, utilities, and stakeholders overseeing queue reform processes should investigate how to include CHP explicitly in queue reform/design where CHP grid support services may allow for the reduction or deferment of interconnection-related upgrade costs.

[40] While reservation charges should be made fair for CHP, this should apply to any interconnecting resource.

[41] CHP grid support benefits and contributions to grid flexibility may vary depending on factors such as existing grid infrastructure and local load profiles. State regulatory agencies and utilities should consider CHP grid support value for their jurisdictions to identify whether CHP could play a role.

1. INTRODUCTION

1.1 PURPOSE AND SCOPE

Congress directed[42] that the US Department of Energy (DOE) initiate a review of interconnection rules to identify barriers to interconnection and ways to better integrate combined heat and power (CHP) and waste heat to power (WHP)[43] in the electric grid. Oak Ridge National Laboratory (ORNL) supports DOE by providing technical assistance for CHP. DOE tasked ORNL with the interconnection review and development of model guidance to enable developers and CHP owners to interconnect more CHP.

This report summarizes the work that DOE initiated in response to the congressional request. The work included two phases:

i. **Identify barriers to deployment.** The initial phase included a review of existing rules and procedures pertaining to interconnection and additional services up to 150 MW to identify barriers to deploying CHP systems.[44]

ii. **Issue model guidance.** Congress directed the secretary of energy to issue model guidance in consultation with Federal Energy Regulatory Commission (FERC) and other appropriate entities. The legislation states that the model guidance shall reflect current best practices.[45]

For informational purposes, the following subsections provide a snapshot of the current CHP installed capacity and CHP-related standards and policies relevant to the existing CHP interconnection landscape. State regulatory agencies and utilities applying the model guidance developed in this study will also need to consider future emerging technologies and policies such as increased penetration of inverter-based CHP and FERC Order 2222, which are not covered here.

2. COMBINED HEAT AND POWER AND INTERCONNECTION

2.1 COMBINED HEAT AND POWER

2.1.1 Definition of CHP

CHP is a cost-effective approach to generating electric power and useful thermal energy on-site from a single fuel source that offers efficient, reliable, and affordable energy services. CHP and WHP (which provides on-site generation of power from waste heat) face similar interconnection barriers and constraints. In this report, the term *CHP*, when used in the context of discussing interconnection barriers, requirements, and best practices, is inclusive of WHP. Figure 2-1 provides an overview of CHP.

[42] Infrastructure Investment and Jobs Act (IIJA), Public Law 117–58, §40556, 2021, congress.gov/117/plaws/publ58/PLAW-117publ58.pdf.
[43] The term *CHP* used in this report is inclusive of WHP.
[44] Per IIJA, "The term 'additional services' means the provision of supplementary power, backup or standby power, maintenance power, or interruptible power to an electric consumer by an electric utility."
[45] In this report, *current best practices* means *baseline industry-recommended practice*, and this latter term is used in this report.

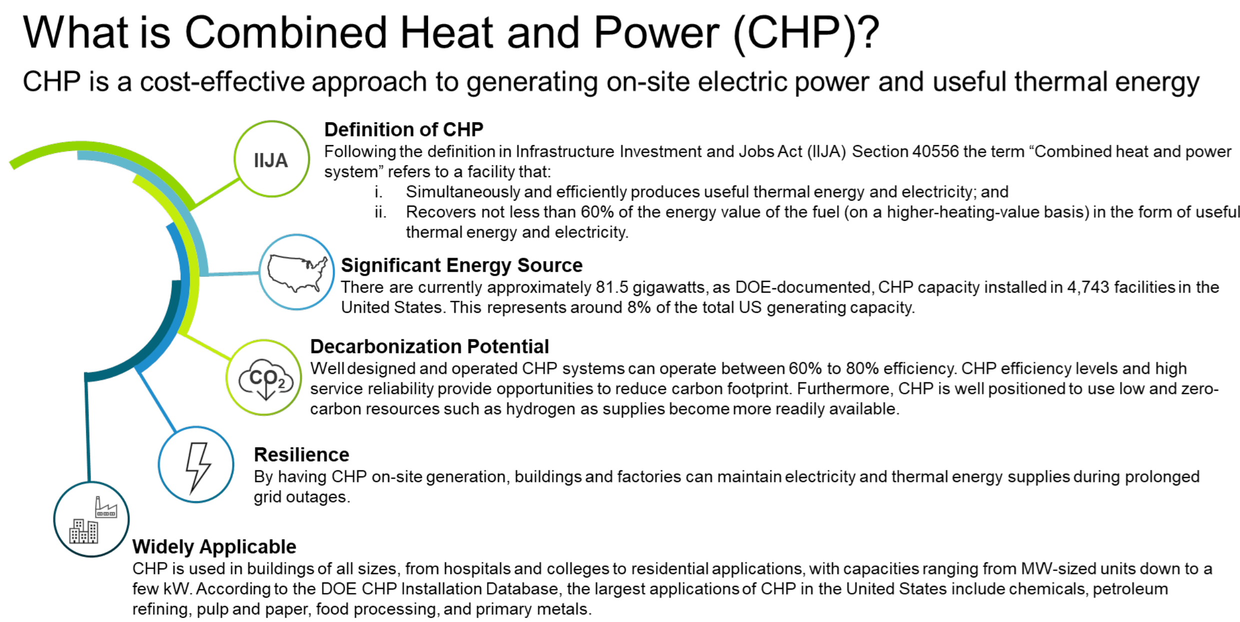

Figure 2-1. CHP overview.

CHP has been providing highly efficient electricity and process heat to some of the most vital industries, urban centers, and campuses in the United States since the early 1900s. Well-designed and well-operated CHP systems can operate between 60% and 80% efficiency.[46] The federal investment tax credit, as well as some state incentives, have required 60% efficiency to qualify. CHP systems can be inverter based and covered by the same inverter-based standards as solar PV, but most CHP systems are induction- and synchronous-generator systems.

Following the definition in IIJA Section 40556,[47] the term *combined heat and power system* used in this report refers to a technology that

- simultaneously and efficiently produces useful thermal energy and electricity, and
- recovers not less than 60%[48] of the energy value in the fuel (on a higher-heating-value basis) in the form of useful thermal energy and electricity.

2.1.2 History of CHP in the United States

CHP became much more widely used in the United States after 1979, when the Public Utility Regulatory Policy Act of 1978 (PURPA) was promulgated. PURPA effectively removed significant barriers to CHP, such as by requiring utilities to allow interconnection by qualifying facilities (QFs), explicitly including

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[46] From "CHP Benefits," US Environmental Protection Agency, last modified December 2, 2022, epa.gov/chp/chp-benefits: "A CHP system's efficiency depends on the technology used and the system design. The five most commonly installed CHP power sources (known as 'prime movers') offer these efficiencies:
- Reciprocating engine: 75–80 percent
- Combustion turbine: 65–70 percent
- Steam turbine: 80 percent
- Microturbine: 60–70 percent
- Fuel cell: 55–80 percent"

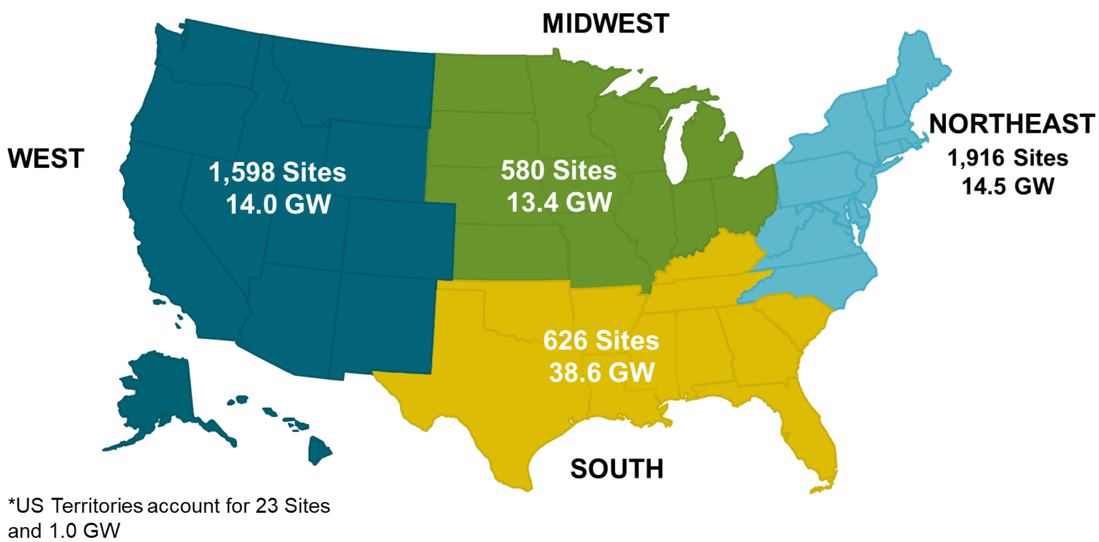
[47] 42 U.S.C. 6341, §6371, Energy Policy and Conservation Act

[48] The CHP minimum efficiency requirement in PURPA, 18 CFR §292.205(a)(2), is lower than this.

CHP[49] as a type of technology eligible to qualify as a QF. PURPA has evolved and currently gives states the authorization to limit its applicability. [50,51] Additionally, amendments made in 2005 and regulations adopted by FERC have limited the applicability of PURPA in some regions, particularly for facilities larger than 20 MW[52] where CHP did not need PURPA support anymore in regions with competitive power markets.[53]

2.1.3 Existing CHP Capacity

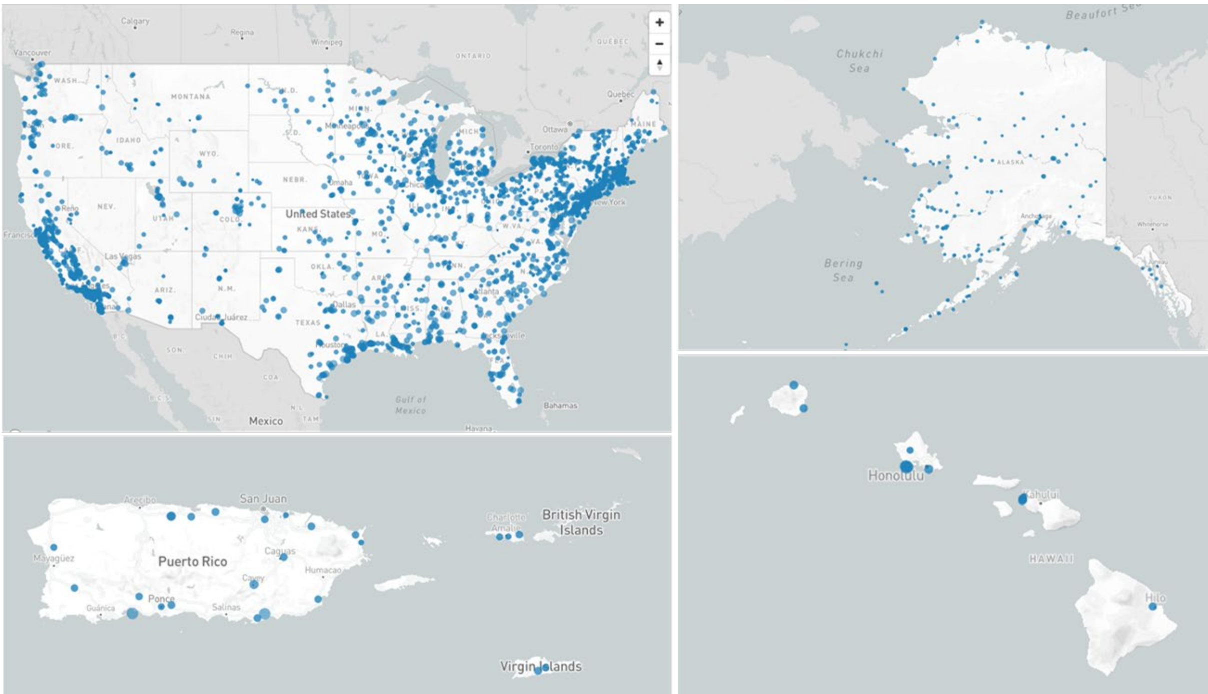
Various industrial, commercial, and institutional sectors rely on CHP for efficient, reliable power and thermal energy. Figure 2-2 and Figure 2-3 provide an overview of existing CHP capacity and project locations across the United States. CHP capacity represents around 8% of the total US generating capacity.[54]



Source: *Based on 2021 data from the DOE CHP Installation Database*[55]

Figure 2-2. CHP installations by US region with capacities and numbers of sites.

[49] PURPA uses the term *cogeneration*. In 18 CFR § 292.202(e), "Regulations under Sections 201 and 210 of the Public Utility Regulatory Policies Act of 1978 with Regard to Small Power Production and Cogeneration," *cogeneration* is defined as "equipment used to produce electric energy and forms of useful thermal energy (such as heat or steam), used for industrial, commercial, heating, or cooling purposes, through the sequential use of energy." In this report, considering the stated definition of CHP, CHP is synonymous with cogeneration. Additionally, WHP is defined in PURPA as *bottoming-cycle cogeneration*.
[50] American Public Power Association, Edison Electric Institute, National Association of Regulatory Utility Commissioners, and National Rural Electric Cooperative Association, *PURPA Title II Compliance Manual 2.0*, 2021, pubs.naruc.org/pub/47AD30DC-1866-DAAC-99FB-975A60906D6B .
[51] Federal Energy Regulatory Commission, FERC Order No. 671
[52] American Public Power Association, Edison Electric Institute, National Association of Regulatory Utility Commissioners, and National Rural Electric Cooperative Association, *PURPA Title II Compliance Manual 2.0*, 2021, pubs.naruc.org/pub/47AD30DC-1866-DAAC-99FB-975A60906D6B.
[53] Exergy Partners Corp and Entropy Research, LLC, *Standby/Capacity Reservation Charge Best Practices and Review: Prepared for Pennsylvania Public Utility Commission CHP Working Group*, 2018, puc.pa.gov/Electric/pdf/CHPWG/Standby_Cap_Res_Best_Practices_Review-071618.pdf.
[54] "Combined Heat and Power: Frequently Asked Questions," US Environmental Protection Agency, last modified April 2022, epa.gov/sites/default/files/2015-07/documents/combined_heat_and_power_frequently_asked_questions.pdf.
[55] DOE, "CHP Installation Database," US Department of Energy Combined Heat and Power and Microgrid Installation Databases, doe.icfwebservices.com/chp (data as of December 31, 2022).



Source: *DOE CHP and Microgrid Installation Databases*[56]

Figure 2-3. Map of CHP projects in the United States.

With its wide applicability across industries and sectors, CHP is an important energy generation source in the United States. Currently, approximately 81.5 GW of CHP capacity is installed in 4,743 facilities in the United States (Figure 2-4) which saves an estimated 1.3 quads (1 quad = 10^{15} Btus) of fuel and 218 million tons of CO_2 emissions annually.[57] This CHP capacity is installed in hospitals, schools, university campuses, and other institutional facilities such as hotels and prisons, government buildings, wastewater treatment facilities, petrochemical plants, and other commercial and industrial facilities.[58] The largest applications of CHP in the United States include chemicals, petroleum refining, pulp and paper, food processing, and primary metals.[59] CHP has long been used in industries with large process thermal demands such as chemicals, refining, pulp and paper, and food processing. CHP is particularly valued for providing resilient heat and power to critical infrastructure such as hospitals, universities, military facilities, and data centers. CHP has also been used to provide power and electricity to residential customers in multifamily homes and in district heating schemes.[60]

Figure 2-4 further shows that most CHP sites are below 20 MW, many are below 5 MW, and over half (58%) are below 1 MW. This proliferation of smaller CHP projects, particularly those under 1 MW, micro-CHP, and newer inverter-based CHP, suggests that it is important for the model guidance to address distribution grid interconnection because smaller-capacity units will be interconnected to the distribution grid.

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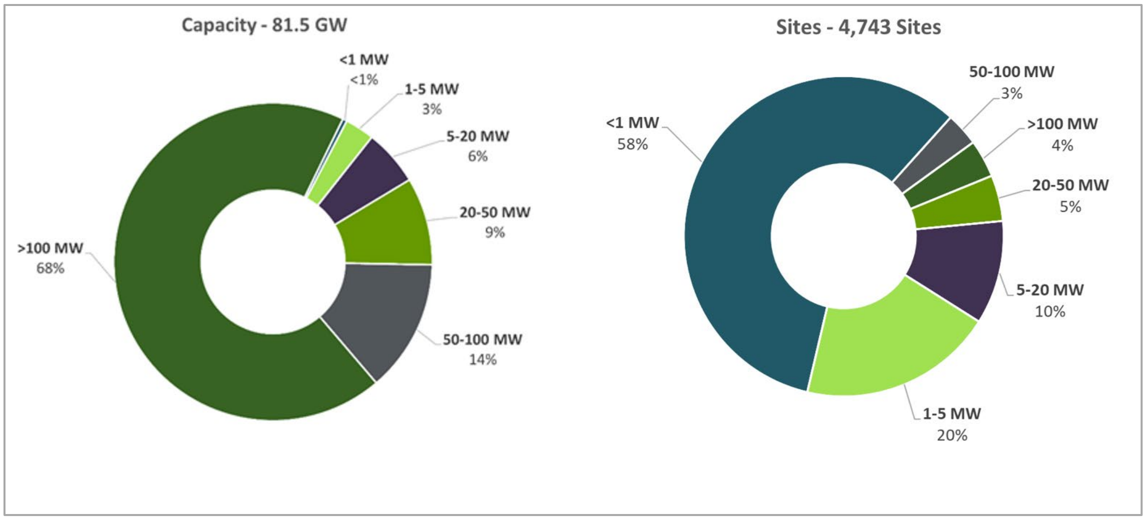
[56] DOE, "CHP Installation Database," US Department of Energy Combined Heat and Power and Microgrid Installation Databases, doe.icfwebservices.com/chp (data as of December 31, 2022).

[57] Ibid.

[58] Based on information from the DOE CHP Installation Database and "A Complex Landscape for the Future of Combined Heat and Power," *Power Magazine*, vol. 167, 2023.

[59] DOE, "CHP Installation Database," US Department of Energy Combined Heat and Power and Microgrid Installation Databases, doe.icfwebservices.com/chp (data as of December 31, 2022).

[60] Ibid.



Source: *Data from DOE CHP Installation Database*[61]

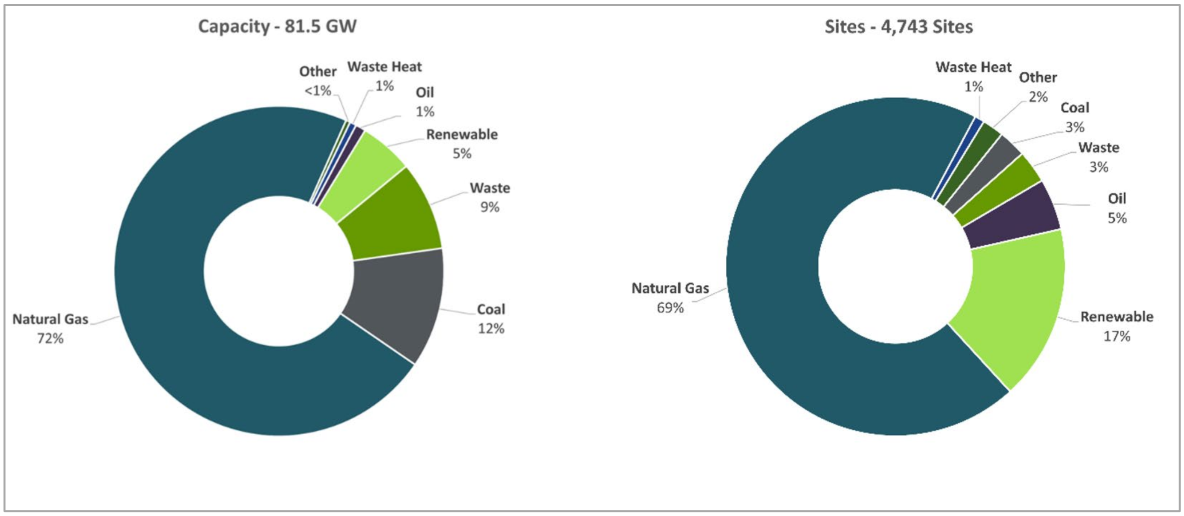
Figure 2-4. Percentage of US CHP installations by capacity and number of sites.

2.1.4 CHP Grid Support and Decarbonization

By hosting CHP on-site generation, buildings and factories can maintain electricity and thermal energy supplies during prolonged grid outages, thus improving their energy resilience and efficiency. Furthermore, CHP efficiency levels and high service reliability provide opportunities to reduce carbon footprint. Although natural gas has historically been the dominant fuel source for CHP because of its wide availability, low emissions, ease of use, and competitive price, CHP systems are fuel neutral. There is well-documented history of CHP using alternative fuels such as biomass and wood, biogas and landfill gas, municipal and process wastes, waste gas streams, renewable natural gas, and hydrogen mixtures where available.

As shown in Figure 2-5, 72% of existing CHP capacity and 69% of existing CHP installations are natural gas fueled. Use of non–fossil fuels for CHP is primarily driven by supply; in places where such fuels are available at competitive prices, they are used. Currently, about 15% of existing CHP capacity is fueled by non–fossil fuels such as biomass and wood, biogas, process waste, and waste heat. Thus, a proven track record and experience base exist for CHP being operated on renewable and other non–fossil fuels by industrial users and CHP suppliers.[62] CHP is well positioned to use such low- and zero-carbon resources as supplies become more readily available, maintaining its significant energy efficiency and emissions advantages in a decarbonized energy economy.

[61] DOE, "CHP Installation Database," US Department of Energy Combined Heat and Power and Microgrid Installation Databases, doe.icfwebservices.com/chp (data as of December 31, 2022).
[62] For instance, within the ~4,700 projects listed in the CHP Installation Database, over 600 CHP systems are operating on digester gas or landfill gas. From *Full CHP Data Set* by the US Department of Energy Combined Heat and Power and Microgrid Installation Databases.



Source: *Based on data from DOE CHP Installation Database*[63]

Figure 2-5. Breakdown of source fuels for US CHP installations.

In its 2022 *Industrial Decarbonization Roadmap*,[64] DOE recognized CHP as a promising option for industrial sites to decarbonize. DOE concluded that CHP provides significant greenhouse gas (GHG) emissions reductions in the near- to medium-term as marginal grid emissions in most areas of the country continue to be based on a mix of fossil fuels. The roadmap also notes that to prevent technology "lock-in" to fossil fuels, CHP units installed today must plan to maintain emissions below marginal grid emissions for the duration of their useful lives and include future retrofits to clean sources of energy where possible. CHP systems capable of fuel switching using either renewable natural gas, hydrogen, or other clean fuels will support the integration of CHP into a fully decarbonized energy economy and can be a long-term path to decarbonizing industrial thermal processes resistant to electrification because of technology or cost barriers. Further, customers could use CHP for critical operations where dispatchable on-site power is needed for resilience and reliability.

With the increasing flexibility of fuel supply in modern CHP systems, the technology is evolving to meet stricter environmental and emissions standards while maintaining its cost-effectiveness and high-efficiency output. However, barriers that cause significant costs and uncertainty for CHP interconnection at both the transmission and distribution system levels can negatively affect the financial viability of CHP systems and complicate the interconnection process for CHP owners and developers, potentially reducing future CHP installations. Thus, opportunities and value streams that could benefit end users, developers, utilities, and communities remain unfulfilled.

CHP developers and owners require a firm understanding of the costs and benefits associated with electrical interconnection to the grid for CHP technologies to be financially successful. End users choose to purchase CHP systems directly or indirectly (e.g., through power purchase agreements) because of their cost-effectiveness, high efficiency, resilience, and/or low–carbon emissions potential. Interconnection processes can increase capital and operating costs, delay project installations, complicate operations, and even stop projects from progressing. The CHP developer's decisions may trigger these

[63] DOE, "CHP Installation Database," US Department of Energy Combined Heat and Power and Microgrid Installation Databases, doe.icfwebservices.com/chp (data as of December 31, 2022).
[64] US Department of Energy, *Industrial Decarbonization Roadmap,* 2022, energy.gov/sites/default/files/2022-09/Industrial Decarbonization Roadmap.pdf.

impacts, but they can also be caused by implicit barriers in interconnection rules, tariffs, or policies. This report provides model guidance to help reduce or eliminate these barriers.

2.1.5 DOE Packaged Systems eCatalog

In 2019, DOE launched the Packaged CHP Systems eCatalog.[65] CHP equipment can be custom engineered or installed as predesigned assembled packages and modular systems. Modern packaged CHP systems provide the same benefits as custom-engineered CHP systems, with additional advantages in reduced cost, installation time, and system complexity. A packaged CHP system is a standardized, pre-engineered system that includes all equipment, piping, wiring, and ancillary components to deliver electricity and thermal energy to a host facility with minimal on-site engineering design adjustments and installation time. Most containerized, packaged, or modular CHP system offerings range from 5 kW to 20 MW.[66] To reaffirm its support of CHP, the DOE continues to publish and update a series of market-sector fact sheets that highlight case studies based on a variety of different application and building types, showing how CHP systems have a proven track record of economically meeting energy demands and resilience requirements.[67]

The availability of standardized packaged CHP systems supported by DOE's Packaged CHP Systems eCatalog has made it easier for businesses and organizations to install and benefit from CHP technology. Overall, CHP technology presents an excellent opportunity for utilities, businesses, and institutions to lower energy costs, reduce emissions, and increase energy resiliency.

2.2 INTERCONNECTION LANDSCAPE

Interconnection rules are essential for the deployment of distributed energy resources (DERs) because interconnection rules provide the technical and procedural requirements and frameworks for connecting DERs to the grid. These rules depend on several factors including utility, local and state jurisdiction, and DER system characteristics such as size. Notably, the FERC *Small Generator Interconnection Procedures* (SGIP) for systems with capacities no larger than 20 MW and *Large Generator Interconnection Procedures* (LGIP) for systems with capacities larger than 20 MW may serve as guidance for generator interconnection even if the generator is installed and interconnected outside of FERC jurisdiction. Within the current landscape of interconnection, projects generally fall within the following ranges:[68]

- 10 MW or larger systems: 10 MW DER systems typically connect at the transmission level. Because such systems are connected directly to the transmission system, FERC has jurisdiction over developing applicable interconnection standards. Interconnected CHP projects above 10 MW are mostly found within the industrial sector and colleges/universities.
- 100 kW to 10 MW systems: Systems between 100 kW and 10 MW are generally interconnected to the distribution system; hence, the interconnection rules are governed by states and utilities. To manage the interconnection process for projects within this range, utilities define different tiers of

[65] DOE launched the Packaged CHP Systems eCatalog to promote increased acceptance of efficient, cost-effective CHP in these applications (https://chp.ecatalog.ornl.gov/). The eCatalog is designed to remove some installation barriers, lower project costs and installation times, and reduce the perceived risk of installing CHP by offering comparable standardization of CHP system performance. As of the end of 2022, the eCatalog included 340 recognized packaged CHP system offerings ranging from 24 kW to 16.7 MW in capacity, 42 packagers, 26 solution and 18 CHP engagement partners.
[66] Oak Ridge National Laboratory, *Project Profile: Columbia Energy Center,* last updated August 2015, chptap.ornl.gov/profile/47/columbia_energy_center-Project_Profile.pdf.
[67] DOE, "CHP Market Sector Fact Sheets," betterbuildingssolutioncenter.energy.gov/accelerators/packaged-chp/market-sector-fact-sheets.
[68] US Environmental Protection Agency, *State Energy and Environment Guide to Action: Interconnection and Net-Metering*, 2022, epa.gov/system/files/documents/2022-08/Interconnection%20and%20Net%20Metering_508.pdf.

interconnection based on system size and complexity. Although interconnection procedures and standards cover projects within 100 kW and 10 MW, they typically exceed the system size covered by net-metering rules.[69]

- Less than 100 kW systems: The systems in this category are considered relatively small. Policy and compensation mechanisms vary by utility and jurisdiction. According to the National Renewable Energy Laboratory (NREL), 41 states and Washington, DC, American Samoa, the US Virgin Islands, and Puerto Rico have mandatory net-metering policies in place.[70] Micro-CHP projects fall into this size category as they are no larger than 50 kW.[71]

2.2.1 Interconnection Engineering Standards

Existing technical standards such as Institute of Electrical and Electronic Engineers (IEEE) 1547-2018, *Standard for Interconnection and Interoperability of DERs*, and Underwriters Laboratory (UL) 1741-SB, *Grid Support Interactive Inverters*, provide specific guidance and recommendations on interconnection parameters potentially relevant to CHP. These include relay protection requirements for synchronous, induction, and inverter generation along with telemetry requirements. Both IEEE 1547-2018 and UL 1741-SB are current versions and are likely to be updated over time.

2.2.1.1 IEEE Standard 1547

IEEE 1547 is a widely recognized industry standard for utilities and regulators that includes recommendations for the performance and testing of all DERs including CHP, allowing them to interconnect with utility electric grids. This section highlights key aspects of interconnection standard IEEE 1547-2018[72] that could pertain to CHP technology interconnection. The IEEE 1547 committee considered high penetration of intermittent DERs, such as solar electric generating facilities, when it developed the standard. The standard emphasizes the challenges of DER integration and covers static power inverter/converter–based, induction-based, and synchronous generator–based interconnection.

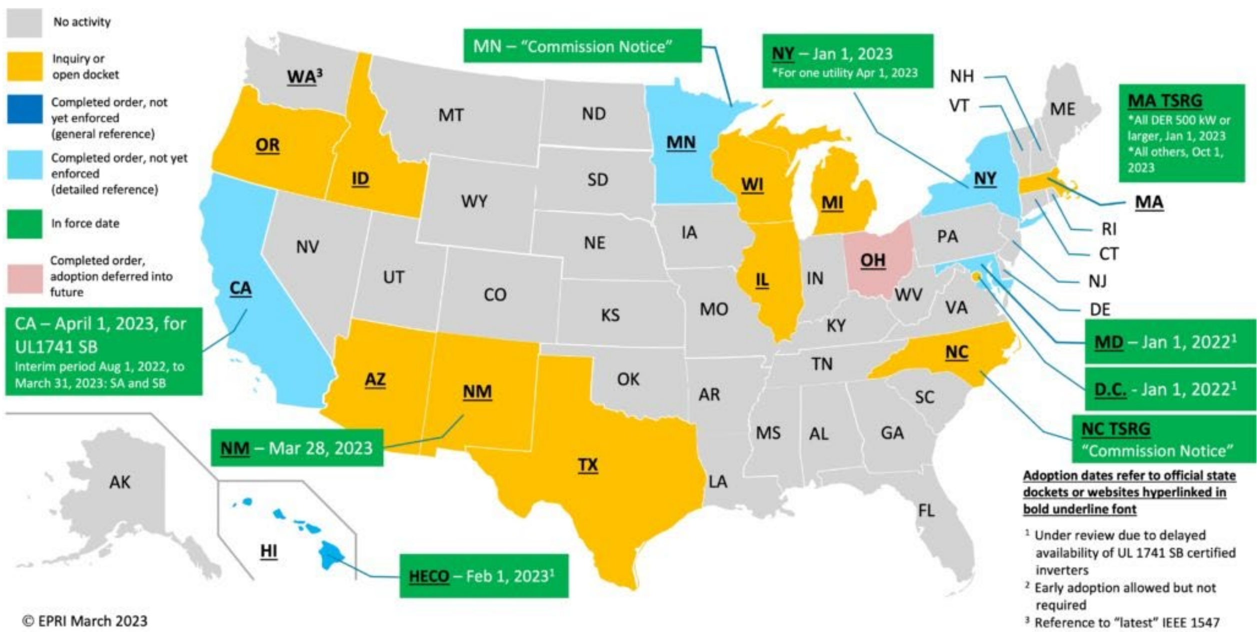
IEEE 1547 Intent and Applicability

This standard establishes criteria and recommended practices for interconnection and interoperability of all types of DERs, including CHP, with electrical power system (EPS) interfaces. The stated technical specifications and requirements in IEEE 1547 are universally recognized for interconnection and interoperability of DERs and are considered some of the best practices in the industry. The specified performance requirements apply at the time of interconnection and as long as the DER remains connected to the electrical grid. The standard is not intended for, and is in part inappropriate for, application to energy resources connected to transmission or networked subtransmission systems.

[69] Ibid.
[70] NREL, "Net Metering," nrel.gov/state-local-tribal/energy-compensation-mechanisms.html.
[71] David Landolfi, "Micro-CHP: Unleashing the Benefits of Cogeneration in the Residential Sector," CHP Alliance, 2021, chpalliance.org/micro-chp-unleashing-the-benefits-of-cogeneration-in-the-residential-sector/.
[72] IEEE Standards Coordinating Committee 21, IEEE Std 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*, 2018.

IEEE 1547-2018 Adoption by State

In 2018, an updated version of IEEE 1547 was established. IEEE 1547-2018 covers a broader range of DERs and builds upon requirements for grid support functionality, interoperability (e.g., communications, data exchange, cybersecurity), testing, and verification. As with IEEE 1547-2003, the standard is applicable to all DER types connected to typical primary and secondary distribution levels. As of March 2023, 15 states have activities and/or proceedings underway toward adopting IEEE 1547-2018 (Figure 2-6).[73] [74]



Source: *Electric Power Research Institute, March 2023*

Figure 2-6. Status of IEEE 1547-2018 adoption by state.

Importance of IEEE 1547 to Electric Grid Stability

As stated by NREL in 2021,[75] if the penetration of intermittent DERs is low, DER operation may not be impactful on the bulk power system. However, when intermittent DER penetration increases, it may cause issues for grid voltage and frequency as well as transmission line loading. Consequently, the aggregated response of intermittent DERs to an abnormal grid operation condition may affect the stability of the bulk power system.[76] IEEE 1547 defines abnormal conditions and sets requirements for DERs to mitigate or to not complicate stability issues by specifying DER ride-through capabilities. These requirements include voltage disturbance ride-through and frequency settings and are important for increasing DER penetration because they provide robustness for the bulk power system during disturbances. The standard provides ranges for the DER operation settings so that the settings can be adjusted to meet local requirements as well.[77]

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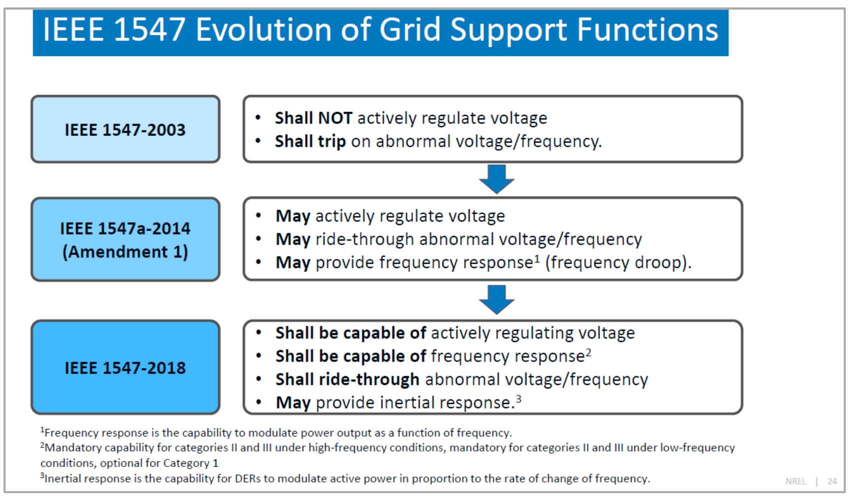
[73]Electric Power Research Institute, March 2023. sagroups.ieee.org/scc21/standards/1547rev/.
[74] This includes states that either have an inquiry/open docket or that have completed an order for IEEE 1547-2018.
[75] National Renewable Energy Laboratory, *A Guide to Updating Interconnection Rules and Incorporating IEEE Standard 1547*, 2021, nrel.gov/grid/ieee-standard-1547/guide-to-updating-interconnection-rules.html.
[76] Ibid.
[77] Ibid.

Impact of IEEE 1547 Evolution on Grid Support Services

The evolution of IEEE 1547 from 2003 to 2018 (Figure 2-7) has implications for CHP ancillary services for utilities that have adopted IEEE 1547. Although IEEE 1547-2018 focuses on advanced inverters for DER interconnection, it also addresses synchronous and induction generator interconnections. Voltage regulation and reactive power control are achievable for synchronous generators such as CHP. The initial version of IEEE 1547 did not require DERs to actively regulate voltage; however, with the revised version from 2018, DERs are required to have such capabilities.[78]

Because synchronous generators, such as CHP generators, can provide both active and reactive power, CHP systems can regulate voltage by complying with IEEE 1547-2018. This capability can enable CHP systems to participate in providing ancillary services such as voltage support. This also enables the capabilities of flexible CHP for the grid. Flexible CHP provides on-site generation, additional generating capacity during times of high demand or when renewable DERs are not available, and grid support service (e.g., voltage regulation). In addition to voltage regulation, requirements for frequency and voltage ride-through ensure the reliability and availability of DERs, which are essential for improving grid flexibility. Following IEEE 1547 grid support requirements, CHP systems have the potential to relieve grid congestion and mitigate impacts resulting from the intermittency of renewable DERs, thereby generating positive value streams for both the CHP developer and the utility.[79]



Source: *David Narang, Highlights of IEEE Standard 1547-2018, Webinar Presented to Arkansas DER Interconnection Stakeholders, October 28, 2019 (Revised 11/21/2019), NREL.*

Figure 2-7. IEEE 1547-2003 to IEEE 1547-2018 grid support function evolution.

References to CHP in IEEE 1547

Table 2-1 summarizes where and how IEEE 1547-2018 references CHP.

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[78] IEEE 1547-2018: "The DER shall provide voltage regulation capability by changes of reactive power. The approval of the Area EPS Operator shall be required for the DER to actively participate in voltage regulation." Sourced from: David Narang, *Highlights of IEEE Standard 1547-2018, Webinar Presented to Arkansas DER Interconnection Stakeholders*, October 28, 2019 (Revised 11/21/2019), NREL , nrel.gov/docs/fy20osti/75436.pdf.

[79] Jal Desai et al., ORNL/TM-2019/1259, *Modeling the Impact of Flexible CHP on the Future Electric Grid In California,* 2020, Oak Ridge National Laboratory, osti.gov/biblio/1649545- modeling-impact-flexible-chp-future electric-grid-california.

Table 2-1. References to CHP in IEEE 1547-2018

IEEE 1547-2018 page number and section	Summary
99; §B.2	Annex B of IEEE 1547 covers guidelines for DER performance category assignment as defined in the standard based on attributes such as technology, purpose, and power generation variability. Here, the standard mentions that synchronous generators (e.g., CHP) possess inherent electrical limitations in that they are unable to remain connected to the area EPS during low-voltage events for extended durations.
102; §B.4.2	Annex B of IEEE 1547 further describes performance category assignments and groupings, noting that the DER application purpose, such as combined heat and power (and cogeneration), is one of the attributes to be considered for categorizing the types of DERs before performance level categories can be assigned.
106; Table B.1	Table B.1 in Annex B of IEEE 1547 shows an example of an illustrative performance category assignment to facilitate the complex categorization of DER types (CHP included) and the assignment of disturbance ride-through performance categories based on criteria.

2.2.1.2 UL Standard 1741-SB

The UL 1741-SB standard is focused on the performance and safety requirements of grid interconnected inverters relating to renewable energy systems and other DERs, including CHP. The standard notes the unique requirements and challenges faced with DER interconnection and addresses the gaps in IEEE 1547 by extending the functionality and safety requirements for inverters beyond the IEEE scope and providing guidance on, for example, grid support function, cybersecurity, and islanding detection. The UL 1741-SB standard provides higher confidence levels in the effective and safe interconnection of inverter-based generation into the grid. Furthermore, by developing methodologies that prevent unwarranted events such as unintentional islanding (DER operation during grid outages), the UL 1741-SB standard allows for safer work environments and enhanced grid resilience as it sets the stage for the implementation of voltage/frequency ride-through, reactive power control, and other grid support functions.

2.3 DOCUMENTED INTERCONNECTION MODEL GUIDANCE

Over the years, working groups comprising industry experts have been developing standards, such as IEEE 1547,[80] to enable safe interconnection of all generation to the electric grid, including CHP. In light of the IIJA Section 40556 congressional request, it is essential that experts continue to further develop models and standards to support the safe interconnection of modern CHP systems, including synchronous, induction-, and inverter-based CHP. Although the model guidance in this report focuses on interconnection rule guidance and updates that would specifically encourage CHP interconnection, some suggested guidance applies to all types of generators.

Model guidance ensures state regulatory agencies and utilities develop uniform interconnection rules and regulations. It seeks to establish minimum requirements to be studied and applied by those seeking to encourage CHP interconnection. Together, existing model rules such as those developed by organizations such as FERC, the National Association of Regulatory Utility Commissioners (NARUC), and the Interstate Renewable Energy Council (IREC) are considered baseline industry-recommended practices

[80] IEEE, February 2018

(i.e., current best practices). Utilities not following these recommendations should explain why those recommended practices are not appropriate for their service areas.[81]

Historically, state regulatory authorities and utilities have developed state interconnection procedures to provide a transparent and efficient means to interconnect generation resources to the electric power system and to maintain the safety, reliability, and power quality of the electric power system. Initially, state commissions sought to regulate the interconnection process and oversaw development of interconnection policies. Then, in the early 2000s, some states launched stakeholder participation–based processes, and inconsistencies among state practices emerged. To address this issue, various organizations have developed model guidance in an effort to harmonize state approaches to interconnection.

Many states took steps between 2000 and 2010 to harmonize with IEEE 1547 and the model rules that were developed by NARUC and FERC. Subsequently, many states and utilities focused on the updated model rules published by IREC after 2012 to guide the interconnection process at the distribution level. Various states and utilities have adopted the above documents either in whole or in part as the bases for their interconnection rules, business processes, and agreements, though some have not.

2.3.1 NARUC Model Interconnection Procedures[82]

NARUC interconnection procedures provide a sound, transparent, and standardized framework for the grid interconnection of DERs. After issuing its model interconnection procedures in 2003, which consisted of provisions that have been implemented by state commission orders and reflected the best practices[83] of existing state procedures and agreements, other updates have been made to these procedures to remain relevant in addressing best practices and technological advancements for the evolving utility industry. NARUC has also released a report that highlights the recommendations for interconnection processes.[84] The report addresses the emerging issues caused by the adoption of varying standard alterations to fit the operability requirements of various utilities. At the onset of increased awareness of DER deployment, NARUC passed a resolution recommending state commissions to adopt and implement IEEE 1547-2018.[85] More recently, in response to a FERC Notice of Proposed Rulemaking (NOPR) in 2022, NARUC submitted comments on addressing queue backlogs, improving certainty, and preventing new-technology discrimination for DER interconnection.[86] NARUC recognizes the need to improve interconnection processes and proposes several improvements via model guidance.

2.3.2 Energy Policy Act[87]

In 2005, Congress passed the Energy Policy Act (EPAct), which in Section 1254 requires state regulatory commissions and certain nonregulated utilities to consider adopting interconnection procedures based on IEEE 1547 standards to streamline nationwide DER interconnection processes. Through Section 1254 of

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[81] Transmission and distribution grids in different locations may be subject to local factors not addressed by industry guidance. Thus, existing model guidance and standards alone may not be sufficient to guarantee safety and reliability in some service areas, and utilities often develop their own rules in addition to the industry-recommended baseline guidance.

[82] NARUC, *Model Interconnection Procedures and Agreement for Small Distributed Generation Resources*, October 2003. pubs.naruc.org/pub.cfm?id=536DBB8C-2354-D714-519F-7869624489AE.

[83] In this report, the terms *best practice* and *current best practice* are understood to mean *baseline industry-recommended practice*.

[84] NARUC and the US Agency for International Development, *An Introduction to Interconnection Policy in the United States*, n.d., pubs.naruc.org/pub.cfm?id=5375FAA8-2354-D714-51DB-01C5769A4007.

[85] NARUC, *Resolutions*, 2020, pubs.naruc.org/pub/4C436369-155D-0A36-314F-8B6C4DE0F7C7.

[86] NARUC, *Comments of the National Association of Regulatory Utility Commissioners*, 2023, pubs.naruc.org/pub/F3AF556A-1866-DAAC-99FB-BFE2357A9443.

[87] Energy Policy Act of 2005, Public Law 109-58, 2005, Office of the Federal Register, National Archives and Records Administration, govinfo.gov/app/details/PLAW-109publ58.

EPAct, FERC issued Order No. 2006, which established the SGIP and *Small-Generator Interconnection Agreement* (SGIA) for smaller DERs as expressed in the Section 2.3.3; this was further refined in 2016 through FERC Order No. 792-B. Other updates and improvements were made to FERC via EPAct throughout the years; Orders 792 and 792-A were released in 2007 and 2013, respectively, and focused on improving the interconnection process for smaller generating DERs including CHP. Section 942 of EPAct authorizes the provision of demonstrations designed to accelerate the use of DER technologies, including CHP. EPAct has proven to be a pivotal tool for the federal, state, and regional tiers to promote the growth of DERs including CHP and has helped foster favorable regulatory interconnection environments that help resolve barriers.

2.3.3 FERC Small-Generator Interconnection Agreements and Procedures[88]

In 2006, FERC established standard terms and conditions for interconnections by issuing the SGIP and SGIA. Although these were primarily intended to apply to new interconnections which fall under FERC jurisdiction at the transmission level, FERC notes that "one of the intended purposes for the small generator interconnection regulations was to serve as a guide for State interconnection procedures."[89] The SGIP provides three ways to evaluate an interconnection request as well as standard contractual provisions. The SGIP requires interconnection equipment to be certified according to IEEE Standard 1547 and UL 1741.[90]

After the main body of this report was written, FERC published Order No. 2023.[91] Appendix E explains this order's implications for the model guidance.

2.3.4 FERC Large Generator Interconnection Agreements and Procedures[92]

FERC's standard LGIP provides guidelines established by FERC that outline the process for the electric grid interconnection of systems larger than 20 MW nameplate capacity. The LGIP plays a crucial role in developing standardized interconnection frameworks and providing an efficient and transparent process for project developers and electric utilities to follow, allowing interconnection processes to be done efficiently. Furthermore, transmission and distribution utilities as well as state regulatory agencies adopted it as a foundational technique in creating procedures for electric grid interconnection. In FERC Order No. 2003, FERC required all public utilities to modify their open access transmission tariffs to incorporate the LGIP. Issued in 2005, FERC Order No. 661 aimed to streamline interconnection processes and remove barriers to large-generator DERs (specifically, wind energy).[93] Following further lessons learned and stakeholder engagements, efforts to improve the accuracy of the results of interconnection studies were made in 2016 through FERC Order No. 827,[94] which adjusted the LGIP to

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[88] Federal Energy Regulatory Commission, Order No. 2006, *Standardization of Small Generator Interconnection Agreements and Procedures*, 2013, federalregister.gov/documents/2013/12/05/2013-28515/small-generator-interconnection-agreements-and-procedures#citation-1-p73242.

[89] As set forth in FERC Order No. 2006, FERC Stats. & Regs. ¶ 31,180 at P 4

[90] IEEE Standard 1547 is listed as an applicable standard in Attachment 3, "Certification Codes and Standards of the pro forma Small Generator Interconnection Procedures (SGIP)." According to the pro forma SGIP, "…the Interconnection Customer's proposed Small Generating Facility must meet the codes, standards, and certification requirements of Attachments 3 and 4 of these procedures, or the Transmission Provider has to have reviewed the design or tested the proposed Small Generating Facility and is satisfied that it is safe to operate."

[91] Federal Energy Regulatory Commission, RM22-14-000, Order No. 2023, *Improvements to Generator Interconnection Procedures and Agreements,* 2023, www.ferc.gov/media/e-1-order-2023-rm22-14-000.

[92] Federal Energy Regulatory Commission, Order No. 2003, *Standardization of Generator Interconnection Agreements and Procedures*, 2003, ferc.gov/sites/default/files/2020-04/E-1_71.pdf.

[93] Federal Energy Regulatory Commission, Order No. 661, *Interconnection for Wind Energy*, 2005.

[94] Federal Energy Regulatory Commission, Order No. 827, *Reactive Power Requirements for Non-Synchronous Generation*, 2016, https://www.ferc.gov/sites/default/files/2020-04/E-1_72.pdf.

accommodate the expanding penetration of nonsynchronous generators[95] and the associated issue of intermittency. It also warranted improved regional coordination for interconnection studies. More recently in 2018, FERC issued Order No. 845, *Reform of Generator Interconnection Procedures and Agreements*, and provided pro forma LGIP to improve the generator interconnection process for large generators.[96]

After the main body of this report was written, FERC published Order No. 2023.[97] Appendix E explains this order's implications for model guidance.

2.3.5 IREC Model Interconnection Procedures[98]

Since the first publication of its *Model Interconnection Procedures* (MIP) in 2005, IREC has worked to promote clean energy policy and best practices and to aid in creating sustainable energy futures by providing expert analysis and resources to policymakers, utilities, and other stakeholders. IREC's MIP was updated in 2009, 2013, and most recently in 2019.[99] These procedures provide an essential framework for the interconnection of renewable energy systems into electric utility grids. Because many states and utilities look to IREC for guidance on interconnection standards, the latest edition (2019) represents a noteworthy step forward in creating clear interconnection guidelines that will encourage efficient, resilient, and sustainable electrical grids. IREC's 2019 MIP presents important updates that reflect advancements and new considerations for interconnecting DER technologies and improving grid resilience. IREC also refers to unique challenges relevant to CHP development and notes its importance as a key element in reducing GHGs.

2.4 DOCUMENTED BARRIERS TO CHP INTERCONNECTION

This section discusses documented barriers to CHP based on two key sources: the 2020 DOE CHP Interconnection Issue Brief[100] and findings from a review of state interconnection policies conducted by the research team.

2.4.1 Summary of the DOE CHP Interconnection Issue Brief

According to the issue brief published by DOE, 45 states and Washington, DC, have established interconnection policies.[101] This DOE overview on interconnection barriers for CHP follows on provisions in EPAct 2005, which in part enable states to support CHP.[102]

The interconnection process is treated as a customized process above a certain nameplate capacity per project in most states. According to the DOE CHP Issue Brief, interconnection policies, which typically determine CHP interconnection timelines, are those that apply to generators with capacities of 10 MW

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[95] A significant number of DERs are nonsynchronous generators.

[96] Federal Energy Regulatory Commission, Order No. 845, *Reform of Generator Interconnection Procedures and Agreements*, April 2018, https://www.ferc.gov/sites/default/files/2020-06/Order-845.pdf

[97] Federal Energy Regulatory Commission, RM22-14-000, Order No. 2023, *Improvements to Generator Interconnection Procedures and Agreements,* 2023, www.ferc.gov/media/e-1-order-2023-rm22-14-000.

[98] Interstate Renewable Energy Council Inc, *Model Interconnection Procedures*, 2019, irecusa.org/resources/irec-model-interconnection-procedures-2019/.

[99] IREC's 2019 *Model Interconnection Procedures* was the most recent version at the time this report was completed. Upon the completion of this report, a discussion of IREC's 2023 *Model Interconnection Procedures* was added as Appendix E.

[100] US Department of Energy, *Interconnection Standards for CHP: State Standards that Impact Interconnection to the Electric Distribution Grid*, Issue Brief, 2020, osti.gov/servlets/purl/164323/.

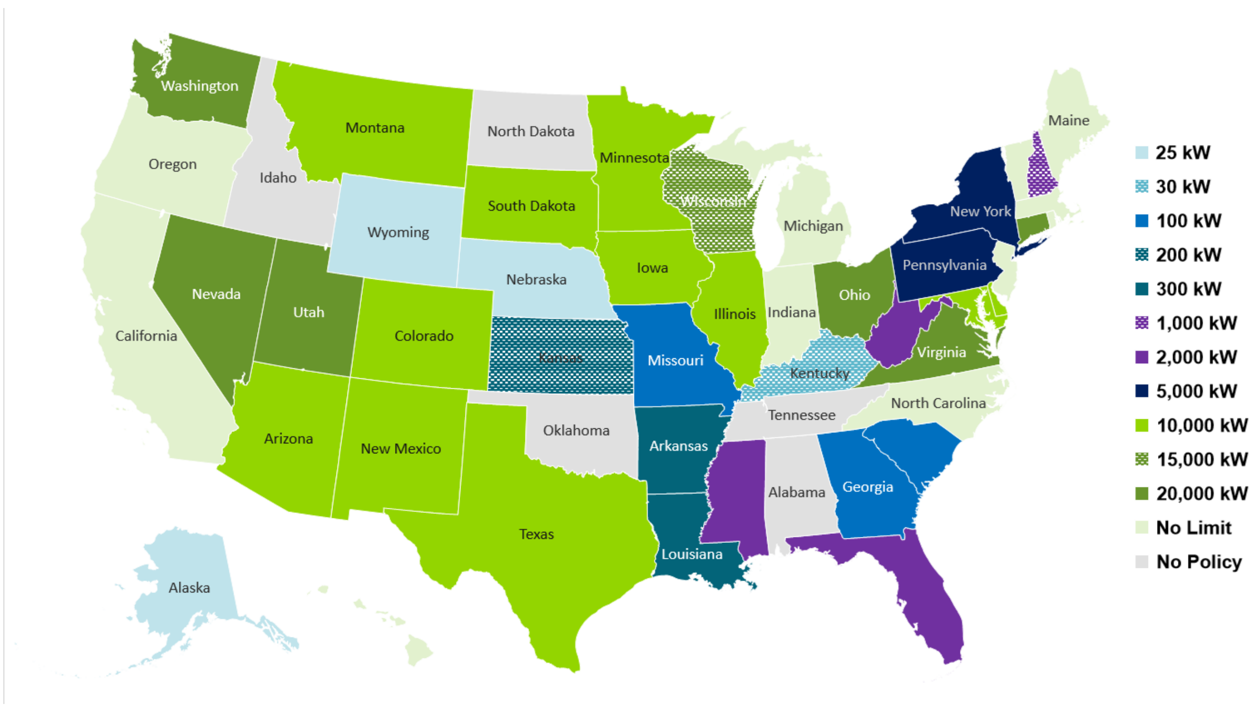
[101] Ibid.

[102] "Many of the incentives were created or are supported by the adoption of recent Acts, such as the Energy Independence and Security Act of 2007 (EISA) and the Energy Policy Act of 2005 (EPAct)." From Office of the Governor, State of Maine, *Combined Heat and Power Report,* 2010.

and higher. States with no stated policies for larger generator systems (i.e., those with no stated policies to address typically sized CHP system interconnections)[103] may have longer interconnection timelines for CHP projects. This is because utilities in those states may automatically conduct customized impact studies at the highest possible level of detail to ensure the safety of the facility and the electric grid for these large projects. Utilities in states with policies that explicitly address the nameplate capacity listed in each CHP interconnection application may be able to study the application more quickly.

States that may have longer CHP interconnection timelines because they have no policies in place for higher-capacity generator systems are shown in Figure 2-8 and Figure 2-9. The figures show, respectively, (1) a heat map of the maximum interconnection capacities (kW) addressed by state policies and (2) the number of states for each capacity block addressed by state interconnection policies.

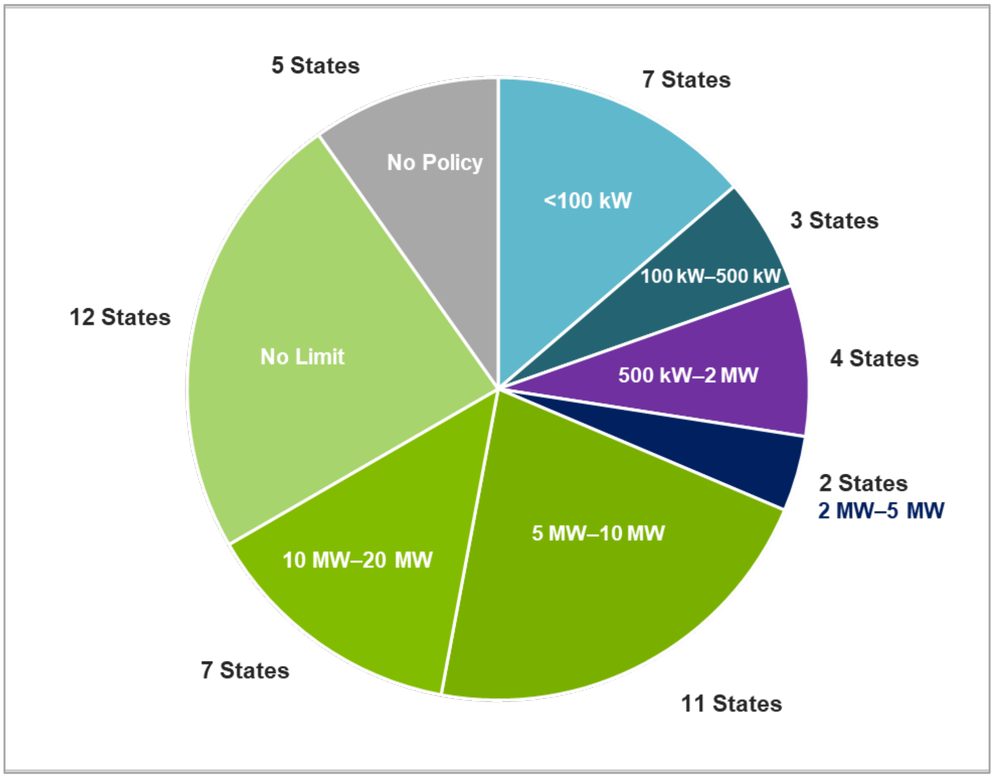
Figure 2-8 shows that as of 2020, five states (Alabama, Idaho, North Dakota, Oklahoma, and Tennessee) have no policies. In other states, the interconnection maximum capacity varies from 25 kW to 20 MW, which is a large range. Of the states with policies, Figure 2-9 shows that the interconnection maximum capacity is lower than or equal to 100 kW in 7 states, and in 20 states the limit is between 100 kW and 10 MW. The limit is more than 10 MW in 18 states, and 11 states have no maximum limit—in other words, only 29 states (around 56%) have stated interconnection policies expected to address explicitly most CHP interconnection applications based on size.



Source: *Research team visualization of Table 1 data in the DOE CHP Issue Brief*

Figure 2-8. Heat map of interconnection-policy maximum capacity by state.

[103] CHP projects may have larger capacities on average than other DER generation such as solar PV.



Source: *Research team visualization of Table 1 data in the DOE CHP Issue Brief*

Figure 2-9. Number of states per interconnection-policy maximum capacity block.

2.4.2 Summary of State Policies on CHP Interconnection

The research team summarized state policies pertaining to CHP (see Appendix A) for 14 states that are of interest because they have standards and policies that encourage CHP interconnection or because utilities in the state are not required to follow FERC orders except at their own discretion as determined by review and evaluation by the research team.[104] Table 2-2 shows how state policies in the 14 selected states align with six key aspects of interconnection highlighted in the DOE Issue Brief:

1. Existing interconnection policy
2. Maximum nameplate capacities in their interconnection standards are large enough to include typical CHP systems
3. Fossil fuel eligibility in the state
4. Tiers or level structures in their interconnection standards
5. Dispute resolution in their interconnection standards
6. CHP eligibility for net-metering according to the DOE CHP Issue Brief

[104] Reasons for selecting states included the following: (1) states that have implemented the recommendations in the 2020 DOE CHP Issue Brief; (2) states of interest based on their higher opportunity potential to interconnect CHP, as evidenced by (a) their explicit mention of CHP or micro-CHP technologies in their state policies and incentives, or (b) the maximum generating facility capacity is explicitly mentioned in their interconnection standards; and (3) states that are vertically integrated (i.e., non–independent system operator).

California, Vermont, Utah, and Virginia were the only states with interconnection policies that included all the aspects of interconnection highlighted in the DOE CHP Issue Brief at the time the Issue Brief was written.[105]

Table 2-2. State interconnection standard alignment with DOE Issue Brief[106]

State	Existing policy	Maximum capacity (MW)	Interconnection eligibility for fossil fuels	Tiers or levels	Dispute resolution	Net-metering eligibility for CHP[107]
States aligned with criteria defined in DOE Issue Brief						
California	✓	No limit	✓	✓	✓	✓
Vermont	✓	No limit	✓	✓	✓	✓
Utah	✓	20	✓	✓	✓	✓
Virginia	✓	20	✓	✓	✓	✓
Other states with high CHP interconnection potential[108]						
Texas	✓	10	✓	✓	X	X
New York[109]	✓	5	✓	✓	✓	X
Minnesota	✓	10	✓	X	X	X
Illinois	✓	No limit	✓	✓	✓	X
Maryland	✓	10	✓	✓	✓	X
Ohio	✓	20	✓	✓	✓	X
Indiana	✓	No limit	✓	✓	✓	X
Michigan	✓	No limit	✓	✓	✓	X
Non–independent system operator states						
North Carolina	✓	No limit	✓	✓	X	X
South Carolina	✓	10	✓	✓	X	X

2.4.3 Overview of Existing CHP Installations in Selected States

Figure 2-10 and Figure 2-11 show the total installed CHP capacities and numbers of installations for selected states. Comparison of the two figures shows that of the three states with the highest installed capacities, Texas has the largest capacity per project (around 139 MW/project) and California and New York have the smallest (around 7 and 6.8 MW/project, respectively). This suggests that on average, Texas may have more transmission-level DERs, whereas California and New York may have more distribution-level DERs.

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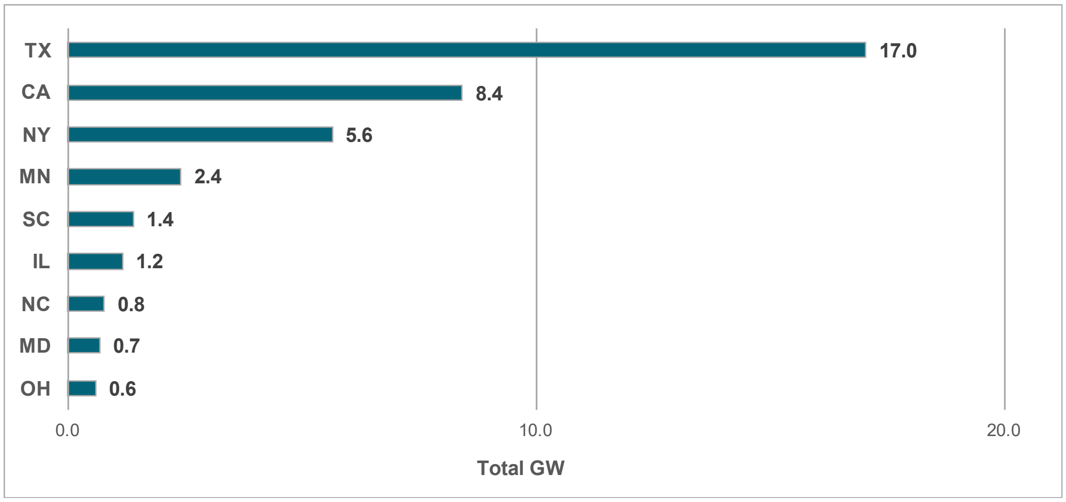
105 US Department of Energy, *Interconnection Standards for CHP: State Standards that Impact Interconnection to the Electric Distribution Grid*, Issue Brief, 2020.

106 Ibid.

107 Some of the listed states do have net metering for micro-CHP and renewably fueled CHP systems.

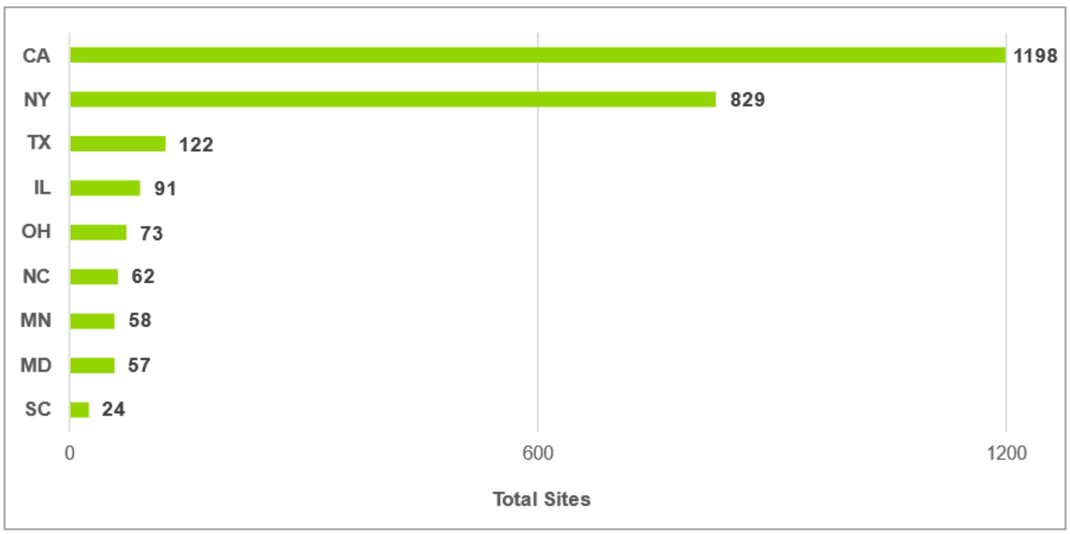
108 Includes states with high CHP in existing queues or DOE CHP Issue Brief factors as follows: (1) no limit in maximum capacity in interconnection rules; (2) eligibility of fossil fuels; (3) a dispute resolution process; and (4) tiers in the interconnection rules. Additionally, New York is included because of the high CHP interconnection capacity in the queue.

109 Although the capacity limit in the New York State interconnection standard is 5 MW, most of the utilities in this state have procedures in place for systems up to 20 MW.



Source: *Based on data from DOE CHP Installation Database*[110]

Figure 2-10. Total installed CHP capacities within selected states.



Source: *Based on data from DOE CHP Installation Database*[111]

Figure 2-11. Total CHP installations within selected states.

Finally, Table 2-3 shows the range of per-project capacities by state. The minimums of the ranges for all these states are distribution sized, and the maximums are transmission sized; this suggests states with generally favorable conditions for CHP are installing projects both on the distribution and transmission systems. This is relevant for the model guidance because, except for Texas, this means FERC has jurisdiction for some CHP installations in each state, and FERC model guidance could be particularly effective in removing barriers to installing higher-capacity CHP in those states.

[110] DOE, "CHP Installation Database," US Department of Energy Combined Heat and Power and Microgrid Installation Databases, doe.icfwebservices.com/chp (data as of December 31, 2022).
[111] Ibid.

Table 2-3. Capacity ranges of installed CHP within selected states

State	Capacity range (MW)
MN	30 kW–1,362 MW
TX	20 kW–1,188 MW
NY	4 kW–1,083 MW
SC	5 kW–630 MW
CA	2 kW–609 MW
IL	6 kW–335 MW
MD	5 kW–230 MW
NC	30 kW–115 MW
OH	24 kW–92.8 MW

Source: *DOE CHP Installation Database*

3. APPROACH

The research team conducted a comprehensive research effort and industry scan. Activities included a literature review, FERC consultation and FERC documents review, and industry stakeholder outreach. The research team synthesized all information gathered to identify and document the key barriers to CHP interconnection and develop model guidance to overcome the barriers.

3.1 LITERATURE AND RULES REVIEW

The research team reviewed literature and interconnection rules to identify CHP interconnection barriers. Sources consulted included, but were not limited to, the reports and resources listed in Table 3-1. The research team identified and gathered these resources via recommendations from industry experts consulted during initial outreach interviews, the experience of the research team, and internet keyword searches.[112]

The research team reviewed interconnection rules for selected utilities that the team deemed to be representative of the different states and geographic regions of the United States (see Figure 3-1) and a range of regional transmission organization (RTO) and independent system operator (ISO) regulatory jurisdictions. The goal of the rules review for these selected utilities was to highlight a range of policies and procedures CHP developers may encounter when interconnecting CHP projects. The following utilities were included in the representative rules review:

- Austin Energy (Texas)
- Investor-owned utilities (IOUs) (California)
- Consolidated Edison (ConEd) (New York)
- Xcel Energy (Minnesota)
- Duke Energy (the Carolinas)
- Commonwealth Edison Company (ComEd) (Illinois)
- EmPOWER–Potomac Electric Power Company (PEPCO) (Maryland)
- American Electric Power (Ohio)

[112] Keyword searches included terms such as *CHP*, *interconnection*, *grid flexibility*, and keywords from IIJA Section 40556.

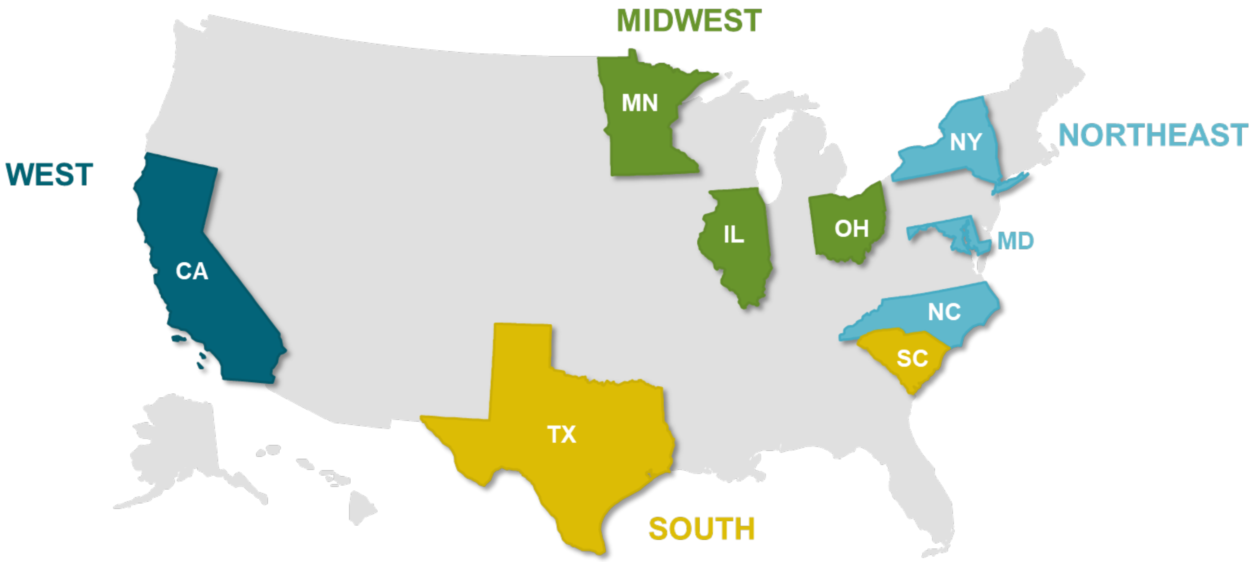


Figure 3-1. Geographic coverage of selected interconnection rules review.

Table 3-1. Literature review documents

Document name	Abbreviation/ hyperlink	Organization/author	Document published date	Full citation
State Energy and Environment Guide to Action: Interconnection and Net-Metering	EPA, 2022	US Environmental Protection Agency (EPA)	2022	EPA, *State Energy and Environment Guide to Action: Interconnection and Net-Metering*, 2022 .
Anti-Islanding Guide DIH_TIH Appendix E, “Conditions That May Trigger Direct Transfer Trip (DTT)”	Pacific Gas and Electric, 2022	Pacific Gas and Electric Company	2022	Pacific Gas and Electric, *Anti-Islanding Guide*, 2022 .
FERC Order 2222: Implementation Plans Create Risks, Challenges, and Growth Opportunities for Market Players	Insights, October 2022	Guidehouse Insights	October 2022	Guidehouse Insights, *FERC Order 2222: Implementation Plans Create Risks, Challenges, and Growth Opportunities for Market Players*, October 2022.
CHP Alliance Comments on Climate Action Scoping Plan	Alliance, July	CHP Alliance	June 2022	CHP Alliance, *CHP Alliance Comments on Climate Action Scoping Plan*, July 2022.
Infrastructure Investment and Jobs Act	US Gov, November 2021	US government	November 2021	US Congress, Infrastructure Investment and Jobs Act (IIJA), Public Law 117–58, §40556, 2021, congress.gov/117/plaws/publ58/PLAW-117publ58.pdf.
Opportunities for Installed CHP to Increase Grid Flexibility in the U.S.	LBNL, August 2021	Lawrence Berkeley National Laboratory (LBNL), Building Technology and Urban Systems Division	August 2021	Hyeunguk Ahn et al., *Opportunities for Installed Heat and Power (CHP) to Increase Grid Flexibility in the U.S.*, 2021, doi.org/10.1016/j.enpol.2021.112485 (//www.sciencedirect.com/science/article/pii/S0301421521003554).
Best Practices for Standby Rates for Combined Heat and Power	GPI, March 2021	Great Plains Institute	March 2021	Hunterston Consulting LLC, *Best Practices for Standby Rates for Combined Heat and Power*, Great Plains Institute, 2021, betterenergy.org/wp-content/uploads/2021/04/best-practices-for-standby-rates-for-combined-heat-and-power.pdf.

Table 3-1. Literature review documents (continued)

Document name	Abbreviation/ hyperlink	Organization/author	Document published date	Full citation
FERC Order No. 2222-A	FERC, March 2021	FERC	March 2021	FERC Order No. 2222-A, March 2021, ferc.gov/media/ferc-order-no-2222-fact-sheet.
FERC Order No. 874, *Fuel Cell Thermal Energy Output and Bloom Energy Corporation Comments*	FERC, December 2020	FERC	December 2020	FERC Order No. 874, *Fuel Cell Thermal Energy Output and Bloom Energy Corporation Comments*, December 2020.
Combined Heat and Power in Integrated Resource Planning: Examples and Planning Considerations	SEE Action, 2020	SEE Action, ICF International	November 2020	SEE Action, ICF International, *Combined Heat and Power in Integrated Resource Planning: Examples and Planning Considerations, State and Local Energy Efficiency Action Network*, 2020, energy.gov/sites/default/files/2022-03/see-action-chpirp-fy22.pdf.
Modeling the Impact of Flexible CHP on the Future Electric Grid in California	ORNL, August 2020	ORNL	August 2020	Jal Desai et al., ORNL/TM-2019/1259, *Modeling the Impact of Flexible CHP on the Future Electric Grid In California,* 2020, Oak Ridge National Laboratory, osti.gov/biblio/1649545- modeling-impact-flexible-chp-future electric-grid-california.
"Divided FERC Revamps PURPA Regulations: What the Final Rule Does and Why it Matters"	Gump, 2020	Akin Gump	August 2020	Akin Gump, "Divided FERC Revamps PURPA Regulations: What the Final Rule Does and Why it Matters," August 2020, https://www.akingump.com/en/insights/blogs/speaking-energy/divided-ferc-revamps-purpa-regulations-what-the-final-rule-does-and-why-it-matters.
FERC Order No. 872	FERC, July 2020	FERC	July 2020	FERC Order No. 872, *Qualifying Facility Rates and Requirements Implementation Issues Under the Public Utility Regulatory Policies Act of 1978*, July 16, 2020
Interconnection Standards for CHP: State Standards that Impact Interconnection to the Electric Distribution Grid: Issue Brief	DOE Issue Brief, April 2020	DOE	April 2020	DOE, *Interconnection Standards for CHP: State Standards that Impact Interconnection to the Electric Distribution Grid: Issue Brief*, April 2020, osti.gov/servlets/purl/1643231/.

Table 3-1. Literature review documents (continued)

Document name	Abbreviation/ hyperlink	Organization/author	Document published date	Full citation
Utility Combined Heat and Power Programs: Issue Brief	DOE Utility CHP, 2020	DOE	April 2020	DOE, *Utility Combined Heat and Power Programs: Issue Brief*, April 2020, energy.gov/eere/amo/articles/utility-combined-heat-and-power-chp-programs.
Clean Peak Standard	ESA, January 2020	Energy Storage Association	January 2020	Energy Storage Association, Clean Peak Standard, January 2020.
Where Things Stand on Standby Rates	Hunterston, August 2019	Hunterston Consulting	August 2019	Hunterston Consulting LLC, *Where Things Stand on Standby Rates*, 2019, hunterstonconsulting.com/Hunterston%20Consulting%20-%20Where%20Things%20Stand%20on%20Standby%20Aug%202019%20Exec%20Summ.pdf.
A Comprehensive Assessment of Small Combined Heat and Power Technical and Market Potential in California	ICF International, March 2019	California Energy Commission, ICF International	March 2019	ICF International, *A Comprehensive Assessment of Small Combined Heat and Power Technical and Market Potential in California*, California Energy Commission, 2019, energy.ca.gov/sites/default/files/2021-06/CEC-500-2019-030.pdf.
Getting Standby Rates Right for a Modern Grid	RAP, July 2018	Regulatory Assistance Project (RAP)	July 2018	RAP, *Getting Standby Rates Right for a Modern Grid*, July 2018.
IEEE 1547-2018	IEEE, February 2018	IEEE	February 2018	IEEE Standards Coordinating Committee 21, IEEE Std 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*, 2018, nrel.gov/docs/fy20osti/75436.pdf.
FERC Order No. 842	FERC, February 2018	FERC	February 2018	FERC Order 842, *Essential Reliability Services and the Evolving Bulk Power System*, February 2018, ferc.gov/sites/default/files/2020-06/Order-842.pdf.

Table 3-1. Literature review documents (continued)

Document name	Abbreviation/ hyperlink	Organization/author	Document published date	Full citation
CHP as a Compliance Option under the Clean Power Plan	Gardiner, April 2016	David Gardiner and Associates, Institute for Industrial Productivity, Wooley Energy & Environment	April 2016	David Gardiner and Associates, Institute for Industrial Productivity, and Wooley Energy & Environment, *Combined Heat and Power (CHP) as a Compliance Option under the Clean Power Plan*, American Gas Association, American Chemistry Council, American Forest & Paper Association, National Propane Gas Association, 2016, chpalliance.org/wp-content/uploads/2016/05/CHP-Pathway_Full-Report_Final.pdf.
Energy and Minerals Provisions Act	CRS, February 2016	Congressional Research Service	February 2016	Congressional Research Service, Energy and Minerals Provisions in the Infrastructure Investment and Jobs Act, Public Law 117-58, February 16, 2022, p. 38. crsreports.congress.gov/product/pdf/R/R47034.
"Combined Heat & Power Really Is the Answer"	ES, October 2015	Engineered Systems (ES)	October 2015	Marcia Karr, "Combined Heat & Power Really Is the Answer," Engineered Systems, October 2015, esmagazine.com/articles/97365-combined-heat-power-really-is-the-answer.
Barriers to Industrial Energy Efficiency	DOE, June 2015	DOE	June 2015	DOE, *Barriers to Industrial Energy Efficiency*, 2015, energy.gov/sites/prod/files/2015/06/f23/EXEC-2014-005846_6%20Report_signed_0.pdf.
Standby Rates for Combined Heat and Power Systems	RAP, February 2014	RAP	February 2014	James Selecky, Kathryn Iverson, and Ali Al-Jabir, Regulatory Assistance Project, *Standby Rates for Combined Heat and Power Systems*, ORNL, 2014, info.ornl.gov/sites/publications/files/Pub47558.pdf.
FERC Small Generator Interconnection Agreements and Procedures	SGIP, November 2013	FERC	November 2013	Federal Energy Regulatory Commission, RM13-2-000, Order No. 792, *Small Generator Interconnection Agreements and Procedures*, 2013, ferc.gov/sites/default/files/2020-06/RM13-2-000_0.pdf.

Table 3-1. Literature review documents (continued)

Document name	Abbreviation/ hyperlink	Organization/author	Document published date	Full citation
Guide to Using Combined Heat and Power for Enhancing Reliability and Resiliency in Buildings	DOE, September 2013	DOE, US Department of Housing and Urban Development, EPA	September 2013	DOE, US Department of Housing and Urban Development, EPA, *Guide to Using Combined Heat and Power for Enhancing Reliability and Resiliency in Buildings*, September 2013, epa.gov/sites/default/files/2015-07/documents/guide_to_using_combined_heat_and_power_for_enhancing_reliability_and_resiliency_in_buildings.pdf.
Guide to the Successful Implementation of State Combined Heat and Power	SEE Action, March 2013	SEE Action	March 2013	SEE Action, *Guide to the Successful Implementation of State Combined Heat and Power*, March 2013, energy.gov/sites/default/files/2022-03/see-action-chpirp-fy22.pdf.
Updating Small Generator Interconnection Procedures for New Market Conditions	NREL, December 2012	NREL	December 2012	NREL, *Updating Small Generator Interconnection Procedures for New Market Conditions*, December 2012, nrel.gov/docs/fy13osti/56790.pdf.
Comments of the California Clean Dg Coalition Regarding Staff Paper: A New Generation of Combined Heat and Power: Policy Planning for 2030	CEC, October 2012	California Energy Commission	October 2012	California Energy Commission, Docket No. 12-IEP-1D, *Comments of the California Clean Dg Coalition Regarding Staff Paper: A New Generation of Combined Heat and Power: Policy Planning for 2030,* 2012, efiling.energy.ca.gov/GetDocument.aspx?tn=67884&DocumentContentId=9689.
A New Generation of Combined Heat and Power: Policy Planning for 2030	CEC, September 2012	California Energy Commission, Brian Neff	September 2012	California Energy Commission, Brian Neff, *A New Generation of Combined Heat and Power: Policy Planning for 2030*, 2012, ourenergypolicy.org/wp-content/uploads/2013/08/new-generation.pdf.
Accelerating Combined Heat and Power Deployment	USEA, August 2011	The United States Energy Association (USEA)	August 2011	USEA, *Accelerating Combined Heat & Power Deployment*, 2011.
Standby Rates for Customer-Sited Resources: Issues, Considerations, and the Element of Model Tariffs	EPA, December 2009	EPA	December 2009	EPA, *Standby Rates for Customer-Sited Resources: Issues, Considerations, and the Element of Model Tariffs*, December 2009, epa.gov/sites/default/files/2015-10/documents/standby_rates.pdf.

Table 3-1. Literature review documents (continued)

Document name	Abbreviation/ hyperlink	Organization/author	Document published date	Full citation
Combined Heat and Power and Clean Distributed Energy Policies	ACEEE, August 2009	American Council for an Energy-Efficient Economy (ACEEE)	August 2009	ACEEE, *Combined Heat and Power and Clean Distributed Energy Policies*, 2009, https://www.aceee.org/fact-sheet/combined-heat-and-power-and-clean-distributed-energy-polici.
Combined Heat and Power: Effective Energy Solutions for a Sustainable Future	ORNL, December 2008	ORNL	December 2008	Anna Shipley, Anne Hampson, Bruce Hedman, Patti Garland, and Paul Bautista, ORNL/TM-2008/224, *Combined Heat and Power: Effective Energy Solutions for a Sustainable Future*, ORNL, 2008, info.ornl.gov/sites/publications/files/Pub13655.pdf.
Combined Heat and Power: Connecting the Gap between Markets and Utility Interconnection and Tariff Practices (Part I)	ACEEE Part I, March 2006	ACEEE	March 2006	ACEEE, *Combined Heat and Power: Connecting the Gap between Markets and Utility Interconnection and Tariff Practices (Part I)*, 2006, https://www.energy.gov/sites/default/files/2013/11/f4/chp_connecting_the_gap_pt1.pdf.
Combined Heat and Power: Connecting the Gap between Markets and Utility Interconnection and Tariff Practices (Part II)	ACEEE Part II, August 2006	ACEEE	August 2006	ACEEE, *Combined Heat and Power: Connecting the Gap between Markets and Utility Interconnection and Tariff Practices (Part II)*, 2006, energy.gov/sites/prod/files/2014/07/f17/chp_connecting_the_gap_pt2.pdf.
FERC Order No. 2003	FERC, July 2003	FERC	July 2003	FERC Order No. 2003, *Standardization of Generator Interconnection Agreements and Procedures*, July 2003, ferc.gov/sites/default/files/2020-06/order-2003.pdf.

3.2 RESEARCH PERTAINING TO FERC

3.2.1 FERC Staff Consultation

The research team met with FERC staff twice: on October 5, 2022, and March 3, 2023. Research questions covered possible barriers to interconnecting CHP at all nameplate capacities and current FERC rules (e.g., SGIP and LGIP) and NOPRs[113] that might affect CHP interconnection.

3.2.2 Review of Orders Published by FERC

At the time of this report, some existing statutes and FERC regulations address CHP systems explicitly. PURPA[114] establishes two types of qualifying facilities (QF): small power production facilities[115] and CHP facilities.[116]

Some FERC documents address CHP systems implicitly relative to their role as a generator, such as FERC Order No. 2003, which seeks to address interconnection queue backlog and prevent undue discrimination against new technologies, and FERC Order No. 2222, which addresses distributed energy resource aggregation (DERA) participation in wholesale markets. To identify barriers to CHP, this study review summarizes key aspects of the following FERC documents as they pertain to CHP. (See Appendix C, "Summary of FERC Documents Pertaining to Generators.")

- FERC Order No. 69, *Small Power Production and Cogeneration Facilities; Regulations Implementing Section 210 of the Public Utility Regulatory Policies Act of 1978*
- FERC Order No. 872, *Qualifying Facility Rates and Requirements Implementation Issues Under the Public Utility Regulatory Policies Act of 1978*
- FERC Order No. 2003, *Standardization of Generator Interconnection Agreements and Procedures*, including 2022 NOPR
- FERC Order No. 2222, *Participation of DERA in Markets Operated by Regional Transmission Organizations (RTOs) and Independent System Operators (ISOs)*
- FERC Order No. 842, *Essential Reliability Services and the Evolving Bulk Power System*
- FERC Order No. 1000, *Transmission Planning and Cost Allocation*, including 2022 NOPR

After the main body of this report was written, FERC published Order No. 2023[117] based on the NOPR *Improvements to Generator Interconnection Procedures and Agreements*. Appendix E explains this order's implications for the model guidance.

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[113] FERC NOPR *Improvements to Generator Interconnection Procedures and Agreements,* paragraph 30, which states "delayed interconnection study results or unexpected cost increases can disrupt numerous aspects of generating facility development, including project financing and the ability to obtain a power purchase agreement," and FERC NOPR *Reliability Standards To Address Inverter-Based Resources*, paragraph 12, which states "synchronous generation resources can provide voltage support during voltage disturbances."

Both NOPRs proceeded to final rules, Order No. 2023 and Order No. 901. Appendix E in this report provides information pertaining to Order No. 2023. FERC Order No. 901 directed the North American Electric Reliability Corporation to develop new or modified reliability standards for inverter-based resources.

[114] 16 U.S.C.§§ 824a-3.

[115] According to 18 CFR § 292.203, small power production facilities are facilities 80 MW or less and fueled by a renewable resource at 75% or more.

[116] According to 18 CFR §292.202(c), cogeneration units produce electric and thermal energy (e.g., heat or steam) used for industrial, commercial heating, or cooling purposes. CHP QFs are not limited by overall size but must meet operating and efficiency standards.

[117] Federal Energy Regulatory Commission, RM22-14-000, Order No. 2023, *Improvements to Generator Interconnection Procedures and Agreements,* 2023, www.ferc.gov/media/e-1-order-2023-rm22-14-000.

3.3 INDUSTRY STAKEHOLDER OUTREACH

The research team identified initial barriers based on issues revealed in the literature review and the team's initial outreach surveys of industry experts. The primary research question for the barrier identification phase of the study was, "What are the barriers to interconnecting CHP generation to the electric grid including transmission and distribution voltages for nameplate capacities up to 150 MW?"

Subsequent stakeholder outreach activities during the model guidance development phase of the study included detailed questions based on the list of barriers initially identified. Discussion guides used for consultation with industry experts are in Appendix D. Stakeholders consulted included developers, vendors, research organizations, and independent consultants.

3.4 DOCUMENTATION OF BARRIERS AND MODEL GUIDANCE

The research team synthesized the literature review and outreach findings to identify key barriers to CHP interconnection and developed model guidance to overcome the barriers.

3.4.1 Barriers Addressed in Model Guidance

The research team organized the barriers discovered during the literature review and outreach activities and then considered whether and how key barriers could be addressed via interconnection model guidance within the scope identified in IIJA Section 40556. For instance, the research team did not address barriers to CHP arising because of states who have banned new natural gas appliance hookups.

3.4.2 Model Guidance Development

Drawing from prior interconnection model guidance outlined in Section 2.3, best practices from existing standards, and the experience of the research team, model guidance that will encourage CHP interconnection was developed for consideration by state regulatory authorities and utilities.

4. FINDINGS

Through the research activities outlined in Section 3, the research team documented findings as summarized in the sections and subsections that follow.

Section 4.1 summarizes findings from the FERC document review and consultations with FERC staff, and Section 4.2 summarizes results from the review of representative utility interconnection rules.

Section 4.3 contains the synthesis of the literature review findings with findings from all other activities. As shown in Figure 4-1, the barriers span 11 key subject areas in 3 categories relevant to generator interconnections: interconnection (Section 4.3), interconnection tariffs (Section 4.4), and regulatory and policy (Section 4.5).

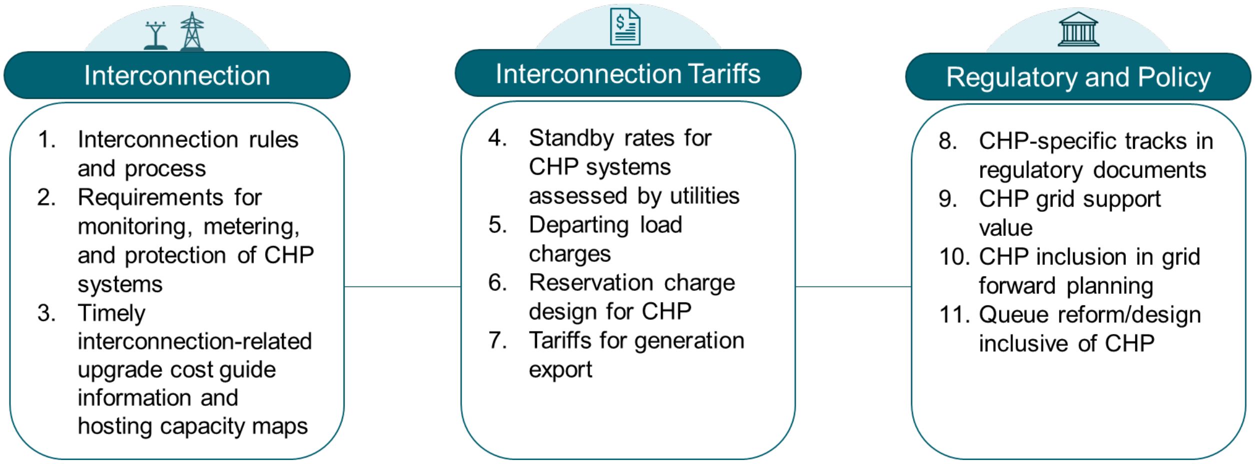

Figure 4-1. Categories and subject areas of CHP barrier findings.

The research team noted some overlap across barrier categories to be addressed by the model guidance. This means that in some cases a single action, such as updates to interconnection rules and handbooks, could address multiple barriers across the three categories.

4.1 FINDINGS FROM FERC STAFF CONSULTATIONS

At the time of this report, some FERC documents implicitly or explicitly address CHP as it relates to QFs and their role as generators. Appendix C, "Summary of FERC Documents Pertaining to Generators," contains further information. The research team consistently found that the challenges of interconnection are considered common to all types of generation resources; any interconnection barriers faced by CHP owners (e.g., packed interconnection queues) are not unique to CHP. Other similar types of generation of similar sizes (e.g., non-inverter-based generation)[118] face similar issues.

Additional findings included the following:

- Under PURPA, FERC is responsible for implementing PURPA by establishing regulations governing QFs, including QF CHP units. Such regulations include requiring electric utilities to purchase electric power from QFs at an avoided cost rate and requiring electric utilities to sell electric energy to QFs, including CHP units, at a rate that is just, reasonable, and in the public interest. Implementation of these rules is reserved to state regulatory authorities and nonregulated electric utilities.
- When a legally enforceable obligation (LEO) is established, QF CHP facilities have the option to sell power at the avoided cost rate calculated at the time the LEO was established or at the avoided cost rate calculated at the time of sale. A bilateral contract may stipulate avoided cost regardless of actual avoided cost based on a cost-of-service study; however, this is not necessarily a barrier to interconnecting CHP.
- Under FERC Order No. 2222, DERs include CHP if it is interconnected to the distribution system or behind the meter. However, if ISOs/RTOs designate a maximum size for resources that can participate in an aggregation, then some CHP units might exceed a proposed threshold.
- The North American Electric Reliability Corporation has noted the value of CHP in that they provide rotating mass inertia to the grid.[119] NERC suggests identifying a wider set of operating conditions that would result in the most extreme operating condition including low inertia. This highlights the

[118] The research team notes that some CHP vendors are starting to package small (<1 MW) CHP systems with smart inverters for easier grid interconnection.
[119] Mandatory standards are proposed by the North American Electric Reliability Corporation and approved by FERC.

importance of inertia and resources with rotating mass including synchronous CHP. More comprehensive information is available in the *Reliability Standards* NOPR for inverter-based resources.[120]

- CHP units provide thermal energy for on-site loads and electric energy for sale to the local utility. For that reason, interconnection requirements are designed based on the full nameplate rating of the generator. However, FERC Order No. 845 permitted interconnections based on injecting power onto the grid below the nameplate rating of the generator.
- PURPA established two categories of QFs: (1) small power production QFs, which are facilities 80 MW or less and fueled by a minimum of 75% renewable resources (e.g., wind, solar, biomass), and (2) CHP QFs, which produce electric energy and thermal energy used for industrial, commercial, heating, or cooling purposes. CHP QFs are not limited by overall size and, unlike small power production QFs, are not subject to the one-mile rule, which groups affiliated generating units for the purpose of the 80 MW limitation. However, CHP QFs must meet operating and efficiency standards.

The research team reviewed FERC documents to identify CHP-related considerations under FERC's jurisdiction (Appendix C) that were relative to rules and thresholds for QFs and fair access to markets that have beneficial technologies. Recent FERC NOPRs supporting information for cost barriers and opportunities identified previously include the following:

- In the *Interconnection* NOPR,[121] under paragraph 30, FERC states, "Delayed interconnection study results or unexpected cost increases can disrupt numerous aspects of generating facility development, including project financing and the ability to obtain a power purchase agreement."
- In the *Reliability Standards* NOPR,[122] under paragraph 12, FERC points to the advantage of CHP and other synchronous resources over inverter-based resources and says, "Synchronous generation resources can provide voltage support during voltage disturbances."

4.2 UTILITY INTERCONNECTION SUMMARY

The research team found a wide range of treatments of CHP interconnection across representative utilities, summarized in Table 4-1. (See Appendix B for more detailed information.) Some utilities do not mention or incentivize CHP, some incentivize CHP through energy efficiency or other programs and may refer to synchronous or induction (or non-inverter) generators without mentioning CHP explicitly in their interconnection rules, and one (PEPCO) has a separate interconnection application for customers seeking to interconnect CHP. These findings suggest that some states are more aligned with CHP technologies and encourage more CHP developer interest.

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[120] Federal Energy Regulatory Commission, 18 CFR Part 40, Docket No. RM22–12–000, *Reliability Standards to Address Inverter-Based Resources*, 2022. This NOPR was the basis for FERC Order No. 901, *Reliability Standards to Address Inverter-Based Resources*, October 2023.

[121] Federal Energy Regulatory Commission, 18 CFR Part 35, Docket No. RM22–14–000, *Improvements to Generator Interconnection Procedures and Agreements*, 2022. This NOPR was the basis for FERC Order No. 2023, *Improvements to Generator Interconnection Procedures and Agreements,* July 2023.

[122] Federal Energy Regulatory Commission, 18 CFR Part 40, Docket No. RM22–12–000, *Reliability Standards to Address Inverter-Based Resources*, 2022. This NOPR was the basis for FERC Order No. 901, *Reliability Standards to Address Inverter-Based Resources,* October 2023.

Table 4-1. Interconnection summary findings for selected utilities by state

State and utility	Do the interconnection rules directly mention CHP interconnection?	Additional notes pertaining to interconnecting CHP for named utilities
Texas Austin Energy	No	• Existing policies and processes exist that support CHP development; for instance, the Distributed Generation Interconnection Tool requires entities responsible for all critical governmental facilities to consider formally the feasibility of implementing CHP technology.
California IOUs	Yes	• Interconnection rules follow California Rule 21. • CHP feed-in tariffs have been developed for capacities less than 20 MW. • State policies have historically encouraged CHP (e.g., the Governor's Clean Energy Jobs Program calls for 6,500 MW of CHP by 2030).
New York ConEd	Yes	• ConEd divides interconnection into small, large distributed, and large CHP projects. • ConEd had a CHP incentive program in 2017 that provided a capacity incentive that covered the entire project cost.
Minnesota Xcel Energy	No	• Three groups are defined to categorize interconnection: small, fast-track, and study. • CHP interconnection is not explicitly called out on the online interconnection portal. • Synchronous and induction machines up to 2 MW are eligible for the fast-track process.
The Carolinas Duke Energy	No	• Three groups are defined to categorize interconnection: small, fast-track, and study. • Small-capacity interconnection refers to net metering of 20 kW or less. Fast-track interconnection includes net-metering intent greater than 20 kW and up to 1,000 kW, including purchased power intent greater than 20 kW and up to 250 kW. Interconnection studies are required for purchased power intent greater than 250 kW. • The interconnection portal does not specifically call out CHP but offers a list of prime movers and options to select inverter-based machine, rotating machine, or both.
Illinois ComEd	No	• ComEd divides interconnection projects into generators that are small, large, and greater than 200 MW. • ComEd offers CHP incentives through its Custom Solutions energy efficiency program provided certain criteria are met and approvals are granted.
Maryland EmPOWER-PEPCO	Yes	• Small generator interconnection projects are categorized into four levels. • The EmPOWER Maryland Efficiency Act of 2008 enables PEPCO to incentivize CHP systems based on kilowatt capacity; a separate application form exists for CHP project customers. Incentives are based on kilowatt values for CHP developers and are allowable for one project per site, are not to exceed \$2.5 million per project, and are not to exceed 50% of the total project cost.
Ohio AEP	No	• The interconnection process is split into three categories depending on size and technology. UL 1741, IEEE 1547, and additional requirements are used depending on the project. • The web portal has options for synchronous and inverter-based technologies using natural gas.

4.3 INTERCONNECTION BARRIERS

Table 4-2 summarizes key findings pertaining to the interconnection process in three subject areas. Further detail in each area is in subsections that follow.

Table 4-2. Findings summary—interconnection

Subject area	Common barriers and impacts
1. Interconnection rules and processes	Interconnection processes are inconsistent across states and utilities; this makes it challenging for CHP developers to plan projects effectively and obtain project approval from utilities. In 2020, DOE examined state interconnection polices that apply to CHP and found that there were significant dissimilarities within the 50 states. The research conducted for this effort confirmed that interconnection processes remain inconsistent across states and utilities. This research also found that a lack of transparency in how interconnection rules and business processes apply to CHP projects makes it challenging for CHP developers to understand the costs and overall viability of a CHP project in a timely manner. CHP developers and end users said these factors significantly contribute to delays in obtaining funding approvals. Some utilities interviewed for this project said that incomplete applications and timelines for nonutility approvals are primary reasons for interconnection delays, including for CHP projects.
2. Requirements for monitoring, metering, and protection of CHP systems	One of the primary responsibilities of electric utilities and RTOs/ISOs is to ensure reliability and safety of electric grid operation. Based on the type of generator (i.e., synchronous, induction, or inverter based) and the size of the generator (i.e., 1, 10, or 100 MW), the utility may include monitoring, metering, and protection requirements which could go beyond what is required by the host customer connected to the generator. Such information is unforeseeable by the CHP developer, and thus funding decisions are negatively affected when the requirements become known. For instance, the utility may require a utility-provided relay where the manufacturer has already included a utility-acceptable relay within the CHP technology or may require a type of metering appropriate for export when the technology is not planned for export. The utility specifies these requirements after completing its interconnection review and system impact studies if they are deemed necessary, which can take several weeks. When monitoring, metering, and protection costs for CHP projects are unknown during the early stages of the interconnection process, CHP project investment costs may increase, and project completion may be delayed.

Table 4-2. Findings summary – interconnection (continued)

Subject area	Common barriers and impacts
3. Timely interconnection-related upgrade cost guide information and hosting capacity maps	Public access to interconnection-related upgrade cost[123] and hosting capacity information is a key factor for the installation of CHP because the cost of interconnection has been growing, and utilities are faced with a growing number of resource interconnection requests.[124] All utilities interviewed stated they do not treat CHP interconnections differently from other types of generation. However, they may have opaque interconnection processes without clear timelines available to CHP developers and owners (e.g., information that could be provided by hosting capacity maps), which may compromise funding of a CHP project. Delayed feasibility studies or funding decisions result when CHP developers do not have timely access to information needed to understand the costs (e.g., reconductoring) and overall viability of a specific CHP project location. Although all interconnection customers face this barrier, not just CHP owners, the lack of essential information is compounded for CHP projects because CHP project nameplate capacities and overall project costs are expected to be larger than other types of generation such as solar. Many utilities use fast-track or preapplication interconnection processes to expedite access to information for developers, particularly for smaller inverter-based generator interconnection projects (generally solar PV projects). As the volume of PV generator interconnection applications has increased, fast-track screening processes in interconnection rules have allowed utilities to accommodate timely interconnection[125] of an increasingly large number of solar PV generators. Fast-track application screening processes developed by state regulatory agencies and utilities have therefore become focused on smaller-capacity inverter-based projects. Because the number of CHP interconnection projects (typically synchronous or induction generators installed without inverters) is small, there is often no market-driven reason for utilities and state regulatory agencies to consider how synchronous or induction-based CHP projects could safely be fast-tracked, so information is not available to CHP developers in a timely manner.

4.3.1 Subject Area #1: Interconnection Rules and Processes

The research team literature review of sources in Table 3-1 found documented barriers to CHP in this subject area as far back as 2006.[126] The following sections provide detailed supporting information and supplementary remarks.

4.3.1.1 Detailed Findings and Supporting Citations

The research team found citations supporting four detailed findings in this subject area as follows.

[123] For example, in the form of unit cost guides that specify cost per mile of reconductoring
[124] Such as for solar PV, energy storage, and electric vehicle–charging infrastructure
[125] In some states, interconnection timelines are required by the state-adopted interconnection process and enforced by the regulator. Utilities in these states must meet the timelines specified.
[126] ACEEE Part I, March 2006

Finding 1-A: Interconnection standards limit the increased capacity of CHP in the United States.

- "Prohibitively complex rate, tariff, and interconnect standards were often constructed that have had the implicit effect of limiting the increased capacity of CHP on a national scale" (ACEEE Part I, March 2006).
- "The lack of uniformity in application processes and fees, as well as the degree to which these requirements are enforced, makes it more challenging for equipment manufacturers to design and produce modular packages and may reduce economic incentives for on-site generation" (DOE, June 2015).
- "Lack of interconnection standards for projects of all sizes can cause confusion and delay in project development" (DOE, June 2015).

Finding 1-B: Rules-based variability across jurisdictions can delay projects and increase financial uncertainty.

- "Predictable interconnection rules-based on industry technical standards and application processes that limit financial uncertainty and delays can encourage CHP projects" (Gardiner, April 2016).
- "A major barrier to CHP is the lack of national business practice standards for the interconnection of distributed generation technologies to the local electric utility grid…This lack of uniform business practice standards results in a patchwork of regulatory models" (ACEEE, August 2009; also supported in DOE, June 2015).
- "Specific barriers include…Interconnection rules that differ between utilities within a state…" (DOE Issue Brief, April 2020).
- Requirements such as telemetry and protection vary by state (based on analysis of interconnection standards databases from the American Council for an Energy-Efficient Economy [ACEEE][127] and the US Environmental Protection Agency [EPA])[128]
- "Forty-three states and the District of Columbia have adopted some form of interconnection standards or guidelines; however, requirements and implementation are inconsistent between states and sometimes within states" (DOE, June 2015).

Finding 1-C: The lack of uniform standards for interconnection procedures is due in part to jurisdiction over interconnection being split between FERC and state regulators.

- "The lack of uniform standards for interconnection procedures is due, in part, to the fact that jurisdiction over interconnection is split between the Federal Energy Regulatory Commission (FERC) and the states' utility regulatory body" (ORNL, December 2008; also quoted in USEA, August 2011).

Finding 1-D: State interconnection standards vary considerably across states.

- "State interconnection standards vary considerably and can lack language or provisions that encourages interconnection" (DOE Issue Brief, April 2020).

4.3.1.2 Supplementary Remarks

Interconnection process logistics

In the literature review, the research team identified a need to standardize technical regulatory rules for interconnection of on-site generation, including CHP. Certain barriers to interconnecting CHP are not

[127] ACEEE, "Interconnection Standards," State and Local Policy Database, database.aceee.org/state/interconnection-standards.
[128] EPA, "CHP Policies and Incentives," referenced November 2022, epa.gov/chp/database-chp-policies-and-incentives-dchpp.

necessarily due to unresolved technological or operational challenges, but evidence suggests that the states' failure to adopt or update regulatory policies (e.g., policies based on IEEE 1547) plays a role.

Interconnection standards for DERs connected to the distribution system are generally under the jurisdiction of state and/or local utility regulators. This jurisdiction allows the utilities and regulators to plan for specific system conditions, needs, and capabilities; however, through the literature review and stakeholder feedback, the research team found that the lack of consistency and transparency in business practice standards for CHP interconnection can be a barrier to timely and clear CHP interconnection. DOE found in their brief that CHP interconnection policies can be encumbered throughout all states whether they adhere to certain industry interconnection standards or do not uphold those standards.[129]

The ACEEE has suggested creating a consistent structure for CHP interconnection processes to prevent practices that systematically impose higher costs and more complex processes for CHP projects.[130]

Financial risk and business case development

Differences in interconnection rules across jurisdictions have made business case development more complicated for CHP developers attempting to interconnect CHP systems in multiple utilities and regulatory jurisdictions. The research team heard in discussions with developers that uncertainties regarding upgrade costs and interconnection impact study timelines for different utilities were key barriers to CHP interconnection. When interconnection rules vary across jurisdictions, financial risk associated with these uncertainties can increase and create a clear disincentive for developers to develop CHP business cases across multiple service areas.

4.3.2 Subject Area #2: Requirements for Monitoring, Metering, and Protection of CHP Systems

The research team literature review of sources in Table 3-1 found documented barriers to CHP in this subject area as far back as 2009.[131] The following sections provide detailed supporting information and supplementary remarks.

4.3.2.1 Detailed Findings and Supporting Citations

The research team found representative citations supporting three detailed findings in this subject area as follows.

Finding 2-A: Initial design of utility protection requirements for grid safety and reliability may overestimate the equipment required (e.g., due to early assumptions made in the absence of required information) and thus increase the estimated interconnection-related costs to such an extent that the project appears infeasible.

- "Currently, various interconnection standards across and within states create barriers for CHP deployment (Chernyakhovskiy et al., 2016). For example, protection requirements ensuring the grid's safety and reliability may not be commensurate with the CHP's size (U.S. Department of Energy Advanced Manufacturing Office, 2020)" (LBNL, August 2021).
- "Specific barriers include: ... Protection requirements that are not commensurate with generator capacity and potential grid impacts" (DOE Issue Brief, April 2020).
- "Communication requirements for direct transfer trip (DTT) can create barriers for CHP" (DOE Issue Brief, April 2020).

[129] DOE Issue Brief, April 2020.
[130] ACEEE, August 2009.
[131] Ibid.

- “Electric utilities are required to ensure grid reliability and safety, and in an effort to meet these needs, utilities may be inclined to push for over-designed protection hardware and controls, driving up costs for CHP and other DG installations” (DOE Issue Brief, April 2020).
- “Meters are necessary, but also an additional financial burden on developers, and may prove redundant as more of them are required to meet the requests of the utilities, the California ISO, and state regulatory agencies” (CEC, September 2012).

Finding 2-B: The cost of protective equipment, such as DTT and the associated relays, could be a significant barrier to CHP systems, imposing substantial costs large enough to potentially affect the feasibility of the project. However, purchasing protective equipment is necessary.

- IEEE 1547 and UL 1741 are existing standards commonly referred to for state interconnection rules. However, there is a lack of technical standards established specifically for CHP systems, resulting in high-cost installation requirements that may not be necessary and could negatively affect the project business case (ACEEE, August 2009).
- Although protective equipment is necessary for CHP systems, the cost of certain approaches can be substantial and potentially affect the feasibility of the project (Pacific Gas and Electric, 2022).

Finding 2-C: Interconnection studies used to determine what additional utility and IEEE requirements may be necessary for the safe interconnection of the CHP unit, however necessary, can discourage CHP by increasing costs and delaying timelines.

- “Some utilities require costly and complex studies and installation of unnecessary and expensive equipment to discourage CHP” (ACEEE, August 2009).

4.3.2.2 Supplementary Remarks

Telemetry and protection

The research team heard in interviews with developers that requirements such as telemetry and protection vary by state, and individual utilities may have their own minimum requirements that exceed the minimum requirements specified in IEEE 1547-2018.

4.3.3 Subject Area #3: Timely Interconnection-Related Upgrade Cost Guide Information and Hosting Capacity Maps

The research team literature review of sources in Table 3-1 found documented barriers to CHP in this subject area as far back as 2020.[132] The following sections provide detailed supporting information and supplementary remarks.

4.3.3.1 Detailed Findings and Supporting Citations

The research team found citations supporting two detailed findings in this subject area as follows.

Finding 3-A: Timelines to complete feasibility and system impact studies and to calculate system upgrade costs for CHP projects are not clearly established in interconnection rules, causing delays and financial uncertainty.

[132] DOE Issue Brief, April 2020

- “Specific barriers include…Interconnection rules that do not clearly establish timelines and fees” (DOE Issue Brief, April 2020).

Finding 3-B: Uncertainty in the interconnection process and delayed access to needed information can cause delays and affect funding decisions.

- Developers found the CHP interconnection process was often complex and opaque (from interviews the research team conducted with CHP developers).

- Developers mentioned difficulty in coordinating and communicating with different departments within the utility and with regulators such as state commissions and FERC (from interviews the research team conducted with CHP developers and technical assistance providers).

- “Interconnection process time and cost has become long and costly, and is particularly damaging for smaller CHP systems” (ICF International, March 2019).

4.3.3.2 Supplementary Remarks

DOE CHP Technical Assistance Partnerships

The research team heard in initial interviews that navigating the complicated interconnection process for CHP sometimes led to years of delay. The CHP Technical Assistance Partnerships emphasized that interconnection rules that do not establish timelines and fees are barriers to CHP development.[133]

CHP developers

Through interviews and stakeholder feedback, the research team found that CHP developers consider the interconnection process complex and opaque. At times, a developer had to coordinate with several parties including the utility, the public utility commission, the ISO/RTO of where the project would be located, and FERC to comply with a utility’s affiliate transaction rules. A stakeholder shared that a utility required direct coordination between the utility’s power procurement group and its transmission and distribution group and that this internal coordination at the utility resulted in project delays.

4.4 INTERCONNECTION TARIFF BARRIERS

Table 4-3 summarizes findings pertaining to interconnection tariffs in four subject areas. Further detail in each area is provided in the sections that follow.

[133] DOE Issue Brief, April 2020

Table 4-3. Findings summary—interconnection tariffs

Subject area	Common barriers and impacts
4. Standby rates for CHP systems assessed by utilities	CHP developers report that utility levies of some standby rates can significantly erode energy cost savings for CHP projects and are often based on worst-case scenarios that would not actually occur during CHP system operation.
5. Departing load charges	Departing load charges, sometimes called stranded cost or exit fees,[134] can negatively affect the financial viability and economics of CHP projects. These charges increase the cost of producing electricity on-site with CHP systems. Although only a few states use departing load charges, the financial burden they create for CHP developers is a key factor to why CHP projects do not move forward. Departing load charges, when combined with standby charges, can result in developers determining that the investment decision of moving forward with CHP is not financially viable. Utilities typically establish departing load charges within utility rate tariffs, and the process for setting the charges may not include the perspective of CHP developers.
6. Reservation charge design for CHP	Reservation charges, if not justifiable, create a financial barrier for CHP projects by charging customers a fixed per-kilowatt fee regardless of whether the CHP sites use the full capacities of the CHP systems. CHP developers report that utility assessments of reservation fees may be too high and/or based on worst-case scenarios that would not occur during CHP system operation. Without accounting for the reliability of the CHP system, and by not fully considering how the CHP system owners design, operate, and maintain the systems using the latest and most reliable technology, reservation charge designs may create a substantial financial barrier to interconnecting more CHP.
7. Tariffs for generation export	Most states do not include CHP in net-metering tariffs even when CHP may offer a more valuable source of power. For instance, when considering CHP's higher capacity factor, the CHP value may have a higher value than solar in some cases.[135] CHP developers lose the opportunity to use excess energy generation to improve the economics of a CHP project. Other barriers to exporting power for CHP facilities include more complex and lengthy interconnection review processes, interconnection-related upgrade costs, and transactional costs to reach wholesale markets.

4.4.1 Subject Area #4: Standby Rates for CHP Systems Assessed by Utilities

The research team literature review of sources in Table 3-1 found documented barriers to CHP in this subject area as far back as 2006.[136] The following sections provide detailed supporting information and supplementary remarks.

[134] ACEEE, August 2009
[135] US Department of Energy and Environmental Protection Agency, *A Clean Energy Solution: Combined Heat and Power*, 2012.
[136] ACEEE Part I, March 2006

4.4.1.1 Detailed Findings and Supporting Citations

The research team found citations supporting four detailed findings in this subject area as follows.

Finding 4-A: Complexity of rates and tariffs can limit increasing CHP capacity.

- "Prohibitively complex rate, tariff, and interconnect standards were often constructed that have had the implicit effect of limiting the increased capacity of CHP on a national scale" (ACEEE Part I, March 2006).
- "One of the most significant barriers to CHP implementation is overly complicated tariffs" (GPI, March 2021).
- Several states are noted to have complex rate/tariff designs implemented (RAP, February 2014).
- "The higher and more confusing these standby charges are, the greater the risk that a utility's approach to providing standby service will pose a barrier to the construction of an otherwise economical CHP system" (Hunterston, August 2019).

Finding 4-B: Standby rate structures developed by utilities can negatively affect the financial viability and economics of CHP projects.

- "[There are utility concerns that] are valid and there is thus some justification for higher backup rates. Unfortunately, there has been little consistency in how these rates are set by utilities and they are often set unjustifiably high" (ACEEE Part II, August 2006).
- A Regulatory Assistance Project (RAP) report on standby rates identifies areas where tariffs could be modified to decrease the barriers to CHP deployment (RAP, February 2014).
- "Many utilities have set these standby charges as well as interconnection charges at levels that will make on-site generation uneconomic. The result is that costs, delays, fees, and pricing strategies have combined to discourage the installation of CHP systems (Elliott and Spurr 1999)" (ACEEE Part II, August 2006).
- "Charges or terms and conditions of a standby tariff that would result in excessive costs for standby service would unnecessarily discourage CHP development, an inherently more energy-efficient technology than taking traditional utility or alternate supplier power" (GPI, March 2021).
- "...standby rates can be poorly designed, or sometimes seem to intentionally discourage the use of CHP"(GPI, March 2021).
- **"**Many utilities currently charge discriminatory backup rates and high fees for interconnection" (ACEEE Part II, August 2006).
- "The level of [standby] charges is often a point of contention between the utility and the consumer, and can, without proper oversight, create unintended and important barriers to CHP" (Gardiner, April 2016).
- "Overall, staff emphasized the need for 'standby tariffs' that properly reflect the costs and benefits of serving customers with distributed generation" (Hunterston, August 2019).

Finding 4-C: Demand ratchets may be a disincentive to CHP.

- "Because it looks to a customer's highest peak over a timeframe in the past, a demand ratchet may reduce the incentive for a standby service customer to make efficient use of the grid in the present month" (GPI, March 2021).
- "Several interviewees expressed doubts as to the fairness of demand ratchets, citing a strong preference for as-used demand charges" (GPI, March 2021).

- "The use of ratchets can be controversial, as some view them as increasing the equity of fixed-cost allocation, while others view them as barriers to economic applications by CHP customer" (Gardiner, April 2016; also supported by DOE, June 2015).
- "Although demand ratchets may be appropriate for recovering the cost of delivery, they arguably do not reflect cost causation for shared distribution and transmission facilities" (Gardiner, April 2016; also supported by DOE, June 2015).

Finding 4-D: Demand charges may not account for periods when utility requirements for a CHP system are low.

- "[Demand charges] are especially detrimental to small projects; not operating during a peak hour can erase the entire savings that a generator has provided for the month of service" (CEC, September 2012).
- "… 77 percent of survey respondents agreed that it should be considered a best practice in standby rates for maintenance demand charge rates to be discounted relative to backup demand charge rates to recognize the scheduling of maintenance service during periods when the utility generation requirements are low" (GPI, March 2021).

4.4.1.2 Supplementary Remarks

Standby services—additional details

Developers adding on-site generation such as CHP to facilities must consider the cost of standby power (i.e., supplemental power[137] and/or backup power[138]) for when the CHP system generation is not sufficient or available, and the utility will be required to deliver the missing load. Standby services include the following:

- **Maintenance power:** Power supplied by the utility when the CHP system is down for scheduled maintenance
- **Backup power:** Power supplied by the utility in the case of unscheduled outages (i.e., malfunction or equipment breakdown)
- **Supplemental power:** Power supplied by the utility during specific times of the day, week, or season when the CHP capacity may not be sufficient to serve the load

In exchange for these services, utilities set a standby charge for the on-site generating technology. The general goals for well-designed standby rates should be to incentivize low forced outage rates for the CHP system, encourage scheduled outages during off-peak periods, and encourage shared capacity. The research team notes that considerations for standby rate designs ideally include the following according to the RAP. When the utility does not account for or provide some or all of the following, standby rates may be perceived as unfairly assessed:[139]

- Customer's savings per kilowatt-hour produced on-site compared with buying from the grid
- Not all CHP generators will fail at the same time or during the system peak.
- Reasonable balance between variable charges and contract demand or reservation charges
- Daily as-used demand charges for backup power and accounting for on-peak vs. off-peak demand

[137] Supplemental power is required when the site requires more power than the CHP system can provide. CHP is typically sized to provide only part of the facility's power needs.
[138] Backup power is required when the CHP system is not operating because of a planned or unplanned outage.
[139] Littell, D., *Getting Standby Rates Right for a Modern Grid*, 2018

- Opportunities to minimize costs imposed on the electric system and avoid charges such as a reservation charge for generation service
- Options for customer demand response or storage to mitigate all or a portion of backup charges

Per the Great Plains Institute, "Depending on the size of a customer's CHP system, standby charges can run in the thousands (or tens of thousands) of dollars per month."[140] Not only does this result in high expenses to a CHP generator owner, it also adversely affects CHP owners' planned energy savings in their business models. In addition, standby rate designs, depending on jurisdiction, may assume that backup or maintenance power will be needed during peak hours, and this may not be the case.

Each utility has its own calculations to determine standby rates, causing a lack of uniformity which makes it difficult for industries and companies to determine the benefits and viability of implementing a CHP project. Challenges may also arise when the language of determining a utility's standby tariff is not sufficiently clear for a potential CHP user to understand and estimate their future bills. The higher and more complex standby rate designs are, the more of a barrier they are in the economics and development of CHP projects.[141]

In their 2009 report on standby rates, the EPA states, "The economic viability of clean, distributed generation (DG) and, in particular, combined heat and power (CHP) facilities, heavily depends on the regulatory policies that determine how they are treated by the electricity network." [142]

Ratchet rates—additional details

In the survey captured in the Great Plains Institute's CHP report,[143] 75% of respondents[144] disagreed that utilities should use demand ratchets to recover fixed costs.[145] These rates may be based on CHP systems' forced outages in one month, which may not be reflective of the facilities' forced outages in future months.[146] According to CHP developers, "…CHP customers [with demand ratchets] are in these cases forced to pay high demand charges every month, based on their usage during a single prior month when their system may have been down for maintenance [or an unplanned outage]." Depending on the design, ratchet rates can also remove the incentive for customers to reduce peak demand.

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140 Great Plains Institute, March 2021
141 Hunterston, August 2019
142 US Environmental Protection Agency, Regulatory Assistance Project, *Standby Rates for Customer-sited Resources*, 2009, epa.gov/sites/default/files/2015-10/documents/standby_rates.pdf.
143 Great Plains Institute, March 2021
144 The following respondent groups were in the 34 respondents of the survey: affiliated with a governmental entity (4 respondents), providers of technical assistance (3), utility consultants (1), advocates (1), consultants for advocacy groups (3), consultants for other groups (3), manufacturers (7), developers (8), equipment suppliers (1), and original equipment manufacturers (1).
145 The following respondent groups were in the 34 respondents of the survey: affiliated with a governmental entity (4 respondents), providers of technical assistance (3), utility consultants (1), advocates (1), consultants for advocacy groups (3), consultants for other groups (3), manufacturers (7), developers (8), equipment suppliers (1), and original equipment manufacturers (1).
146 The following respondent groups were in the 34 respondents of the survey: affiliated with a governmental entity (4 respondents), providers of technical assistance (3), utility consultants (1), advocates (1), consultants for advocacy groups (3), consultants for other groups (3), manufacturers (7), developers (8), equipment suppliers (1), and original equipment manufacturers (1).

4.4.2 Subject Area #5: Departing Load Charges

The research team literature review of sources in Table 3-1 found documented barriers to CHP in this subject area as far back as 2009.[147] The following sections provide detailed supporting information and supplementary remarks.

4.4.2.1 Detailed Findings and Supporting Citations

The research team found citations supporting one detailed finding in this subject area as follows.

Finding 5-A: Departing load charges, which are typically established within utility rate tariffs, can negatively affect the financial viability and economics of CHP projects and lack CHP developer input.

- "The CHP industry unanimously views departing load charges as excessive and detrimental to new CHP development" (CEC, September 2012).
- Developers reported that CHP is sometimes not exempt from departing load charges, while other forms of renewable and nonrenewable fuel cells are. Further, renewables and fuel cells are eligible for notably better incentives than CHP, which turns investment attention away from CHP (stakeholder interviews).
- "Departing load charges frequently are a key reason a CHP project does not go forward. They have shown up on various CHP barrier lists for years" (CEC, October 2012).
- "[The Energy Producers and Users Coalition] concludes that 'departing load charges materially and directly increase the cost of investment in CHP above the cost that would be faced by a utility installing the same facility'" (CEC, September 2012).

4.4.3 Subject Area #6: Reservation Charge Design for CHP

The research team literature review of sources in Table 3-1 found documented barriers to CHP in this subject area as far back as 2014.[148] The following sections provide detailed supporting information and supplementary remarks.

4.4.3.1 Detailed Findings and Supporting Citations

The research team found citations supporting one detailed finding in this subject area as follows.

Finding 6-A: Reservation charges create a financial barrier by charging customers a fixed per-kilowatt fee regardless of whether utility service is used or not and without consideration of how CHP systems may be designed and operated.

- "Generation reservation demand charges should be based on the utility's cost and the forced outage rate of customers' generators on the utility's system" (RAP, February 2014).
- The RAP analyzed utility tariffs in five states and "suggested tariff improvements for a selected set of proxy utility customers who have CHP systems," including improvements to reservation charge design (RAP, February 2014). The suggested improvements included the following: allowance for scheduled maintenance hours for all standby customers, development of daily demand charges to provide incentives to improve generator performance, unbundling of generation and transmission cost

[147] EPA, December 2009
[148] RAP, February 2014

elements of reservation fees, and several other state-specific potential modifications to the rate designs, terms, and conditions of standby tariffs.

4.4.3.2 Supplementary Remarks

Missed opportunity

CHP developers believe that regulators lack understanding of CHP systems, which leads to missed opportunities for standardizing energy policy and determining equitable reservation charge methodologies.

4.4.4 Subject Area #7: Tariffs for Generation Export

The research team literature review of sources in Table 3-1 found documented barriers to CHP in this subject area as far back as 2006.[149] The following sections provide detailed supporting information and supplementary remarks.

4.4.4.1 Detailed Findings and Supporting Citations

The research team found citations supporting two detailed findings in this subject area as follows.

Finding 7-A: There is a lack of net-metering provisions for CHP; in some instances, net metering is not allowed, creating a financial barrier for CHP projects.

- "As is true in other states, a lack of net-metering provisions tends to make small (e.g., less than 100 kW) CHP projects economically unfeasible, creating a significant barrier to new CHP" (ACEEE Part II, August 2006).
- "Tecogen raised two additional issues that are worth mentioning in regard to barriers to small-scale CHP development… [one of the barriers] is net energy metering (NEM)" (CEC, September 2012).
- "The second issue Tecogen raised is net energy metering. CHP facilities [in California] are not eligible for NEM, unless they use biogas or are a fuel cell" (CEC, September 2012).
- "The inability to sell excess power or to sell excess power at a competitive price can serve as a deterrent to CHP projects sized to meet the facility's thermal needs" (DOE, June 2015).
- "In many states, industrial plants that operate CHP systems do not have the ability to deliver excess electricity to nearby plants that are under common ownership, or sell excess power to any entity other than the electric utility that serves the CHP site. This may hinder the industrial site from securing financing or moving forward with the project" (DOE, June 2015).

Finding 7-B: Opportunity for revenue generation by QFs may be limited by FERC Order No. 872 and cogeneration requirements in PURPA.

FERC Order No. 872 revised the implementation of PURPA, including to provide flexibility for[150]

- state regulatory authorities to require the utilities pay as-available QF energy rates based on locational marginal pricing at the time of the energy delivery,
- state regulatory authorities to require that energy rates under QF contracts or LEOs be determined at the time of delivery rather than being fixed for the term of contract or LEO, and

[149] ACEEE Part II, August 2006

[150] FERC Order No. 872, *Qualifying Facility Rates and Requirements Implementation Issues Under the Public Utility Regulatory Policies Act of 1978*, July 16, 2020.

- state regulatory authorities to require the utilities located outside of RTO/ISO markets to pay as-available QF energy rates based on competitive prices.

These revisions may disincentivize CHP because they limit the opportunities for CHP systems to sell power and generate revenue.

4.4.4.2 Supplementary Remarks

Energy sales at a loss and uncertainty in market rates

In addition to the lack of net-metering provisions and the difficulty CHP customers may face in selling excess power to the grid, current regulations may force CHP customers to sell energy to utilities at a loss. Generally, utilities purchase energy and capacity from QFs using a utility's avoided cost rate. Avoided costs rates are the cost a utility would pay a qualified facility for electricity that is equal the costs the utility would incur to generate the electricity or purchase it from another source. They are determined by the utilities using set considerations and rules in PURPA.[151] Setting the avoided cost too low could limit the benefit of exported generation for CHP customers and may constrain the economics of a CHP project. Furthermore, FERC Order No. 872 gives states flexibility to implement variable avoided costs rates and allows utilities to require that energy rates under QF contracts or LEOs be determined at the time of delivery rather than being fixed for the term of contract or LEO. This flexibility may add uncertainty that could further impede the deployment of CHP projects and have ongoing impacts on CHP project economics over the life of the technology. Additionally, avoided costs in some regions are now the time-of-delivery wholesale price, which can be far below the generation costs of CHP power.[152]

4.5 REGULATORY AND POLICY BARRIERS

Table 4-4 summarizes findings pertaining to regulatory and policy matters in four subject areas. Further detail in each area is provided in sections that follow.

Table 4-4. Findings summary—regulatory and policy

Subject area	Common barriers and impacts
8. CHP-specific tracks in regulatory documents	CHP developers and owners need a well-defined regulatory policy addressing the specific challenges, logistical requirements, and timelines for CHP projects. CHP projects can be complex, involving multiple fuel types, contracts, and agreements that may require coordination across multiple agencies and different departments within utilities. Therefore, the lack of an explicit CHP track in regulatory documents can result in lost opportunity to secure funding and complete projects.

[151] 18 CFR §292.101, "Definitions," *Code of Federal Regulations*, Title 18, *Conservation of Power and Water Resources,* Part 292, "Regulations Under Sections 201 and 210 of the Public Utility Regulatory Policies Act of 1978 with Regard to Small Power Production and Cogeneration"

[152] Exergy Partners Corp and Entropy Research LLC, *Standby/Capacity Reservation Charge Best Practices and Review: Prepared for Pennsylvania Public Utility Commission CHP Working Group*, 2018.

Table 4-4. Findings summary—regulatory and policy (continued)

Subject area	Common barriers and impacts
9. CHP grid support value	Not including CHP when valuing DER grid assets ignores its value in integrated resource plans or other grid planning,[153, 154] which affects CHP project financial feasibility. Advances in CHP, such as expanding inverter-based systems, and R&D efforts underway at DOE for flexible CHP systems that decouple power and thermal output will further enhance the potential value of CHP in supporting the grid. However, if state regulatory authorities and utilities do not value CHP alongside other DERs in supporting grid operations (e.g., as a firm dispatchable baseload or source of volt-amp reactive) when developing policies with the potential to drive the market value of CHP, CHP developers cannot include the associated financial benefits in their business plans.
10. CHP inclusion in grid-forward planning	State regulatory authorities overlook CHP technology as a resource that can be utilized for carbon reduction on a forward-planning basis. Statewide grid-forward and integrated resource planning, which does not mention or include CHP explicitly,[155] causes CHP to be left out of the dialogue when planning and funding[156] grid modernizations to accommodate more DERs. In addition, the cost of upgrading the utility system to accommodate a single CHP project could be shared among other DER project interconnections to reduce project capital costs.
11. Queue reform/design inclusive of CHP	State regulatory agencies may not explicitly consider CHP when designing queue reforms. The interconnection-queue cost-allocation methodology discussion (i.e., cost allocation of required interconnection-related upgrades needed to interconnect a new generator safely)[157] normally does not consider potential benefits of CHP to other customers on the circuit. This results in a lost opportunity to reduce barriers to interconnecting more CHP through innovative queue reform strategies such as cluster- and milestone-based cost-allocation approaches.[158]

[153] A California study of CHP supporting the grid found that dispatchable CHP reduced overall grid operating costs including energy, capacity, and grid stress.
E. Chartan et al., *Modeling the Impact of Flexible CHP on California's Future Electric Grid*, US Department of Energy, 2018.
[154] A study by ICF developed for SEE Action states, "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."
SEE Action, *Combined Heat and Power in Integrated Resource Planning: Examples and Planning Considerations,* 2020, energy.gov/sites/default/files/2022-03/see-action-chpirp-fy22.pdf.
[155] Exceptions include New York (e.g., coned.com/-/media/files/coned/documents/our-energy-future/our-energy-projects/distributed-system-implementation-plan.pdf) and California (e.g., cpuc.ca.gov/industries-and-topics/electrical-energy/electric-power-procurement/combined-heat-and-power-program-overview).
[156] Funding includes cost recovery strategies for utilities.
[157] Cost-allocation approaches range from cost-causer pays to prorated strategies and rate decoupling schemes, depending on the state.
[158] A cluster-based approach in which queued new resource projects are evaluated in multiproject cohorts by the utility might allow for CHP to be evaluated alongside existing operational facilities and other DERs in the queue, reducing or deferring interconnection-related upgrade costs for all customers on a circuit. A milestone-based approach adopts a first-ready first-through approach, allowing projects that are ready to move ahead of projects that are not ready.

4.5.1 Subject Area #8: CHP-Specific Tracks in Regulatory Documents

The research team literature review of sources in Table 3-1 found documented barriers to CHP in this subject area as far back as 2006.[159] The following sections provide detailed supporting information and supplementary remarks.

4.5.1.1 Detailed Findings and Supporting Citations

The research team found citations supporting two detailed findings in this subject area as follows.

Finding 8-A: CHP is often not accounted for in interconnection rules and handbooks.

- CHP may not be explicitly accounted for in interconnection rules and handbooks. This is supported by the following:
  - Analysis of the interconnection standards databases from ACEEE[160] and EPA[161]
  - Analysis of Table 1, "Comparison of CHP Interconnection Standards Between States," in DOE Issue Brief, April 2020
  - DOE Issue Brief, April 2020
  - ACEEE Part I, March 2006
- "A major barrier to CHP is the lack of national business practice standards for the interconnection of distributed generation technologies to the local electric utility grid…This lack of uniform business practice standards results in a patchwork of regulatory models" (ACEEE, August 2009).
- "…A number of regulatory barriers impede broad deployment of combined heat and power technology and waste heat-to-power technology…"[162]

Finding 8-B: CHP is absent from regulatory orders/filings.

- "In many regions of the country, CHP is absent from regulatory dialogues. Regulators sometimes overlook the potential of CHP as an energy and an efficiency resource, or do not mandate utilities to consider CHP in their integrated resource plans" (USEA, August 2011).

4.5.1.2 Supplementary Remarks

Lost opportunities for CHP as a DER

The proliferation of intermittent renewables on the grid and advances in CHP technologies create the potential for CHP to be a key resource to support grid flexibility and resiliency. Customer-sited CHP can deliver resource adequacy economically while providing an additional revenue stream (such as ancillary services, where markets exist) that enhances project economics. However, CHP's potential as a grid-supporting resource will not be achieved unless CHP is recognized evenly and consistently along with other DERs when developing policies, procedures, and mechanisms for valuing and interconnecting grid support resources. Interconnection-related upgrades create capacity on the grid and can be used by future interconnections as well as the one project[163] that triggers the need for an interconnection-related upgrade. These costs burden a single project if they are not shared.

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[159] ACEEE Part I, March 2006

[160] ACEEE, "Interconnection Standards," State and Local Policy Database, database.aceee.org/state/interconnection-standards.

[161] EPA, "CHP Policies and Incentives," referenced November 2022, epa.gov/chp/database-chp-policies-and-incentives-dchpp.

[162] US Congress, HEAT Act, S.2706 §2(8)(A), 2019, congress.gov/bill/116th-congress/senate-bill/2706/text#ID93ebd8f9a1c345808faf3d569a57449d.

[163] Sometimes called the cost-causer project

Lack of incentives for CHP

CHP is often not fully regarded in regulatory dialogue. For instance, the USEA states that "regulators sometimes overlook the potential of CHP as an energy efficiency resources" and "regulatory policies often do not incentivize utilities to encourage CHP deployment."[164] As a result, the full potential of CHP as a generation resource may not be considered, and opportunities to encourage the deployment of CHP through incentives are lost. Furthermore, without consideration of CHP in policy and incentives, CHP capacity that could be used support energy needs and grid flexibility remain underutilized.[165]

The Heat Efficiency through Applied Technology (HEAT) Act, introduced in the Senate in October 2019, identifies the need to review and establish interconnection rules and standards for the deployment of heat recovery technologies including CHP. The bill states that "a number of regulatory barriers impede broad deployment of combined heat and power technology and waste heat-to-power technology…"[166] The bill calls on government agencies to review and establish rules for interconnection, determine associated fees and costs, and create voluntary grant programs that may incentivize heat recovery projects that reduce emissions.[167]

4.5.2 Subject Area #9: CHP Grid Support Value

The research team literature review of sources in Table 3-1 found documented barriers to CHP in this subject area as far back as 1999.[168] The following sections provide detailed supporting information and supplementary remarks.

4.5.2.1 Detailed Findings and Supporting Citations

The research team found citations supporting two detailed findings in this subject area as follows.

Finding 9-A: Electricity markets do not fully monetize or recognize the benefits of grid support from CHP systems.

- "Many [CHP] grid benefits are not currently monetized in U.S. electricity markets…" (ORNL, August 2020).

Finding 9-B: Utilities do not fully recognize benefits of grid support from CHP as part of their planning portfolio evaluations.

- "Finally, many utility staff are not aware of the full range of benefits that a CHP system can produce for the customer and the utility. Many of these utility benefits fall into the arcane area of ancillary services that can include voltage, frequency, and reactive power support. While these services may offer important benefits to utilities in areas of constrained transmission and distribution, it can be difficult to assess these benefits, even if the utility is aware of them (Elliott and Spurr 1999)" (ACEEE Part I, March 2006).

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164 USEA, August 2011
165 LBNL, August 2021
166 US Congress, HEAT Act, S.2706 §2(8)(A), 2019, congress.gov/bill/116th-congress/senate-bill/2706/text#ID93ebd8f9a1c345808faf3d569a57449d.
167 US Congress, "S.2706 – HEAT Act: Summary," 2019, congress.gov/bill/116th-congress/senate-bill/2706/text.
168 Elliott and Spurr, 1999, as referenced in ACEEE Part I, March 2006

- "There is an under-appreciation of the system benefits that CHP can contribute to the electric grid, such as alleviating bottlenecks and delaying other infrastructure investments in congested regions" (USEA, August 2011).

4.5.2.2 Supplementary Supporting Analysis

System-wide benefits of CHP

CHP has the potential to serve as a flexible generation resource while providing additional benefits to utilities, other utility customers, and CHP developers and owners. As renewable (intermittent) generation sources such as solar PV and wind turbines penetrate the grid, the need for grid flexibility will increase.[169] Although distributed renewable generation resources provide benefits of low cost and reduced GHG emissions, the inability to predict generation output and the high intermittency of these resources raises issues regarding balancing electric supply and demand and meeting rapidly changing peak demand. As renewable DER penetration increases, the need for grid flexibility to manage the resulting variability and uncertainty in generation will increase.

CHP systems have the potential to provide system-wide benefits through ancillary services including voltage regulation, frequency response, and ramping capabilities. With the development of market rules for DERs in energy markets (e.g., FERC Order No. 2222), flexible CHP can provide an additional value stream for CHP owners and aggregators.[170] Depending on the RTO/ISO market design, CHP developers could sell surplus energy, capacity, and/or ancillary services as well.

Reduced GHG emissions

CHP systems can meet demand while emitting less GHGs compared with traditional peaker plants.[171]

4.5.3 Subject Area #10: CHP Inclusion in Grid-Forward Planning

The following sections provide detailed supporting information and supplementary remarks.

4.5.3.1 Detailed Findings and Supporting Citations

The research team found citations supporting two detailed findings in this subject area as follows.

Finding 10-A: There is a lack of financial incentives and support for the development of CHP projects.

- "Policy actions are needed at all levels for CHP Federal financial incentives…" (Gardiner, April 2016).
- "Regulatory policies often do not incentivize utilities to encourage CHP deployment in their service areas" (USEA, August 2011).

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[169] Per Louis Brasington, "Smart Grid Flexibility Markets – Entering an Era of Localization," Cleantech, 2020, Accessed November 18, 2022, cleantech.com/smart-grid-flexibility-markets-entering-an-era-of-localization/#:~:text=%E2%80%9CGrid%20Flexibility%E2%80%9D%20refers%20to%20the,variable%20renewables%20into%20the%20grid: "*grid flexibility* refers to the capability of a power system to maintain balance between generation and load during uncertainty, resulting in increased grid efficiency, resiliency, and the integration of variable renewables into the grid."

[170] Jal Desai et al., ORNL/TM-2019/1259, *Modeling the Impact of Flexible CHP on the Future Electric Grid in California*, 2020, Oak Ridge National Laboratory, osti.gov/biblio/1649545- modeling-impact-flexible-chp-future electric-grid-california.

[171] LBNL, August 2021

- “Efficient CHP may be the best technology to meet the needs of the developer, as well as support state policy, but because of the perceived financial risks and regulatory uncertainty, many projects are not built” (CEC, September 2012).
- “Traditionally, CHP end-users are also CHP owners/operators. The relatively high up-front capital costs for CHP projects combined with lower returns than other investment opportunities and tight credit markets has made it increasingly difficult to finance new CHP projects” (Gardiner, April 2016).
- “Within the financial community, CHP is less visible than other clean, distributed generation technologies” (USEA, August 2011).

Finding 10-B: State regulatory agencies may not fully consider the value of CHP in integrated resource planning.

- “Utilities compare the value of resource alternatives in integrated resource plans that are prepared for state utility regulatory commissions; however, these comparisons frequently omit sources of CHP value” (DOE, June 2015).
- “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” (SEE Action, 2020).

4.5.3.2 Supplementary Remarks

New York

New York is one of many states establishing 100% renewable electricity goals by 2040 to achieve net-zero carbon emissions by 2050. New York stands in contrast to most states that have not explicitly accounted for CHP in grid planning and demonstrates this planning is conducted at the state level, beyond the influence of individual CHP developers and owners. The fact that New York is an exception reinforces the need for model guidance to address CHP inclusion in grid-forward planning for broader consideration by regulators and state clean-energy planners.

CHP Alliance

The CHP Alliance has encouraged California to consider implementing more CHP because “CHP systems utilizing renewable and lower carbon fuels such as renewable natural gas and clean hydrogen can enable significant emissions reductions.”[172] Furthermore, in the DOE *Industrial Decarbonization Roadmap*,[173] improving energy efficiency is determined as a “foundational, crosscutting decarbonization strategy and is the most cost-effective option” for GHG emission reduction in the near- to medium-term, and thermal heat optimization using CHP is listed as one of the decarbonization efforts implemented through improving energy efficiency.

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[172] CHP Alliance, “CHP Alliance Responds to CEC’s Request for Comments on the 2022 IEPR,” https://chpalliance.org/chp-alliance-responds-to-cecs-request-for-comments-on-the-2022-iepr/.

[173] DOE Office of Energy Efficiency & Renewable Energy, *DOE Industrial Decarbonization Roadmap*, 2022, energy.gov/sites/default/files/2022-09/Industrial%20Decarbonization%20Roadmap.pdf.

4.5.4 Subject Area #11: Queue Reform/Design Inclusive of CHP

The research team literature review of sources in Table 3-1 found documented barriers to CHP in this subject area as far back as 2013.[174] The following sections provide detailed supporting information and supplementary remarks.

4.5.4.1 Detailed Findings and Supporting Citations

The research team found citations supporting one detailed finding in this subject area as follows.

Finding 11-A: CHP may not be explicitly considered when designing queue reforms.

- FERC found that CHP interconnection recommendations submitted in response to the small-generator interconnection agreements and procedure ruling were "beyond the scope of the proceeding" (SGIP, November 2013).

4.5.4.2 Supplementary Remarks

Queue reform is being addressed by many utilities, especially in light of FERC Order No. 2222.

5. CHP INTERCONNECTION MODEL GUIDANCE

This section contains model guidance to overcome the barriers to CHP interconnection identified in Section 4, "Findings." See also Appendix E, which provides additional guidance in light of FERC Order No. 2023[175] and the 2023 IREC MIP,[176] which were published after this report was written.

5.1 MODEL GUIDANCE

State and regulatory bodies, utilities, and system operators can encourage installation of more CHP by considering and/or implementing the model guidance proposed in this section. The 11 sections of the model guidance address each of the 11 subject area findings in Section 4. Each model guidance section beginning with Section 5.1.3 starts with a description of the barriers addressed in that section followed by high-level, then more detailed, model guidance.

5.1.1 Definition

The term *model guidance* used in this report is defined as guidance that establishes minimum requirements for interconnection-related rules and regulations which encourage CHP interconnection. Further, model guidance provides for uniformity, which to some extent relieves authorities of the burden of starting from the beginning when adapting rules for their own jurisdictions.

5.1.2 Intent and Applicability

In accordance with the legislative request, the intended audience for this model guidance is state regulatory authorities and regulated and nonregulated electrical utilities. When utilities and state

[174] Federal Energy Regulatory Commission, RM13-2-000, Order No. 792, *Small Generator Interconnection Agreements and Procedures*, 2013, ferc.gov/sites/default/files/2020-06/RM13-2-000_0.pdf.
[175] Federal Energy Regulatory Commission, RM22-14-000, Order No. 2023, *Improvements to Generator Interconnection Procedures and Agreements,* 2023, www.ferc.gov/media/e-1-order-2023-rm22-14-000.
[176] Interstate Renewable Energy Council Inc, *Model Interconnection Procedures*, 2023, irecusa.org/resources/irec-model-interconnection-procedures-2023/.

regulatory agencies consider how to apply the following model guidance in their services areas, they should consider that the intent of the model guidance is to provide references and citations that can serve as the basis of, or establish minimum requirements for, interconnection regulations that are inclusive of and encourage CHP interconnection. It addresses an extensive set of detailed barriers, which fall into three categories and related subject areas. It is not the intent of this report to prioritize the barriers addressed by the model guidance.

In its approach to developing this model guidance, the research team considered baseline industry-recommended practices for interconnection standards, existing interconnection model rules, or specific practices in certain states. The research supporting this model guidance included discussions with over 20 stakeholder organizations to gain insights into CHP interconnection barriers and baseline industry-recommended practices. The stakeholders included developers, vendors, utility experts, FERC, and DOE CHP Technical Assistance Partnerships. The model guidance considers the following factors as stated in the congressional request:

- Relevant, current standards developed by IEEE (i.e., IEEE 1547-2018) and model codes and rules adopted by states or associations of state regulatory agencies
- The appropriateness of using standards or procedures for interconnection service that vary based on unit size, fuel type, or other relevant characteristics
- The appropriateness of establishing fast-track procedures for interconnection service
- The value of consistency with federal interconnection rules established by FERC
- The best practices used to model outage assumptions and contingencies to determine fees or rates for additional services
- The appropriate duration, magnitude, or usage of demand charge ratchets
- Potential alternative arrangements with respect to the procurement of additional services, including the following:
    - Contracts tailored to individual electric consumers for additional services
    - Procurement of additional services by an electric utility from a competitive market
    - Waivers of fees or rates for additional services for small electric consumers
    - Outcomes such as increased electric reliability, fuel diversification, enhanced power quality, and reduced electric losses that may result from increased use of CHP systems

The model guidance represents the synthesis of essential information obtained from these consultations, factors, and an extensive literature review.[177] In some sections, the model guidance recommends updates to existing model rules and standards applicable to all energy generation including CHP. Additionally, the barrier categories addressed by the model guidance sometimes overlap one another—in some cases a single action, such as updates to interconnection rules and handbooks, could address multiple barriers.

The three categories for the model guidance include topics directly applicable to individual CHP projects (e.g., interconnection) and topics applicable to broader policies such as utility cost recovery mechanisms (e.g., regulatory and policy), which may affect CHP interconnection at the state, grid, and intra- and interagency[178] levels. The model guidance categories and subject areas are listed in Table 5-1.

[177] Those considering whether and how to apply the guidance in their regions must keep in mind that specific items in the guidance may not, in some instances, apply to all regions, states, utilities, and transmission or distribution networks. The model guidance is not broadly representative of every utility service region in the continental United States.
[178] For instance, departments within a utility which are not directly responsible for generator interconnections, such as those responsible for writing export agreements or access tariffs, or nonutility agencies whose approvals intersect with and may affect the timeline of the utility interconnection process

Table 5-1. CHP interconnection model guidance and subject areas

Category	Subject area
Interconnection	Interconnection rules and processes
	Requirements for monitoring, metering, and protection of CHP systems
	Timely interconnection-related upgrade cost guide information and hosting capacity maps
Interconnection tariffs	Standby rates for CHP systems assessed by utilities
	Departing load charges
	Reservation charge design for CHP
	Tariffs for generation export
Regulatory and policy	CHP-specific tracks in regulatory policy documents
	CHP grid support value
	CHP inclusion in grid-forward planning
	Queue reform/design inclusive of CHP

Importantly, individual barriers and specific provisions of the model guidance may apply differently to transmission system or distribution system interconnection.[179] The model guidance is not based on system parameters such as the specific voltage and location of the point of interconnection of the CHP system to the grid (either on the transmission or distribution system). The intent is for state regulatory agencies and utilities to consider the applicability of the specific practices in the model guidance to their jurisdictions. Individual states, regulators, and utilities should carefully think through the applicability of specific provisions of the model guidance that follows based on the jurisdictionally specific safety and reliability considerations for their service areas.

One of the most important recommendations made herein is to initiate the development of up-to-date model rules that incorporate detailed recommendations from existing interconnection model rules to better support CHP interconnection. Although CHP systems can be inverter-based and covered by the same inverter-based standards as PV, most CHP systems are induction- and synchronous-generator systems connected to the electric grid with no inverters, and the treatment of these are especially inconsistent from state to state and utility to utility. To support CHP interconnection, model rules should apply the recommended effective model rule structures, timelines, and screening tests to synchronous and induction-based generators with no inverters in addition to inverter-based machines. Additionally, to the extent possible, state regulatory agencies should synchronize their interconnection rules with best practices per EPAct.[180]

[179] For instance, required interconnection-related upgrade costs may be a lower percentage of overall project costs for larger projects connected to the transmission system than for medium or smaller projects connected to the distribution system and therefore may be less of a barrier for transmission-connected CHP.

[180] Federal Energy Regulatory Commission, *Energy Policy Act of 2005 Fact Sheet,* 2006, ferc.gov/sites/default/files/2020-04/epact-fact-sheet.pdf. EPAct (2005) is known as Public Law 109–58, govinfo.gov/content/pkg/PLAW-109publ58/pdf/PLAW-109publ58.pdf.

Finally, the "High-Level Model Guidance" and "Detailed Model Guidance" subsections within each subject area are not duplicative and are intended to be complementary and considered together.

5.1.3 Model Guidance—Interconnection

Utilities and state regulatory agencies set interconnection rules and processes for all interconnection customers. This includes rules governing interconnection timelines; rules utilities use to size and specify monitoring, metering, and protection requirements for generator interconnection; requirements to provide public access to interconnection information such as via hosting capacity maps; and rules to allocate interconnection-related costs.

Utilities and state regulatory agencies seek input from stakeholders, including CHP developers and owners, in their processes to develop and update interconnection rules. However, utilities and state regulatory agencies make the final decisions as to which provisions of industry standards such as IEEE 1547-2018 to adopt and how to adopt them appropriately to the safety requirements for their grids. Utilities and state regulatory agencies should adopt model guidance that considers the capabilities of current CHP systems and that allows them to adjust requirements while still ensuring the grids are safe and reliable.

5.1.3.1 Interconnection Rules and Processes

Model guidance in this section addresses the following barriers:

- "Prohibitively complex rate, tariff, and interconnect standards were often constructed that have had the implicit effect of limiting the increased capacity of CHP on a national scale."[181]
- Rules-based variability across jurisdictions can delay projects and increase financial uncertainty.
- "The lack of uniform standards for interconnection procedures is due, in part, to the fact that jurisdiction over interconnection is split between the Federal Energy Regulatory Commission (FERC) and the states' utility regulatory body."[182]
- "State interconnection standards vary considerably and can lack language or provisions that encourages interconnection."[183]

IIJA Section 40556 subsections addressed by this subject area
(c)2A, "Current Best Practices"—"relevant current standards developed by the Institute of Electrical and Electronic Engineers"
(c)2B, "Current Best Practices"—"model codes and rules adopted by states or regulatory agencies"
(c)3A, "Factors for Consideration"—"appropriateness of using standards or procedures for interconnection service that vary based on unit size, fuel type, or other"
(c)3B, "Factors for Consideration"—"the appropriateness of establishing fast track procedures for interconnection service"

[181] ACEEE, March 2006

[182] Anna Shipley, Anne Hampson, Bruce Hedman, Patti Garland, and Paul Bautista, ORNL/TM-2008/224, *Combined Heat and Power: Effective Energy Solutions for a Sustainable Future*, ORNL, 2008, info.ornl.gov/sites/publications/files/Pub13655.pdf. As quoted in USEA, August 2011.

[183] DOE Issue Brief, April 2020

High-level model guidance

State regulatory agencies and utilities periodically review and update state-adopted and utility-specific interconnection rules to streamline and modernize the interconnection process. States that have not adopted IEEE 1547-2018 and other standards such as UL 1741 designed to simplify the interconnection of DER projects should leverage their stakeholder processes and adopt these modern, up-to-date interconnection standards. This would provide more timely information to CHP project developers and owners to prove the feasibility of their CHP projects and facilitate funding from investors.

Similarly, states that have not considered developing fast-track processes that apply to generator types other than inverter-based generators should consider doing so to eliminate time-intensive modeling and impact studies where possible while still ensuring grid safety and reliability. Finally, utilities should revise their interconnection rules to allow for consideration of cost-effective alternatives to interconnection requirements. For example, IEEE 1547 allows radio frequency communication, which is more cost-effective than fiber-optic communications infrastructure for DTT control on a project-specific basis. Provided this or other alternatives can deliver safe and reliable service, utilities should present them as an option to interconnection applicants.

Detailed model guidance

The following points provide additional detailed guidance to reduce barriers to CHP interconnection:

- The recommended approach to address these barriers is to convene industry standard working committees (e.g., NARUC, IREC, FERC) to identify conditions for a screening process under which all generators, including CHP technologies, could be included under expedited interconnection rules. State regulatory agencies and utilities could then adapt this guidance to their service areas. The NARUC model rules developed in 2003 were developed with the support of DOE.
- Interconnection rules should provide clear procedures and timelines for dispute resolutions. Differences may arise between a utility and an interconnection applicant regarding aspects such as required studies and protective equipment.[184] Having a clearly defined structure can facilitate efficient and timely resolutions of disputes that arise. IREC MIP Section IV.C provides detailed guidance on a dispute resolution process. The guide outlines necessary timelines and procedures, which include the provision of a notice of dispute by the disputing party, acknowledgement of the notice by the nondisputing party, and the process for resolution. Thus, the guidance allows for dialogue and negotiations between the disputing parties. Additionally, the process uses an ombudsperson for assistance while still following a defined process.
- State regulatory agencies and utilities should look for ways to include an expedited process for interconnecting induction and/or synchronous generators (e.g., CHP) if a review determines that certain conditions are met. This review should have a goal to develop and ensure clarity and consistency in interconnection processes across utilities within a state. It should also seek to identify conditions under which induction or synchronous generators may qualify for expedited interconnection without triggering utility studies, particularly if the project is of smaller capacity and can furnish documentation that indicates it meets utility protective equipment standards.
- State regulatory agencies and utilities should develop interconnection processes that provide more timely access to information throughout the interconnection process. Timely access to information includes (1) access to information about project costs, such as by providing interconnection-related

[184] DOE Issue Brief, April 2020, states, "For example, a utility may request a detailed technical study or perhaps an expensive protection relay or communication system that a customer may view as unnecessary."

upgrade cost guides, and (2) access to information about interconnection application process timelines. Utilities and state regulatory agencies should consider the following points:

    - Provide interconnection-related upgrade unit cost guides to developers.
    - Provide clearly stated expected timelines for CHP interconnection projects, including interconnection study timelines.
    - Provide clearly stated regulatory cost-allocation processes and mechanisms that recognize that upgrade costs should be shared between developers and ratepayers, particularly if the system upgrades are designed to serve more than one customer. This allocation will reduce the financial risk and uncertainty to all generation-project developers including CHP.
    - Adapt existing model interconnection rules and protocols that encourage consistency and transparency. For instance, in Section II.B.1 of the 2019 MIP, IREC recommends a preapplication report that provides critical information to an applicant prior to them submitting a full application. This preapplication includes factors which, when known, could allow an interconnection applicant to judge whether they have selected a potentially constrained utility circuit. These factors include the following:[185]
        - Total megawatt capacity of the substation/area bus or bank and circuit likely to serve the proposed site, along with the available capacity likely to serve the proposed site
        - "…existing or known constraints such as, but not limited to, electrical dependencies at that location, short circuit interrupting capacity issues, power quality or stability issues on the circuit, capacity constraints, or secondary networks"
    - How consistent use of standards such as IEEE 1547-2018 and UL 1741 will streamline the interconnection process by removing misinterpretations of technical requirements such as voltage and frequency requirements, islanding detection, telemetry, and anti-islanding protection, which are referenced in these standards
- State regulatory agencies and utilities should provide informative web-based interconnection businesses processes. This should include web-based interconnection application platforms that explicitly ask for CHP-specific project details such as whether the project is planning to export available electricity generated but not needed by the site. This will streamline the interconnection process by automating the collection of essential project information to the extent possible and will reduce CHP interconnection queue timelines and investment cost uncertainty. State regulatory agencies and utilities should consider staff augmentation or independent third parties, such as the DOE i2X initiative, to manage these application platforms for higher throughput of all interconnection projects.
- In their interconnection applications and in publicly available web-based frequently asked question (FAQ) documents, state regulatory agencies and utilities should identify the external agencies that control certain aspects of CHP interconnection that are outside the utility's control and outside the stated electric utility interconnection target timelines.
- State regulatory agencies should require in their interconnection rules guidance that utilities provide clear milestones and timelines for processing CHP interconnection applications. Utilities should provide timelines for key milestones to developers, such as when they will provide estimated interconnection-related upgrade costs, when they will complete facility studies and system impact studies, and when final interconnection-related upgrade costs will be available. This would help CHP owners and developers plan CHP projects based on realistic expectations for receiving the necessary information from the utility. The model guidance documents from NARUC[186] and IREC[187] offer clearly defined timelines for interconnection application and screening procedures. Both serve as

[185] Interstate Renewable Energy Council Inc, *Model Interconnection Procedures*, 2019, irecusa.org/resources/irec-model-interconnection-procedures-2019/.
[186] Recommended time guidelines for the application process and interconnection reviews are outlined in Sections I–III in the NARUC *Model Interconnection Procedures and Agreement for Small Distributed Generation Resources.*
[187] Recommended time guidelines for the application process and interconnection reviews are outlined in Sections II and III of the 2019 *Model Interconnection Procedures* by IREC.

examples of guidance documents that establish specific timeframes that can add more clarity to the interconnection process for CHP projects.

5.1.3.2 Requirements for Monitoring, Metering, and Protection of CHP Systems

Model guidance in this section addresses the following barriers:

- Initial design of utility protection requirements for grid safety and reliability may overestimate the equipment required (e.g., due to early assumptions made in the absence of required information) and thus increase the estimated interconnection-related costs to such an extent that the project appears infeasible.
- Utilities and IEEE-recommended standards require a utility protection scheme, such as DTT and associated protective relays, when interconnecting synchronous CHP generators to ensure the electric grid will not be inadvertently energized when the grid must remain de-energized for the safety of utility workers and the general public.[188] Utilities must determine on a case-by-case basis whether a CHP system meets the protection requirements for the point of interconnection. It is important to note that DTT permits the CHP to operate, providing continuous power to the host customer during a utility power outage. The cost of protective equipment such as DTT and the associated relays could be a significant barrier to CHP systems with substantial costs large enough to potentially affect the feasibility of the project; however, protective equipment is necessary.[189]
- Interconnection studies are used to determine what additional utility and IEEE requirements may be necessary for the safe interconnection of the CHP unit. However necessary, these studies can discourage CHP by increasing costs. The added cost of the interconnection study and the time to complete the study and inform the developer of the results may render the project infeasible within the original cost estimate and timeline.

IIJA Section 40556 subsections addressed by this subject area
(c)2A, "Current Best Practices"—"relevant current standards developed by the Institute of Electrical and Electronic Engineers"
(c)2B, "Current Best Practices"—"model codes and rules adopted by states or regulatory agencies"
(c)3A, "Factors for Consideration"—"appropriateness of using standards or procedures for interconnection service that vary based on unit size, fuel type, or other"

High-level model guidance

State regulatory agencies and utilities should revise interconnection rules so that metering and protection requirements are consistent with the most cost-effective IEEE 1547-2018-compliant requirements that will ensure grid safety and reliability for all resource additions. For instance, some utilities selectively apply the recommended standards in IEEE 1547-2018 using lower-cost methods and do not require DTT for all sizes of generation, instead relying on supervisory control and data acquisition system scripts to perform protection functions, resulting in lower costs.

Some CHP systems may contain onboard protection equipment that satisfies utility safety requirements without additional DTT and protective relays specified by the utility. If the CHP developer can demonstrate the CHP system has sufficient protective equipment, the utility could—through review of as-installed, as-commissioned system settings and specifications (i.e., equipment not requiring material

[188] National Renewable Energy Laboratory, *Current Solutions: Recent Experience in Interconnecting Distributed Energy Resources*, Sentech, 2003.
[189] Pacific Gas and Electric, *Anti-Islanding Guide*, 2022.

modifications), type testing, or witness testing—allow the CHP interconnection customer to demonstrate safety and reliability. Certification of CHP protective equipment through type testing based on IEEE or other industry-based standards would reduce barriers to CHP.

The development of low-cost monitoring, metering, and protection methods should include methods applicable to all three types of CHP systems (synchronous, induction, and inverter based). Further, state regulatory agencies and utilities should consider whether some interconnection-related upgrades to electric metering of CHP systems, which are required to monitor grid conditions, could justifiably seek utility rate-base treatment as necessary equipment for a modern grid. This alternative to allocating the full cost of such required equipment to individual interconnecting customers would encourage CHP interconnection by reducing interconnection-related costs. Reducing costs makes it easier to demonstrate the feasibility of CHP business cases to investors. (See also the "Regulatory and Policy" section).

Additionally, utilities should provide clear timelines for processing CHP interconnection applications, including the time needed to address requirements for monitoring, metering, and protection equipment. This will allow CHP owners and developers to use realistic timelines for confirming project feasibility to investors based on having received the necessary information from the utility.

Detailed model guidance

The following points provide additional detailed guidance to reduce barriers to CHP interconnection in this area:

- To ensure monitoring, metering, telemetry, and protection requirements are appropriately established, state regulatory agencies and utilities should ensure existing rules reference the industry standards (IEEE 1547 and UL 1741) and are tailored to the requirements for CHP systems based on the type of generator (inverter, induction, synchronous), generation size, and operational characteristics, including specifications for protective relaying that would enable certain CHP to qualify for expedited treatment. These rules and standards should, through a stakeholder process in consultation with industry experts, allow for CHP systems to deploy utility-preapproved protection equipment as an anti-islanding protection alternative to DTT.
- Utilities should review their minimum import requirements for CHP systems to ensure they are based on sound engineering practices to allow CHP systems to operate as efficiently as possible while maintaining safety.
- As may be consistent with IEEE 1547, state regulatory agencies and utilities should allow for data-driven decision-making in sizing monitoring, metering, and protection for CHP generator interconnections. State regulatory agencies could update interconnection rules and standards to inform cost estimations and streamline interconnection studies by establishing a screening process that would permit exemptions from interconnection studies, where feasible, for projects that are inverter based and/or have smaller nameplate capacities and protective relaying documentation that meet utility criteria.
- SGIP[190] Section 4.10.3 allows for defining a limit on capacity below the nameplate maximum capacity of a generator provided the "Interconnection Customer…obtain[s] the Transmission Provider's agreement, with such agreement not to be unreasonably withheld."[191] This section could be

[190] FERC small-generator interconnection procedures guideline for generating facilities no larger than 20 MW. Federal Energy Regulatory Commission, *Small Generator Interconnection Procedures,* last updated 2018, ferc.gov/sites/default/files/2020-04/sm-gen-procedures.pdf.
[191] FERC SGIP Section 4.10.3 states: "The Interconnection Request shall be evaluated using the maximum capacity that the Small Generating Facility is capable of injecting into the Transmission Provider's electric system. However, if the maximum capacity that the Small Generating Facility is capable of injecting into the Transmission Provider's electric system is limited

modified to mention CHPs explicitly and require limiting equipment (or determine certified limiting equipment) so that a maximum capacity below the nameplate capacity can be transparently and clearly communicated and considered by transmission operators and utilities.
- IEEE should establish a technical type-testing industry standard addressing protective relaying and associated equipment to foster expedited interconnection of induction and synchronous machines.

5.1.3.3 Timely Interconnection-Related Upgrade Cost Guide Information and Hosting Capacity Maps

Model guidance in this section addresses the following barriers:

- Timelines to complete feasibility and system impact studies and calculate system upgrade costs for CHP projects are not clearly established in interconnection rules, causing delays and financial uncertainty.
- Uncertainty in the interconnection process and inability to access needed information can cause delays and affect funding decisions.

IIJA Section 40556 subsections addressed by this subject area
(c)2A, "Current Best Practices"—"relevant current standards developed by the Institute of Electrical and Electronic Engineers"
(c)2B, "Current Best Practices"—"model codes and rules adopted by states or regulatory agencies"
(c)3A, "Factors for Consideration"—"appropriateness of using standards or procedures for interconnection service that vary based on unit size, fuel type, or other"

High-level model guidance

State regulatory agencies and utilities should update interconnection rules to require publicly available, clear, and transparent interconnection-related upgrade unit cost guides and hosting capacity information. For instance, some utilities include circuit-level queue status information (i.e., the capacity in the interconnection queue for that circuit) in their public-facing hosting capacity maps, and several provide unit cost guides and online calculators to help interconnection customers calculate likely interconnection costs for a prospective interconnection location. Additionally, state regulatory agencies and utilities should consider including a section of the rules that explicitly addresses CHP projects so that CHP interconnection customers have a clear understanding of specific timelines that may affect CHP projects.

Detailed model guidance

The following points provide additional detailed guidance to reduce barriers to CHP interconnection in this area:

- State regulatory agencies should review interconnection rules and develop access-to-information guidance that provides more transparency in hosting capacity and interconnection-related upgrade

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(e.g., through use of a control system, power relay(s), or other similar device settings or adjustments), then the Interconnection Customer must obtain the Transmission Provider's agreement, with such agreement not to be unreasonably withheld, that the manner in which the Interconnection Customer proposes to implement such a limit will not adversely affect the safety and reliability of the Transmission Provider's system. If the Transmission Provider does not so agree, then the Interconnection Request must be withdrawn or revised to specify the maximum capacity that the Small Generating Facility is capable of injecting into the Transmission Provider's electric system without such limitations. Furthermore, nothing in this section shall prevent a Transmission Provider from considering an output higher than the limited output, if appropriate, when evaluating system protection impacts."

costs triggered by individual interconnection projects. This will streamline the interconnection process for both the utility and CHP developers and ensure clarity and consistency in interconnection across all utilities in a state. For instance, requiring that available hosting capacity, circuit-level queue status, and interconnection-related upgrade unit costs be made publicly available would allow the developer to modify its project design and business plan prior to submitting its application, reducing iterations with the utility and associated wait times. Information on hosting capacity and interconnection-related upgrade costs (e.g., unit cost guides) must be readily available and transparent in the early stages of project development to inform project decisions appropriately.

- As previously mentioned, state regulatory agencies and utilities should adapt existing interconnection rules with model interconnection protocols that encourage consistency and transparency across utilities and across state lines relative to the availability of information on interconnection-related upgrade costs and hosting capacity. For instance, in Section II.B.1 of the 2019 MIP, IREC recommends a preapplication report that provides critical information to an applicant prior to them submitting a full application. Furthermore, the model guidance states the following:

  > …some utilities are now publishing publicly available maps of their systems, which provide basic information such as line voltage and capacity at specific points on the systems, or even offer actual calculated hosting capacity for each node. Adoption of mapping tools enable customers to get information without requiring utility staff time and can reduce the number of requests for Pre-Application Reports.

  The availability of such information will help reduce the amount of work required to retrieve that information and will allow for applicants to plan and design their projects more effectively and efficiently.
- State regulatory agencies and utilities could update their model rules[192] to recommend hosting capacity maps. This would reduce the time needed for the application process and provide the opportunity for the developers to identify locations with high potential for CHP systems prior to submitting applications or preapplications to utilities.
- State regulatory agencies and utilities should standardize the information provided on hosting capacity maps and preapplication reports and the update frequency of hosting capacity map data based on available guidance such as from the NREL and IREC 2019 MIP. This will allow CHP developers to make timely, informed project decisions. [193] [194]

5.1.4 Model Guidance—Interconnection Tariffs

Interconnection tariffs and fees are often a point of contention between the utility and CHP consumer. CHP developers believe that regulators lack understanding of CHP systems, which leads to missed

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[192] Such as the FERC SGIP generator interconnection guideline for generating facilities no larger than 20 MW, Section 1.2.2, or other model guidance frameworks. Federal Energy Regulatory Commission, *Small Generator Interconnection Procedures,* §1.2.2, last updated 2018, ferc.gov/sites/default/files/2020-04/sm-gen-procedures.pdf.

[193] National Renewable Energy Lab and Interstate Renewable Energy Council, *Data Validation for Hosting Capacity Analyses,* 2022, nrel.gov/docs/fy22osti/81811.pdf.

[194] Sources include the following web resources, accessed March 14, 2023:
National Renewable Energy Lab, "Advanced Hosting Capacity Analysis," nrel.gov/solar/market-research-analysis/advanced-hosting-capacity-analysis.html.
National Renewable Energy Lab, "Advanced Hosting Capacity Analysis Data Validation," nrel.gov/grid/hosting-capacity-analysis-data-validation.html, nrel.gov/docs/fy22osti/82450.pdf.
National Renewable Energy Lab, "NREL and IREC Identify Best Practices for Validating Hosting Capacity Analyses," nrel.gov/news/program/2022/nrel-and-irec-identify-best-practices-for-validating-hosting-capacity-analyses.html;
Interstate Renewable Energy Council, "Hosting Capacity Analysis," irecusa.org/our-work/hosting-capacity-analysis/.
National Renewable Energy Lab and Interstate Renewable Energy Council, *Data Validation for Hosting Capacity Analyses,* 2022, nrel.gov/docs/fy22osti/81811.pdf.
Interstate Renewable Energy Council, *Key Decisions for Hosting Capacity Analyses,* 2021, p. 8, irecusa.org/resources/key-decisions-for-hosting-capacity-analyses/, irecusa.org/resources/irec-model-interconnection-procedures-2019/.

opportunities for standardizing energy policy and determining equitable charge methodologies that reflect the value of CHP to both utilities and utility customers.

Utilities and state regulatory agencies generally determine and set tariffs and avoided costs rates. Only regulators and utilities can change how utilities assess rates or whether utilities are open to negotiating with CHP owners on a facility-specific basis—CHP developers and owners do not have the authority to renegotiate how these are implemented. Furthermore, federal laws and regulations that may address export tariffs (e.g., PURPA and FERC Order No. 872) are beyond the control of CHP developers.

Collaboration among stakeholders and possible standardization of the aforementioned charges are unlikely without independent third-party model guidance. Therefore, model guidance concerning uniform tariff application is needed for consideration by utilities and state regulatory agencies.

5.1.4.1 Standby Rates for CHP Systems Assessed by Utilities

Model guidance in this section addresses the following barriers:

- Complexity of rates and tariffs can limit increasing CHP capacity.
- Standby rate structures developed by utilities can negatively affect the financial viability and economics of CHP projects.
- Demand ratchets may disincentivize CHP.
- Demand charges may not account for periods when utility requirements for a CHP system are low.

IIJA Section 40556 subsections addressed by this subject area
(b)2A, "Inclusion"—"ensuring adequate cost recovery by an electric utility for interconnection service and additional services"
(c)3D, "Factors for Consideration"—"the best practices used to model outage assumptions and contingencies to determine fees or rates for additional services"
(c)3E, "Factors for Consideration"—"the appropriate duration, magnitude, or usage of demand charge ratchets"
(c)3F, "Factors for Consideration"—"potential alternative arrangements with respect to the procurement of additional services, contracts tailored to individual electric consumers for additional services, procurement of additional services by an electric utility, waivers of fees or rates for additional services for small electric consumers"

High-level model guidance

Regulatory agencies and utilities should increase transparency and reduce the complexity of standby rates and tariffs by providing publicly available (i.e., posted on utility websites), clear, and transparent interpretations of the structures used in developing existing standby rates and tariff structures. Utilities should provide customer service web-based mailboxes to enable easier communication regarding rates and tariffs. Further, as already provided by some utilities,[195] standby rate bill calculator tools should be provided.

To overcome barriers associated with standby rates, state regulatory agencies and utilities should establish a new standardized framework for assessing and applying standby rates and tariffs consistently across all utilities within the same regulatory jurisdiction or state.

[195] "Program Profile: Ameren Missouri's Bill Calculator Tool," CHP Technical Assistance Partnerships, chptap.ornl.gov/profile/10/MissouriAmerenStandbyBillCalculator-Profile.pdf.

Updates to how utilities structure and apply rates could encourage CHP interconnection by improving CHP project economics in some utility service areas. Utilities should update rate structures and demand charges regularly (e.g., every 3 years) to ensure rates remain equitable as the grid continues to evolve in response to the increasing presence of intermittent renewables, energy storage, and electrification. Utilities should modernize their rate structures by updating calculation methodologies to consider the actual operation of CHP systems and not a worst-case scenario.

States and utilities should revise interconnection rules that discourage net-metering of fossil fuel–based resources to exclude CHP when banning natural gas equipment. CHP systems are highly efficient, can support net decarbonization today, and can be ready to use low- and zero-carbon fuels efficiently in the future.

Detailed model guidance

The following points provide additional detailed guidance to reduce barriers to CHP interconnection in this area:

- To reduce CHP barriers due to standby rate complexity and make rate structures clear to CHP owners, state regulatory agencies and utilities should do the following:
  - Provide clear and transparent interpretation of rate and tariff structures with detailed guidance on how to calculate the rates and tariffs for different scenarios. Transparency will improve the ability of CHP developers to forecast costs, secure funding from investors, and advance CHP projects in the queue more efficiently.
  - Establish standardized structures for rates and tariffs across all utilities to enable CHP developers and owners to streamline their business processes. A standardized rate structure with a consistent methodology for modeling CHP outages, for instance, will eliminate the requirement to explore and understand differing rates' impacts for each utility.
  - Provide a web-based FAQ document on standby rates and assign a customer service mailbox to enable utilities and CHP owners and developers to communicate regarding rates and tariffs.
  - Provide an online bill calculator to help navigate the complexity of standby rates.
- To ensure consistent economic treatment of CHP projects, states, regulatory agencies, and utilities should adopt the following baseline industry-recommended practices:
  - Review and update regularly (e.g., every 3 years) methodologies and model assumptions used to calculate incurred cost on the grid due to CHP systems (e.g., from generation reserves, transmission, and distribution costs). This will ensure that standby rates evolve with changes to the grid and energy markets and that they are fair and justified. Utilities should not calculate standby rates solely based on a worst-case scenario, which results in rates that are unjustified based on the actual operation of the CHP system.

    For example, standby rates should not be calculated solely based on an unjustified assumption that an outage would occur when it is most expensive to provide backup power. The utility should consider the actual CHP system performance over a period (e.g., 1 year).
  - Reevaluate standby rates that have not been recently updated to ensure the rate structure treats scheduled and unscheduled outages separately. Utilities and CHP owners can coordinate and plan for scheduled maintenance outages; therefore, treating scheduled and forced outages the same when determining standby rates may not be justified. Moreover, utilities should treat outages in peak and nonpeak hours differently considering that the costs of backup generation during these periods can differ dramatically.
- Regulatory agencies, utilities, subject matter experts, and developers should collaborate in a moderated environment to establish standardized, justifiable rates and tariff structures.

- Regulatory agencies and utilities should modify or eliminate demand ratchets from CHP rate structures if they cannot be justified. The normal load level of a grid-connected CHP customer and its peak billing demand can differ significantly because CHP is sized to serve loads behind the meter but may sometimes go offline for maintenance, in which case customer power is fully supplied by the grid. Through ratchet demand billing, a utility uses a high percentage of a CHP owner's highest demand for billing, and this percentage remains the basis of the billing calculation for a relatively long period. Applying ratchet rates to CHP because of one unscheduled 15 min outage may not be justifiable. Additionally, the CHP owner can plan CHP system maintenance with the utility in advance; therefore, maintenance outages should not represent an unknowable, random risk to deliverability and grid reliability. As for unscheduled outages, unless a CHP site is experiencing regular outages that are creating wide swings in demand, justifying a demand ratchet is difficult. Using prorated, hourly, or daily as-used charges to recover utility costs that result from an outage would be a baseline industry-recommended practice.

5.1.4.2 Departing Load Charges

Model guidance in this section addresses departing load charges.

IIJA Section 40556 subsections addressed by this subject area
(b)2A, "Inclusion"—"ensuring adequate cost recovery by an electric utility for interconnection service and additional services"
(c)3F, "Factors for Consideration"—"potential alternative arrangements with respect to the procurement of additional services, contracts tailored to individual electric consumers for additional services, procurement of additional services by an electric utility, waivers of fees or rates for additional services for small electric consumers"

High-level model guidance

State regulatory agencies and utilities should investigate the approach, assumptions, and data used to justify departing load charges regularly.

Detailed model guidance

States, regulatory agencies, and utilities should regularly (e.g., every 3 years) review the methodology, assumptions, and data used to calculate departing load charges imposed on CHP and other DER projects to ensure they are still correct and that no alternative cost recovery mechanisms could be considered, developed, and implemented.

5.1.4.3 Reservation Charge Design for CHP

Model guidance in this section addresses reservation charges.

IIJA Section 40556 subsections addressed by this subject area
(b)2A, "Inclusion"—"ensuring adequate cost recovery by an electric utility for interconnection service and additional services"
(c)3F, "Factors for Consideration"—"potential alternative arrangements with respect to the procurement of additional services, contracts tailored to individual electric consumers for additional services, procurement of additional services by an electric utility, waivers of fees or rates for additional services for small electric consumers"

High-level model guidance

Utilities should review and update the methodologies for all resource additions they use to determine reservation charges for CHP projects regularly (e.g., every 3 years) to ensure they remain justifiable.

Detailed model guidance

The following points provide additional detailed guidance to reduce barriers to CHP interconnection in this area:

- Utilities should consider the following to prevent reservation charges from creating a financial barrier for CHP projects:
  - Utilities should review and update the methodologies used to determine reservation charges for CHP projects regularly (e.g., every 3 years).
  - Utilities should base demand charges for CHP on a CHP system's impact on the utility. Thus, demand charges for CHP should be based on the system's outage history or should be based on prorated hourly or daily as-used charges to recover utility costs that result from an outage. In the CHP system's first year, utilities should use standard forced-outage rates for similar generators. Utilities may also use the otherwise applicable tariffs, with the demand charge based on actual demand that includes the impact of the CHP unit so that the customer sees a higher demand charge in months when the CHP was down during peak periods and lower charges when the CHP was down during off-peak periods or not down at all during the month. These options are baseline industry-recommended best practices that utilities should incorporate in lieu of reservation charges to recover utility costs that result from an outage.
- Regulatory agencies and utilities should create alternate energy, capacity, and ancillary service pricing structures (e.g., dynamic pricing) such that when reservation charges are justifiable, CHP projects are still feasible because of other value streams.

5.1.4.4 Tariffs for Generation Export

Model guidance in this section addresses the following barriers:

- There is a lack of net-metering provisions for CHP; in some instances, net metering is not allowed, creating a financial barrier for CHP projects.
- Opportunity for revenue generation by QFs may be limited by FERC Order No. 872[196] and cogeneration requirements in PURPA.[197]

IIJA Section 40556 subsections addressed by this subject area
(b)2A, "Inclusion"—"ensuring adequate cost recovery by an electric utility for interconnection service and additional services"
(c)3F, "Factors for Consideration"—"potential alternative arrangements with respect to the procurement of additional services, contracts tailored to individual electric consumers for additional services, procurement of additional services by an electric utility, waivers of fees or rates for additional services for small electric consumers"

[196] "Grant states the flexibility to set 'as available' QF energy rates," Federal Energy Regulatory Commission, *PURPA Fact Sheet,* 2020, ferc.gov/sites/default/files/2020-07/07-2020-E-1-PURPA-fact-sheet.pdf.
[197] See Federal Energy Regulatory Commission, *PURPA Fact Sheet,* 2020, ferc.gov/sites/default/files/2020-07/07-2020-E-1-PURPA-fact-sheet.pdf, and 18 CFR §292.205, "Criteria for Qualifying Cogeneration Facilities," *Code of Federal Regulations*, Title 18, *Conservation of Power and Water Resources,* ecfr.gov/current/title-18/chapter-I/subchapter-K/part-292/subpart-B/section-292.205.

High-level model guidance

Utilities and regulators can develop pathways for additional revenue generation for CHP, such as participating in wholesale or retail markets, or by creating programs and incentives that encourage CHP export in support of grid flexibility and resilience. Furthermore, utilities and regulatory agencies should review and evaluate current interconnection regulations and tariffs that may discourage CHP deployment.

Detailed model guidance

The following points provide additional detailed guidance to reduce barriers to CHP interconnection in this area:

- Regulatory agencies and utilities should evaluate and amend tariffs, agreements, and programs such as net metering and adopt a compensation framework that considers the benefits CHP provides to energy infrastructure resilience and reliability, utility customers, and society.
- Regulatory agencies and utilities should reform interconnection tariffs to monetize the value of CHP projects servicing the grid by allowing them to participate in capacity, energy, and ancillary markets such as through distribution tariffs and net metering.
- FERC should review PURPA and FERC Order No. 872 considering new developments in the CHP industry such as inverter-based CHP (currently up to about 125 kW, with research underway for larger inverters) to understand the conditions under which these orders may discourage CHP projects, such as by limiting the opportunity for revenue generation for cogeneration QFs.
- Utilities, states, and regulators should develop programs and financial incentives to encourage CHP export that would be beneficial on distribution circuits, which have a high penetration of intermittent DER with few energy storage resources in close electrical proximity to provide reliable service.[198]

5.1.5 Model Guidance—Regulatory and Policy

Because CHP systems are connected to the distribution grid and are typically under state jurisdictions, FERC sometimes has limited authority over interconnection rules governing CHP. Only state regulatory agencies and utilities can change policies to clarify required coordination across multiple agencies for CHP projects. State regulatory agencies and utilities primarily determine regulatory and policy-development activities such as integrated DER planning and the management of the interconnection queue process, both of which may leverage CHP as a grid support and flexibility resource to reduce or defer interconnection-related upgrade costs.[199] In the case of transmission and wholesale market agreements, FERC determines market mechanisms that enable CHP systems to access markets. Therefore, to unlock the benefits of CHP to support an evolving grid, state regulatory agencies, utilities, and FERC should consider model guidance pertaining to CHP grid support valuation.[200]

This suggests the need for a streamlined and collaborative approach to create CHP-specific tracks in policy that considers the barriers identified in this report, in addition to the appropriate delegation of responsibilities for authoritative roles to allow for timely project processing. State regulatory agencies,

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[198] For instance, although some developers suggest that interconnection of CHP projects under 5 MW nameplate should be standardized, and FERC considers cogeneration projects under 5 MW to meet the requirements for a facility seeking to "sell electric energy pursuant to Section 210 of the Public Utility Regulatory Policies Act of 1978, 16 U.S.C. 824a-1," utilities and regulatory agencies should consider whether such a CHP facility could participate in retail markets or in a wholesale market under FERC Order No. 2222.

[199] Although developers may proactively group projects within adjacent circuits, the management of the queue process is determined and implemented by regulators and utilities.

[200] For instance, FERC suggested that in order for synchronous generation resources to provide voltage support distribution, utilities would need to develop procedures, methods, and thresholds used for compensation.

clean energy planners, and FERC should assess and document the value of implementing CHP-specific tracks in regulatory policy documents. CHP developers and owners cannot initiate this activity.

5.1.5.1 CHP-Specific Tracks in Regulatory Documents

Model guidance in this section addresses the following barriers:

- CHP is often not accounted for in interconnection rules and handbooks.
- CHP is absent from regulatory dialogue.

IIJA Section 40556 subsections addressed by this subject area
(c)2B, "Current Best Practices"—"model codes and rules adopted by states or regulatory agencies"
(c)3C, "Factors for Consideration"—"the value of consistency with Federal interconnection rules established by FERC"

High-level model guidance

To encourage the interconnection of more CHP generation, state regulatory agencies and utilities should collaborate to review and evaluate tracking of CHP projects in regulatory documents. Such collaboration will facilitate the consideration and integration of CHP within future and existing interconnection rules, rulemaking procedures, and existing regulatory documents. This will ensure a complete inventory of all types of generation resources is accounted for in interconnection policy. In addition to improved collaborative efforts, interconnection standards need to outline requirements clearly for smaller-capacity induction- or synchronous-generator CHP.

Detailed model guidance

The following points provide additional detailed guidance to reduce barriers to CHP interconnection in this area:

- State regulatory agencies and utilities should undertake a stakeholder process to investigate how they could include an expedited review of smaller induction- or synchronous-generator CHP systems that meet certain protection standards in interconnection rules and associated interconnection business process handbooks while maintaining grid safety and reliability.
- State regulatory agencies should direct utilities to create CHP-specific tracks in web-based application processes with clear requirements categorized by ranges of nameplate capacities and technology type.
- State regulatory agencies should facilitate a stakeholder-engagement process for addressing barriers to CHP. The goal of the stakeholder process is to consider addressing all CHP-related processes explicitly in existing interconnection application processes and related documents. This includes, for instance, regulators, system operators, and utilities specifying how they will study CHP projects included within a DERA under FERC Order No. 2222 with other generators in an aggregation, including intermittent generators such as wind and solar.

5.1.5.2 CHP Grid Support Value

Model guidance in this section addresses the following barriers:

- Electricity markets do not fully monetize or recognize the benefits of grid support from CHP systems.

- Utilities do not fully recognize benefits of grid support from CHP as part of their planning portfolio evaluations.

High-level model guidance

To realize the value of CHP to support and enhance grid resilience, state regulatory agencies and utilities must establish processes to assess CHP value streams and create pathways to incentivize CHP grid support.

Detailed model guidance

The following points provide additional detailed guidance to reduce barriers to CHP interconnection in this area:

- State regulatory agencies should establish a cost-allocation structure for CHP that reflects its grid support value for resource adequacy, reliability, and resilience.
- State regulatory agencies and utilities should compare the CHP market value with solar and other intermittent renewables' market values in grid-forward planning and integrated distribution/DER plans. Compared with solar and other intermittent renewables, CHP may have a higher value rating in markets because it has a higher capacity factor. An objective evaluation of all resources on the same footing could increase the actual value of CHP. Additionally, such evaluation could be tied to incentives eligibility or favorable regulatory treatment such as net metering or compensation for exported generation as a positive resource to support decarbonization mandates.
- State regulatory agencies should establish clear and transparent measurement and verification protocols to measure the services provided by CHP to the grid accurately. The services provided to the grid should be factored into the billing and settlement paid to the CHP operators. Furthermore, state regulatory agencies and utilities developing methods to value CHP grid support should consider the benefits of exported generation from CHP. For example, CHP exported generation used within the same area of the transmission and distribution system will save on transmission and distribution line losses,[201] and compensation structures should be adjusted accordingly.
- State regulatory agencies, utilities, and system operators should implement transmission and distribution management systems that can utilize the services that CHPs can provide for voltage and frequency regulation support.
- Through monetization and incentives, state regulatory agencies, utilities, and system operators should recognize the value of synchronous and induction CHP in increasing grid inertia, which will be essential in the low-inertia grid that will result from high penetration of inverter-based resources.
- State regulatory agencies, utilities, and system operators should review and update the current framework to evaluate the full range of impacts resulting from DERs, including CHP. Resources such as the *National Standard Practice Manual for Benefit-Cost Analysis of Distributed Energy Resources*[202] and the EPA CHP project development process[203] provide frameworks for assessing and evaluating CHP system benefits. NARUC states in Section III.D.5. of its *Model Interconnection Procedures and Agreement for Small Distributed Generation Resources*, "If the Small Resource was invited or otherwise selected to provide benefits to the Interconnection Provider's system, costs

[201] The US Energy Information Administration estimates that annual electricity transmission and distribution losses averaged about 5% of the electricity transmitted and distributed in the United States in 2017 through 2021. "Frequently Asked Questions," US Energy Information Administration, eia.gov/tools/faqs/faq.php?id=105&t=3#:~:text=The%20U.S.%20Energy%20Information%20Administration,States%20in%202017%20through%202021.

[202] National Energy Screening Project, *The National Standard Practice Manual*, nationalenergyscreeningproject.org/national-standard-practice-manual/.

[203] US Environmental Protection Agency, "CHP Project Development Steps," epa.gov/chp/chp-project-development-steps.

charged to the interconnection Customer will be reduced commensurate with such benefit. Benefits must be measurable and verifiable." Therefore, efforts toward assessing and evaluating the benefits of CHP should aim to clarify the value proposition of CHP and define quantifiable and verifiable metrics when practical.

- FERC should review the market design to ensure fair access of CHP to the grid and opportunities to provide energy and capacity in wholesale markets.
- State regulatory agencies and utilities should clarify future requirements and eligibility of CHP for market participation through initiatives and policy (e.g., FERC Order No. 2222) in their interconnection rules and associated handbooks. Considering CHP systems can provide ancillary services, CHP developers should be given information on opportunities in both wholesale and retail markets. FERC should continue to act as necessary to remove barriers in FERC Order No. 2222 implementation to CHP participating in DERAs, such as barriers created by RTO/ISO implementation rules, and should specifically examine the participation of CHP within its Order No. 2222–compliance proceedings to identify potential remaining barriers.

5.1.5.3 CHP Inclusion in Grid-Forward Planning

Model guidance in this section addresses the following barriers:

- There is a lack of financial incentives and support for the development of CHP projects.
- State regulatory agencies may not fully consider the value of CHP in integrated resource planning.

IIJA Section 40556 subsections addressed by this subject area
(b)2B, "Inclusion"—"ensuring adequate cost recovery by an electric utility for interconnection service and additional services"
(c)2B, "Current Best Practices"—"model codes and rules adopted by states or regulatory agencies"
(c)3F, "Factors for Consideration"—"potential alternative arrangements with respect to the procurement of additional services, contracts tailored to individual electric consumers for additional services, procurement of additional services by an electric utility, waivers of fees or rates for additional services for small electric consumers"
(c)3G, "Factors for Consideration"—"outcomes such as increased electric reliability, fuel diversification, enhanced power quality, and reduced electric losses that may result from increased use of combined heat and power systems and waste heat-to-power systems"

High-level model guidance

For state regulatory agencies and utilities to optimize CHP in grid planning, collaboration among all CHP stakeholders, including beneficiaries of grid-forward investments, is needed. All stakeholders should evaluate opportunities where CHP could be an integral component of the future decarbonized grid.

Detailed model guidance

The following points provide additional detailed guidance to reduce barriers to CHP interconnection in this area:

- State regulatory agencies should establish collaborative stakeholder forums to raise awareness of the key role of CHP in grid reliability.
  - Deploying knowledge-exchange programs similar to those offered by DOE (e.g., i2X) will encourage discussion on CHP-related codes and standards, provide stakeholders with up-to-date

information supporting informed decisions, and result in strategic roadmaps that include more CHP interconnection. CHP developers will be able to interconnect more CHP when all stakeholders have a clearer understanding of how modern CHP systems can serve as a grid resource.

- State regulatory agencies, utilities, and transmission system operators should incentivize CHP facilities with market agreements they design to support grid flexibility and help achieve state and local clean energy or environmental goals.
- State regulatory agencies, utilities, and transmission system operators should develop or adopt baseline industry-recommended practice to assess, evaluate, and quantify benefits provided to the grid by CHP.
- State interconnection rules should provide a process by which interconnection-related upgrade costs are not borne by a single interconnection project if the interconnection-related upgrade can serve multiple customers. This will ease the capital cost burden of interconnection-related upgrades applied to CHP systems. The FERC NOPR on the SGIP and LGIP proposed provisions to address this issue, and if these are included in final rules, states should review their rules for potential modifications to adopt provisions related to the allocation of interconnection-related upgrade costs.

5.1.5.4 Queue Reform/Design Inclusive of CHP

Model guidance in this section addresses queue reform inclusive of CHP.

IIJA Section 40556 subsections addressed by this subject area
(c)2B, "Current Best Practices"—"model codes and rules adopted by states or regulatory agencies"
(c)3F, "Factors for Consideration"—"potential alternative arrangements with respect to the procurement of additional services, contracts tailored to individual electric consumers for additional services, procurement of additional services by an electric utility, waivers of fees or rates for additional services for small electric consumers"

High-level model guidance

State regulatory agencies, utilities, and stakeholders overseeing queue reform processes should investigate how to include CHP explicitly in queue reform design where CHP grid support services may allow for the reduction or deferment of interconnection-related upgrade costs. This will promote additional CHP interconnection that will support grid integrity and improve the reliability of the grid.

Detailed model guidance

The following points provide additional detailed guidance to reduce barriers to CHP interconnection in this area:

- State regulatory agencies, utilities, and stakeholders including nonprofit organizations, subject matter experts, and consultants should implement innovative approaches to interconnection queue management and cost allocation that leverage CHP to potentially reduce or defer interconnection-related upgrade costs. This approach to defer interconnection-related upgrades is commonly known as *non-wires alternatives*.
- State regulatory agencies and utilities can more fully realize the positive impacts of modern CHP systems on grid flexibility, resilience, and power reliability by studying them alongside existing operational facilities, interconnection-related upgrades, and other DERs in the interconnection queue.

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APPENDIX A. LEGISLATIVE LANGUAGE

The research team prepared this study in response to Section 40556 of the Infrastructure Investment and Jobs Act (IIJA) (Public Law 117–58). Section 40556 is titled, "Model Guidance for Combined Heat and Power Systems and Waste Heat-to-Power Systems," wherein it is stated:

(a) Definitions—In this section:

(1) Additional Services—The term ''additional services'' means the provision of supplementary power, backup or standby power, maintenance power, or interruptible power to an electric consumer by an electric utility.

(2) Waste Heat-To-Power System—The term ''waste heat-to-power system'' means a system that generates electricity through the recovery of waste energy.

(3) Other Terms—

(A) PURPA—The terms ''electric consumer'', ''electric utility'', ''interconnection service'', ''nonregulated electric utility'', and ''State regulatory authority'' have the meanings given those terms in the Public Utility Regulatory Policies Act of 1978 (16 U.S.C. 2601 et seq.), within the meaning of title I of that Act (16 U.S.C. 2611 et seq.).

(B) EPCA—The terms ''combined heat and power system'' and ''waste energy'' have the meanings given those terms in section 371 of the Energy Policy and Conservation Act (42 U.S.C. 6341).

(b) Review—

(1) In General—Not later than 180 days after the date of enactment of this Act, the Secretary, in consultation with the Federal Energy Regulatory Commission and other appropriate entities, shall review existing rules and procedures relating to interconnection service and additional services throughout the United States for electric generation with nameplate capacity up to 150 megawatts connecting at either distribution or transmission voltage levels to identify barriers to the deployment of combined heat and power systems and waste heat-to-power systems.

(2) Inclusion—The review under this subsection shall include a review of existing rules and procedures relating to—

(A) determining and assigning costs of interconnection service and additional services; and

(B) ensuring adequate cost recovery by an electric utility for interconnection service and additional services.

(c) Model Guidance—

(1) In General—Not later than 18 months after the date of enactment of this Act, the Secretary, in consultation with the Federal Energy Regulatory Commission and other appropriate entities, shall issue model guidance for interconnection service and additional services for consideration by State regulatory authorities and nonregulated electric utilities to reduce the barriers identified under subsection (b)(1).

(2) Current Best Practices—The model guidance issued under this subsection shall reflect, to the maximum extent practicable, current best practices to encourage the deployment of combined heat and power systems and waste heat-to-power systems while ensuring the safety and reliability of the interconnected units and the distribution and transmission networks to which the units connect, including—

(A) relevant current standards developed by the Institute of Electrical and Electronic Engineers; and

(B) model codes and rules adopted by—

(i) States; or

(ii) associations of State regulatory agencies.

(3) Factors For Consideration—In establishing the model guidance under this subsection, the Secretary shall take into consideration—

(A) the appropriateness of using standards or procedures for interconnection service that vary based on unit size, fuel type, or other relevant characteristics

(B) the appropriateness of establishing fast track procedures for interconnection service

(C) the value of consistency with Federal interconnection rules established by the Federal Energy Regulatory Commission as of the date of enactment of this Act

(D) the best practices used to model outage assumptions and contingencies to determine fees or rates for additional services

(E) the appropriate duration, magnitude, or usage of demand charge ratchets

(F) potential alternative arrangements with respect to the procurement of additional services, including—

(i) contracts tailored to individual electric consumers for additional services

(ii) procurement of additional services by an electric utility from a competitive market; and

(iii) waivers of fees or rates for additional services for small electric consumers; and

(G) outcomes such as increased electric reliability, fuel diversification, enhanced power quality, and reduced electric losses that may result from increased use of combined heat and power systems and waste heat-to-power systems.

APPENDIX B. RULES, POLICY, AND INCENTIVE TABLES FOR SELECTED STATES

The following tables (Table B-1, “Financing table”; Table B-2, “Policy and regulatory table”; and Table B-3, “Interconnection rules findings for selected utilities”) summarize existing interconnection financing and regulatory policy and incentives potentially relevant to interconnecting combined heat and power (CHP) and micro-CHP projects in key states. The policies, mechanisms, and incentives in the tables could be relevant to impediments to the interconnection of CHP systems such as impediments to demonstrating project feasibility and obtaining funding to interconnect and operate the systems. Thus, they are potentially relevant to the success of CHP business plans and may affect whether CHP projects will be successfully interconnected. This list is not exhaustive. [204, 205]

Table B-1. Financing table[206, 207, 208]

State	Financing mechanisms and incentives[209]
Texas 	• **Commercial property assessed clean energy (PACE)** ○ Programs include Lone Star PACE and Texas PACE Authority.
California[210] 	• **Commercial PACE** ○ Programs include California Economic Development Authority, California Statewide Communities Development Authority, Sonoma County Energy Independence Program, Western Riverside Council of Governments Commercial HERO Program – CHP systems eligible for financing for commercial properties, Los Angeles County–Commercial PACE, FIGTREE, City of San Francisco–GreenFinanceSF, City of Palm Desert–Energy Independence Program– CHP Systems fall under the Custom Measure track, and CaliforniaFIRST. • **Energy efficiency financing for public sector projects**

[204] In some instances, PACE is listed as a potential financing mechanism for CHP. According to a CHP Technical Assistance Partnerships PACE report, “Combined heat and power (CHP) is an ideal technology for PACE financing because it can yield significant savings in a single project and typically has a long project life of 15–20 years.” See the full report for more information on PACE financing for CHP: US DOE Southeast CHP Technical Assistance Partnership, *PACE Financing for CHP*, 2020, chptap.ornl.gov/profile/285/PACEFinancing-Profile.pdf.

[205] The Clean Energy Finance and Investment Authority notes that potential areas of CHP opportunities for commercial PACE (C-PACE) in Connecticut include community energy systems (i.e., district heat and cooling, microgrids) and the 400 MW of technical potential remaining in the industrial sector. Clean Energy Finance and Investment Authority, *C-PACE: A Financing Tool for CHP in Commercial & Industrial Buildings*, Energize Connecticut, epa.gov/sites/default/files/2015-07/documents/c-pace_a_financing_tool_for_chp_in_commercial_industrial_buildings.pdf.

[206] American Council for an Energy-Efficient Economy, “Deployment Incentives,” database.aceee.org/state/deployment-incentives.

[207] PACENation, “PACE Programs,” pacenation.org/pace-programs/.

[208] “Combined Heat and Power Policy Profile,” State Policy Opportunity Tracker, spotforcleanenergy.org/policy/combined-heat-and-power/.

[209] Includes PACE, loans, public benefit funds, grant rebates, production incentives, taxes, and feed-in tariffs

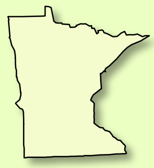
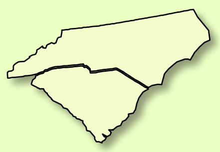
[210] EPA, “CHP Policies and Incentives,” referenced November 4, 2022, epa.gov/chp/database-chp-policies-and-incentives-dchpp.

Table B-1. Financing table[211] [212] [213] (continued)

State	Financing mechanisms and incentives[214]
	Self-generation incentive programs – Only renewable-fueled CHP is eligible within San Diego Gas & Electric, PG&R, Southern California Edison, and SoCal Gas customer base including industrial, agricultural, commercial, or residential hosts. Link deleted. We don't need to chase down links that were working when we wrote the report and have been moved due to the length of time it has taken to publish. We don't need to chase down links that were working when we wrote the report and have been moved due to the length of time it has taken to publish. • • **Sales and use tax exemption for electric power generation and storage equipment** – The exemption does not apply to the production of electricity from fossil fuels except when used in cogeneration. The exemption does apply to the storage and distribution of electric power from any source. • **Sales and use tax exclusion (CA)** – The program has approved financial assistance to biogas capture and production, demonstration hydrogen fuel production, biomass processing and fuel production, etc. • **California feed-in tariff** – Owners of new CHP systems in operation after January 1, 2008, are eligible. Additionally, the system must meet other eligibility criteria outlined.
New York[215] 	• **Commercial PACE** ○ Programs include NYC C-PACE and EIC NY PACE • **NY Green Bank** • **Tax-Exempt Equipment Leasing Program** • **Energy conservation improvements property tax exemption** • **Clean Energy Fund** • **CHP Acceleration Program** • **New York System Benefit Charge** – Funding for any CHP projects provided by these resources would be found under related Database of Combined Heat and Power Policies and Incentives (dCHPP) incentive types (e.g., loan, grant, rebate).
Minnesota[216]	• **Commercial PACE**

[211] American Council for an Energy-Efficient Economy, "Deployment Incentives," database.aceee.org/state/deployment-incentives.
[212] PACENation, "PACE Programs," pacenation.org/pace-programs/.
[213] "Combined Heat and Power Policy Profile," State Policy Opportunity Tracker, spotforcleanenergy.org/policy/combined-heat-and-power/.
[214] Includes PACE, loans, public benefit funds, grant rebates, production incentives, tax, and feed-in tariffs
[215] EPA, "CHP Policies and Incentives," referenced November 4, 2022, epa.gov/chp/database-chp-policies-and-incentives-dchpp.
[216] Minnesota Commerce Department, "Leverage Existing Financing Programs Applicable to CHP," Energy and Utilities, mn.gov/commerce/energy/solar-wind/distributed-energy/leverage-existing-financing-programs-applicable-to-chp.jsp.

Table B-1. Financing table[211,212,213] (continued)

State	Financing mechanisms and incentives[214]
	◦ Programs include MinnPACE and Southwest Regional Development Commission • **Guaranteed Energy Savings Program** • **Local Energy Efficiency Program** • **Energy Savings Partnership** • **Rev it Up Program**
The Carolinas 	• **Commercial PACE** • **Conserfund and Conserfund Plus Loans** • **Energy Efficiency Revolving Loan**
Illinois[217] 	• **Commercial PACE** ◦ Programs include Chicago PACE and Illinois Energy Conservation Authority PACE. • **Illinois CHP Pilot Program Development for Public Sector Facilities** • **Ameren Illinois Company combined heat and power production incentive** – Private and public sector gas customers are eligible for incentives. Public sector entities eligible for enhanced rates include municipalities, local governments, schools, etc. • **Ameren Illinois Company combined heat and power feasibility study incentive** – Offers 50% of the cost of a CHP feasibility study up to $20,000 per project • **ComEd Custom Incentive for CHP** – Newly designed conventional or topping-cycle CHP systems must have an annual efficiency of 60% or higher heating value with at least 20% of the system's total useful energy output in the form of useful thermal energy. • **Illinois Clean Energy Community Foundation Grant–Other Renewables** • **Net Zero Energy Building Program** • **Net Zero Energy Wastewater Treatment Plants** • **Nicor Gas combined heat and power feasibility study** – Nicor Gas customers that consume less than 4 million therms of gas annually are eligible for engineering support. • **North Shore Gas combined heat and power feasibility study incentive** – Natural gas projects that meet a minimum 60% efficiency qualify. • **Peoples Gas combined heat and power feasibility study incentive** – Peoples Gas or North Shore Gas customers with service classifications of two or higher qualify, but service classification–five customers are exempt.
Maryland[218]	• **Commercial PACE**

[217] EPA, "CHP Policies and Incentives," referenced November 4, 2022, epa.gov/chp/database-chp-policies-and-incentives-dchpp.
[218] EPA, "CHP Policies and Incentives," referenced November 4, 2022, epa.gov/chp/database-chp-policies-and-incentives-dchpp.

Table B-1. Financing table[211] [212] [213] (continued)

State	Financing mechanisms and incentives[214]
	○ No specification of CHP • **Baltimore Energy Initiative Loan Program** – The loans are up to $2 million and up to 15 years and can be used to finance systems such as CHP. • **Jane E. Lawton Conservation Loan Program** – The loans are up to $2 million and up to 15 years and can be used to finance systems such as CHP. • **Game Changer Competitive Grant Program** • **Baltimore Gas and Electric (BGE) Smart Energy Savers Program** – CHP systems: 50 kW at $2,000/kW; 51–200 kW at $1,600/kW; 201 kW–1 MW at $1,200/kW; greater than 1 MW at $800/kW. Incentives are tiered, which means the incentive levels vary based upon the installed rated capacity. For example, a 500 kW CHP system would receive $2,000/kW for the first 50 kW, $1,600/kW for the next 150 kW, and $1,200/kW for the remaining 300 kW, for a total incentive of $700,000. The maximum incentive any one CHP project could receive is $2.5 million. CHP projects using biogas and natural gas operating at a minimum of 65% efficiency are eligible. • **Delmarva Power Combined Heat and Power Program** – Similar to BGE • **FirstEnergy** – Similar to BGE • **Maryland Energy Administration CHP Grant Program** – Capacity payments are $600/kW (61–500 kW), up to $550/kW (501 kW–1 MW), or up to $500/kW (>1 MW) for eligible systems operating at a minimum of 60% higher-heating-value efficiency. "Resilient and biogas" systems that include black start and islanding tech may be eligible for up to 20% additional funding. • **Maryland Energy Administration Resilient Maryland Program** – Projects using biogas, natural gas, woody biomass, hydrogen, landfill gas, and waste heat recovery operating at a minimum of 60% higher-heating-value efficiency are eligible. • **PEPCO Combined Heat & Power Program** – Similar to BGE • **Southern Maryland Electric Cooperative (SMECO)** – Similar to BGE
Ohio 	• **Commercial PACE** ○ Programs include Columbus-Franklin County Finance Authority, Northeast Ohio Public Energy Council, and Ohio PACE • **Energy conversion facilities sales tax exemption** • **Qualified energy property tax exemption for projects over 250 kW (payment in lieu)**
Additional states	
Massachusetts[219] 	• **Massachusetts Renewable Energy Trust Fund** – Projects less than 0.06 MW qualify for funding for property owners using Class I and Class II renewables. • **Energy Efficiency Fund** – Incentives for natural gas–fueled CHP and impacts of CHP in the future are being evaluated under the Energy Efficiency Advisory Council 3-Year Plan.

[219] EPA, "CHP Policies and Incentives," referenced November 4, 2022, epa.gov/chp/database-chp-policies-and-incentives-dchpp.

Table B-1. Financing table[211] [212] [213] (continued)

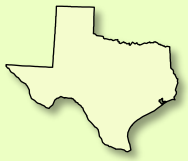
State	Financing mechanisms and incentives[214]
	• **Massachusetts Renewable Energy Trust Fund** – Eligible systems are fuel cell CHP systems. • **Massachusetts Renewable Energy Trust Fund** – Projects less than 0.06 MW qualify for funding for property owners using Class I and Class II renewables. • **Commonwealth Organics to Energy Program** • **Mass Save – Combined Heat and Power Program** – The program considers four different levels of efficiency of a CHP system and grants different pricing dependent on the level met. • **Massachusetts Municipal Commercial Industrial Incentive Program** • **Massachusetts Renewable Energy Trust Fund** – The fund may support CHP systems less than 60 kW and solar hot water. • **MA Renewable Energy Trust Fund** – Less than 60 kW of CHP and solar hot water is eligible.

Vermont [220]

	• Eligible projects for the three loan programs are woody biomass– and landfill gas–related fuel sources
	    ○ Agricultural Energy Loan Program
	    ○ Commercial Energy Loan Program
	    ○ Small Business Energy Loan Program
	• **Efficiency Vermont**
	• **Vermont Clean Energy Development Fund** – Eligible CHP systems (biomass, wood, agriculture, or food waste) must meet Vermont air quality standards and maintain 65% efficiency.
	• **Biomass Electricity Production Incentive** – No direct mention of CHP systems, but woody biomass and biogas fuel sources remain eligible
	• **Renewable Energy Systems Sales Tax Exemption** – 250 kW or less for eligible renewable energy resources and 20 kW or less for micro-CHP systems
	• Local option – property tax exemption – no direct mention of CHP systems

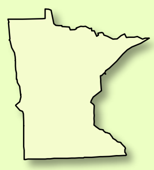
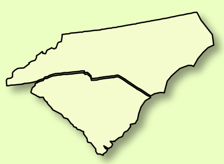
[220] EPA, "CHP Policies and Incentives," referenced November 4, 2022, epa.gov/chp/database-chp-policies-and-incentives-dchpp.

Table B-2. Policy and regulatory table[221 222 223]

State	Policy and regulatory table
Texas 	• **Chapter 399 of the Texas Local Government Code** • **House Bill 2049** – Allows CHP system owners to sell electric energy to multiple customers
California[224] 	• **California Public Utilities Code § 218 and 353** – Provide conditions in which CHP facilities are exempt from being considered electrical corporations • **Green Building Action Plan** – Plan to improve energy efficiency of all state buildings • **CA Emissions Performance Standards** – Thermal output from the CHP systems must have a useful thermal energy output equivalent to a conversion factor of 3.413 MWh. • **CAP-and-Trade Program Distributed Generation Certification Regulation** – CHP systems must be >60% efficient at full-load operation. • **Integrated Energy Policy Report (IEPR)** – The 2019 IEPR includes CHP under Section 25303.5(b) (2), "Determining the Role of Natural Gas Fired Generation as Part of a Resource Portfolio." Under this section, the IEPR discusses how CHP can fit into California's future energy mix. • **California Net Energy Metering** – Renewable-fueled CHP and all fuel cell CHP systems are eligible. • **California Renewable Portfolio Standard** – Renewable-fueled CHP is eligible.

221 American Council for an Energy-Efficient Economy, "Deployment Incentives," database.aceee.org/state/deployment-incentives.
222 PACENation, "PACE Programs," pacenation.org/pace-programs/.
223 "Combined Heat and Power Policy Profile," State Policy Opportunity Tracker, spotforcleanenergy.org/policy/combined-heat-and-power/.
224 EPA, "CHP Policies and Incentives," referenced November 4, 2022, epa.gov/chp/database-chp-policies-and-incentives-dchpp.

Table B-2. Policy and regulatory table[225] [226] [227] (continued)

State	Policy and regulatory table
New York[228] 	• **Community Risk and Resiliency Act** • **New York – Reforming the Energy Vision** • **State Climate Change Plan** – This plan recognizes CHP as a method for increasing energy efficiency and reducing emissions. CHP is included under policy recommendation RCI-2, "Energy Efficiency Incentives," which promotes whole-building, integrated analysis to identify high-performance efficiency measures, including CHP, for existing and new buildings. • **NY State Energy Plan** – The plan states that the Public Service Commission is investigating standby tariff policies that are beneficial to CHP and highlights New York State Energy Research and Development Authority support for CHP by vetting equipment and developers and through standardization. • **NY net-metering rules** – Eligible projects are micro-CHP up to 10 kW for residential, farm-based biogas CHP systems up to 1 MW, and renewable-fueled fuel cells up to 1.5 MW. • **Clean Energy Standard** – State goal of 70% renewables by 2030 and reduced greenhouse gas emissions to below 85% of 1990 levels by 2050. Renewable-fueled CHP and fuel cells are eligible.
Minnesota[229] 	• **Energy Efficiency Resource Standard** • **Minnesota's Combined Heat and Power (CHP) Action Plan** • **MN net-metering rules** • **Next Generation Energy Act** • **Conservation Improvement Program**
The Carolinas 	• **NC Renewable Energy and Energy Efficiency Portfolio Standard** • **NC net-metering rules** • **SC Energy Efficiency Act** • **SC net-metering rules** • **SC Distributed Energy Resource Program**
Illinois[230]	• **Report of the Illinois Climate Change Advisory Group** – The report recommends making grants or rebates available to existing facilities to implement efficiency upgrades, including the installation of CHP. • **Illinois net-metering rules** – Renewable-fueled CHP systems up to 2 MW are eligible.

225 American Council for an Energy-Efficient Economy, "Deployment Incentives," database.aceee.org/state/deployment-incentives.
226 PACENation, "PACE Programs," pacenation.org/pace-programs/.
227 "Combined Heat and Power Policy Profile," State Policy Opportunity Tracker, spotforcleanenergy.org/policy/combined-heat-and-power/.
228 EPA, "CHP Policies and Incentives," referenced November 4, 2022, epa.gov/chp/database-chp-policies-and-incentives-dchpp.
229 Also referenced Minnesota's Combined Heat and Power (CHP) Action Plan. See MN-chp-implementation-model.pdf (energy.gov).
230 EPA, "CHP Policies and Incentives," referenced November 4, 2022, epa.gov/chp/database-chp-policies-and-incentives-dchpp.

Table B-2. Policy and regulatory table[225] [226] [227] (continued)

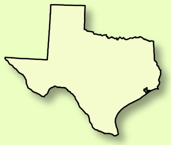
State	Policy and regulatory table
	• **Illinois Energy Efficiency Resource Standards** – Renewable-fueled and fossil-fueled CHP systems as well as waste-heat-to-power systems are eligible. • **Illinois Renewable Portfolio Standard** – Renewable-fueled CHP systems are eligible, but municipal solid waste fuels are explicitly excluded. Qualifications include less than 2 MW systems, interconnected at the distribution level, and located on the customer side of the meter.
Maryland[231] 	• **Maryland's Plan to Reduce Greenhouse Gas Emissions** – Requires the state to achieve a minimum 25% reduction in statewide GHG from 2006 levels by 2020 • **Maryland net-metering rules** – Fuel cell CHP systems, fossil-fueled micro-CHP systems (up to 30 kW), and renewable-fueled CHP systems (up to 2 MW) are eligible. • **EmPower Maryland Energy Efficiency Act** – Renewable- and fossil-fueled CHP systems and waste-heat-to-power systems that meet 65% system efficiency are eligible. • **Maryland Renewable Energy Portfolio Standard** – Renewable-fueled CHP is eligible.
Ohio 	• **OH Alternative Energy Portfolio Standard** • **Ohio Administrative Code 3745-14** – CHP is allowed to count as allowances for energy efficiency and renewable-energy Nox set-asides under Ohio's Nox Budget Trading Program.[232]
Additional states	
Vermont[233] 	• **Vermont Comprehensive Energy Plan 2016** – The plan recommends the state to identify barriers to CHP deployment, provide recommendations for greater deployment, and determine how to address the initial capital costs. Vermont law also outlines an electric plan of at least 60 MW of CHP generation by 2028. • **Vermont net-metering rules –** Eligibility includes up to 20 kW for fossil-fueled micro-CHP systems, and renewable-fueled systems are limited to 500 kW. • **Vermont Renewable Energy Standard** – Projects <5 MW are eligible if connected to the subtransmission or distribution system of an electricity provider.
Massachusetts[234] 	• **Industry Performance Standards for Combined Heat and Power** – The purpose of 310 *Code of Massachusetts Regulations* (CMR) 7.26(45) is to encourage the installation of CHP systems. To be eligible for the emission credit, CHP systems must meet the requirements below:

[231] EPA, "CHP Policies and Incentives," referenced November 4, 2022, epa.gov/chp/database-chp-policies-and-incentives-dchpp.
[232] Great Plains Institute, "Ohio Combine Heat and Power Fact Sheet," betterenergy.org/wp-content/uploads/2018/03/Ohio.pdf.
[233] EPA, "CHP Policies and Incentives," referenced November 4, 2022, epa.gov/chp/database-chp-policies-and-incentives-dchpp.
[234] EPA, "CHP Policies and Incentives," referenced November 4, 2022, epa.gov/chp/database-chp-policies-and-incentives-dchpp.

Table B-2. Policy and regulatory table[225] [226] [227] (continued)

State	Policy and regulatory table
	○ Power-to-heat ratio must be between 4.0 and 0.15. ○ Design system efficiency must be at least 55%. ○ The CHP project must comply with the requirements of 310 CMR 7.02(5)(c). ○ The engine must have a rated power output >50 kW, or the turbine must have a rated power output <10 MW. • **MA Clean Energy and Climate Plan for 2020** – The plan for reducing greenhouse gas in the state should be updated every 5 years. As of the 2016 update, two of the recommendations include CHP through incentives in the mass save program and advocates for higher-density growth for more feasible CHP. • **MA Comprehensive Energy Plan** – The Comprehensive Energy Plan promotes CHP as a key clean energy technology used to increase energy resiliency at critical infrastructure facilities through the state Community Clean Energy Resiliency Initiative. • **MA net-metering rules** – All systems up to 60 kW are eligible, systems generating electricity from agriculture products can be up to 2 MW in size, and public facilities can be up to 10 MW. • **MA Alternative Energy Portfolio Standard** – CHP systems in the ISO New England area and adjacent control area can qualify. The systems must meet a new CO_2 emission rate of 690 lb/MWh. • **MA Clean Energy Standard** – Renewable-fueled CHP is eligible. • **MA Energy Efficiency First Fuel Requirement** – CHP systems must have efficiencies of >60% with the goal of achieving 80% by 2020. • **MA Renewable Portfolio Standard** – Renewable-fueled CHP is eligible.

Table B-3. Interconnection rules findings for selected utilities

State and utility	Interconnection rules table
Texas **Austin Energy** 	In Texas, the interconnection process for distributed generation projects that are 10 MW or less is facilitated by the transmission or distribution service. For example, Austin Energy categorizes interconnection into five classifications,[235] that is, less than 50 kW, 50–499 kW, 50–9,999 kW, greater than 10 MW, and lastly, any projects on the downtown network. The interconnection process includes three stages: interconnection studies and project development, resource modeling and registration, and commissioning and testing; the interconnection studies and project development stage comprises a screening study followed by a full interconnection study. Austin Energy's interconnection guide does not address CHP directly but lists additional requirements for non-inverter-based generation.[236] Process and policies set in place to support CHP development in the state include the Distributed Generation Interconnection Tool for Texas developed by the Houston Advanced Research Center and Texas Government Code Title 10, which requires entities responsible for all critical governmental facilities to consider formally the feasibility of implementing CHP technology.[237]
California investor-owned utilities 	Each utility regulated under the California Public Utilities Commission, including investor-owned utilities (IOUs), must administer required elements of the California Rule 21 tariff within their interconnection procedures.[238] IOUs in California outline two separate study tracks for their interconnection process. The first study process, fast-track, is intended for projects that can be interconnected to the distribution system without requiring system upgrades; the second track is a detailed study. Generally, projects that are not eligible for fast-track evaluation are processed through a detailed study, which can be either an independent study, distribution group study, or a transmission cluster study. Utilities programs designed to acquire CHP systems on the grid include the qualifying facilities, CHP Program Settlement, and the Self-Generation Incentive Program. Through the Waste Heat and Carbon Emission Reductions Act, a feed-in tariff has been established for CHP systems that are smaller than 20 MW and meet the requirements set in California Public Utilities Code Section 2840.[239] Additionally, SoCalGas has a CHP program that allows SoCalGas or a third-party provider on behalf of SoCalGas to develop and provide distributed energy resource (DER) equipment, including CHP, to provide on-site energy.[240] The program has an opt-in tariff schedule with prices based on the cost of service and payment terms arranged with customers. State policies and energy plans in California have historically encouraged installation of CHP likely in part because of policies that support CHP projects in the state such as the recent Governor's Clean Energy Jobs Program, which called for the addition of 6,500 MW of CHP by 2030,[241] and the California Global Warming Solutions Act of 2006, which originally called for 4,000 MW of new CHP in California.

[235] Project classifications include only projects that are not on the downtown network. See austinenergy.com/-/media/project/websites/austinenergy/contractors/ae_dg_interconnection_guide.pdf.

[236] Ibid.

[237] *Energy Security Technologies for Critical Governmental Facilities,* 10 Tex. Govt. Code §2311.002, statutes.capitol.texas.gov/Docs/GV/htm/GV.2311.htm#2311.002.

[238] Guidehouse, *Rule 21 Interconnection Program Evaluation,* California Public Utilities Commission, 2021, cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/rule21/rule-21-interconnection-program-eval_2021.pdf.

[239] California Public Utilities Code, §2840, leginfo.legislature.ca.gov/faces/codes_displaySection.xhtml?lawCode=PUC&sectionNum=2840.2.

[240] SoCalGas, "Distributed Energy Resources Service Tariff," socalgas.com/for-your-business/power-generation/ders-tariff.

[241] ACEEE, State and Local Policy Database, database.aceee.org/state/california.

Table B-3. Interconnection rules findings for selected utilities (continued)

<table>
<tr><th>State and utility</th><th>Interconnection rules table</th></tr>
<tr><td>New York
</td><td>ConEd divides interconnection projects into three categories: small distributed generation (<50 kW), large distributed generation (50 kW–5 MW), and large CHP projects (5–20 MW). The processes for small distributed generation and large distributed generation are similar, with the primary difference being different application portals. Both processes are subject to the New York State Standardized Interconnection Requirements, which take precedence over the process outlined by ConEd.

Small distributed generation interconnection starts with a customer inquiry and the assignment of an energy services customer project manager by ConEd. Customers engaged in large CHP projects must contact ConEd directly for additional guidance. After a CHP application is approved, engineering studies are performed by ConEd to analyze system impacts and estimate costs. ConEd started a CHP incentive program in 2017 as part of the Brooklyn Queens Demand Management program. The program provides a capacity incentive in dollars per kilowatt, which can cover up to the entire cost of the project.</td></tr>
<tr><td>Minnesota
</td><td>Xcel Energy in Minnesota splits the interconnection process into three categories: simplified, fast-track, and study; CHP is not explicitly mentioned. The simplified process is for inverter-based projects that are 20 kW or less. After the application is submitted online, Xcel Energy will review the project against initial screens and determine that it can be interconnected safely. The fast-track process is for distribution-level interconnection customers within varying size limits. The process gives more flexibility with type of generation than the simplified process. Size limits are described in the table below. Synchronous and induction machines are eligible up to 2 MW, regardless of the line voltage.

Fast-track eligibility table
<table>
<tr><th>Line voltage</th><th>Fast-track eligibility regardless of location</th><th>Fast-track eligibility for certified, inverter-based DER on mainline and ≤2.5 electrical circuit miles from substation</th></tr>
<tr><td><5 kV</td><td>≤500 kW</td><td>≤500 kW</td></tr>
<tr><td>≥5 kV and <15 kV</td><td>≤1 MW</td><td>≤2 MW</td></tr>
<tr><td>≥15 kV and <30 kV</td><td>≤3 MW</td><td>≤4 MW</td></tr>
<tr><td>≥30 kV and ≤69 kV</td><td>≤4 MW</td><td>≤5 MW</td></tr>
</table></td></tr>
<tr><td>The Carolinas
</td><td>Duke Energy divides interconnection projects into three groups: smaller capacity, fast-track, and the definitive interconnection study process. The interconnection process at Duke Energy does not give specific instructions to CHP customers. Instead, customers can find their designated groups determined by the sizes of their systems and apply through the regular interconnection process.

The smaller capacity group is for net metering or purchased power customers with systems 20 kW or less. Customers in this group are not eligible for fast-track or preapplication reports and can apply through Duke's Interconnection Portal. The fast-track process is for net-metering customers with systems 20 to 1,000 kW or purchased power customers with systems 20 to 250 kW.</td></tr>
</table>

Table B-3. Interconnection rules findings for selected utilities (continued)

State and utility	Interconnection rules table
	The definitive interconnection study process is for purchased power customers with systems greater than 250 kW. Net-metering customers are not eligible for this process.[242] The definitive interconnection system impact study request window opens on January 1 and remains open for 180 calendar days. During that time, customers can enter the interconnection queue by submitting their applications. The interconnection process follows FERC's *Large Generator Interconnection Procedures* and either North Carolina's or South Carolina's generator interconnection procedures.
Illinois 	In Illinois, ComEd divides interconnection projects into three groups: smaller generators, larger generators, and generators greater than 20 MW. Smaller generators, which are defined as DER projects less than 10 MVA, are then split into four levels: level 1 (25 kW or less and a lab-certified inverter-based distributed generation technology), level 2 (5 MW or less and a lab-certified distributed generation technology), level 3 (10 MW or less if the technology does not export power), and level 4 (10 MW or less if the project does not qualify for levels 1 through 3). Larger generators are defined as generations greater than 10 MW and less than 20 MW. There are no specific requirements or processes that call out CHP in the interconnection application. However, ComEd runs a Custom Solutions program where customers can receive incentive payments for installing energy-saving systems like CHP. The Custom Solutions program started in 2014 as an energy efficiency measure. Applicants must complete a project screening form, complete the custom incentives application, and receive approval before purchasing and installing new equipment. After the equipment is in place, customers must resubmit the custom incentives application to receive the incentive payment. Notably, there is a production incentive accessible in dollars per therm once the CHP systems are operational.
Maryland 	PEPCO created the Green Power Connection process to facilitate small-generator interconnection and net-metering requests in their service area. Small-generator interconnection projects are categorized into four levels: level 1 (10 kW or less and inverter based), level 2 (2 MW or less with a radial distribution circuit or spot network serving one customer), level 3 (area network projects with 50 kW or less or radial distribution network projects with 10 MW or less), and level 4 (projects 10 MW or less that do not qualify for levels 1–3). Customers interested in installing large generating systems (>10 MW) to sell power back to the grid must complete wholesale power purchase agreements through the Pennsylvania–New Jersey–Maryland Interconnection. Partially because of the EmPOWER Maryland Efficiency Act of 2008, PEPCO is one of five utilities in Maryland that incentivize CHP systems; BGE, Delmarva Power, Potomac Edison, and SMECO all have similar CHP stand-alone programs. For PEPCO, there is a separate application form for customers installing CHP systems. The application is based on the small-generator interconnection application for levels 2–4. Customers installing CHP systems are not eligible for net metering, and because no excess energy can be fed back to Maryland's grid, CHP customers do not need to install DC-to-AC inverters. CHP incentives based on kilowatts are offered, which are paid in three installments, that is, design (10%), construction (30%), and production (up to 60%).

[242] This is an example of how the interconnection process could inadvertently prevent CHP systems from exporting generation, since many CHP systems are larger than 250 kW.

Table B-3. Interconnection rules findings for selected utilities (continued)

State and utility	Interconnection rules table
Ohio 	AEP Ohio recognizes UL 1741 and IEEE1547 as the basis for interconnection technical requirements for most of its jurisdictions; however, it also has additional technical requirements to cover issues that may not be addressed in the standards. The utility technical requirements indicate issues with the interconnection of inverter-based technologies and synchronous generators, which lends to these additional requirements. Although CHP is not explicitly mentioned, AEP Ohio's web-based portal portrays options for synchronous generators and inverter-based technologies using natural gas. AEP notes their intent to make their interconnection process efficient, inexpensive, and more importantly, technology neutral. For interconnection approval criteria, technologies are separated into different qualification levels, which provides the approval criteria to be met for interconnection. Level 1 refers to inverter-based equipment 25 kW or less, level 2 is a fast-track method for projects between 500 kW and 4 MW, and level 3 (standard review procedure) identifies projects that do not meet level 1 or level 2 requirements that are 20 MW or less.

APPENDIX C. SUMMARY OF FEDERAL ENERGY REGULATORY COMMISSION DOCUMENTS PERTAINING TO GENERATORS REVIEWED FOR THIS REPORT

The Public Utility Regulatory Policies Act of 1978, Including Amendments

The Public Utility Regulatory Policies Act of 1978 (PURPA) was developed and implemented for five main goals as listed by the Federal Energy Regulatory Commission (FERC):[243]

- Energy conservation
- Increased efficiency by electric utilities
- Equitable retail rates for electric consumers
- Expeditious development of hydroelectric potential at existing small dams
- Conservation of natural gas while ensuring that rates for natural gas consumers are equitable

To accomplish these goals, PURPA defined "a new class of generating facilities that would receive special rates and regulatory treatments." These generation facilities are known as qualifying facilities (QFs). QFs include two categories, small power-production facilities and cogeneration facilities, which are described as follows:

- Small power-production facilities[244]
  - Power-production capacity, including the capacity of all power-production units that use the same energy resource, are owned by the same person(s) or affiliates and are located at the same site (1 mi or less).
  - The primary energy source of the generation facility must be biomass, waste, renewable resources, geothermal resources, or any combination thereof, and 75% or more of the total energy input must be from these sources. Use of oil, natural gas, and coal by the facility must not exceed 25% of the energy inputs in the facility.[245]
- Cogeneration facilities[246]
  - Topping-cycle facilities
    - The useful thermal energy output of the facility must not be less than 5% of the total energy output.
    - For the topping-cycle cogeneration facilities for which the energy input is natural gas or oil, the useful-power output of the facility plus one-half of the useful–thermal energy output must be no less than 42.5% of the total energy input of natural gas and oil to the facility or must be no less than 45% of the total energy input of natural gas and oil to the facility if the useful–thermal energy output is less than 15% of the total energy output of the facility.
  - Bottoming-cycle facilities
    - The useful power output of the bottoming-cycle facility must be no less than 45% of the energy input of natural gas and oil for supplementary firing.

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[243] FERC, "PURPA Qualifying Facilities," ferc.gov/qf, referenced on November 4, 2022.
[244] 18 CFR §292.204, "Criteria for Qualifying Small Power Production Facilities," *Code of Federal Regulations*, Title 18, *Conservation of Power and Water Resources,* ecfr.gov/current/title-18/chapter-I/subchapter-K/part-292?toc=1.
[245] US Congress, Federal Power Act, Section 3(17)(B), energy.gov/sites/prod/files/2019/10/f67/Federal%20Power%20Act_2019_508_0.pdf.
[246] 18 CFR §292.205, "Criteria for Qualifying Cogeneration Facilities," *Code of Federal Regulations*, Title 18, *Conservation of Power and Water Resources,* ecfr.gov/current/title-18/chapter-I/subchapter-K/part-292/subpart-B/section-292.205.

- The output of a cogeneration facility is not intended fundamentally to sell electricity. Therefore, for a cogeneration facility to be a QF, the electricity sold to the grid cannot be 50% or more of the total output of the facility. Facilities of 5 MW or smaller are presumed to satisfy this requirement.

Obtaining QF status provides three benefits for QFs:

- The right to sell energy or capacity
- The right to purchase services
- Relief from some regulatory burdens

FERC Order No. 872, *Standardization of Generator Interconnection Agreements and Procedures*[247]

FERC issued Order No. 872 in July 2020 and made major revisions to its regulations implementing PURPA to better protect ratepayers from subsidizing QFs.[248] The major changes that potentially can affect combined heat and power (CHP) interconnections are explained as follows:

- Variable avoided rates
    - They provide flexibility for state regulatory authorities to require the utilities located inside regional transmission organization (RTO)/independent system operator (ISO) markets to pay as-available QF energy rates based on locational marginal pricing at the time of the energy delivery.
    - They provide flexibility for state regulatory authorities to require the utilities located outside of RTO/ISO markets to pay as-available QF energy rates based on competitive prices determined by (1) liquid market hub energy prices and (2) formula rates based on observed natural gas prices and a specified heat rate.
    - They provide the flexibility for state regulatory authorities to require that energy rates under QF contracts or legally enforceable obligations (LEOs) be determined at the time of delivery rather than being fixed for the term of the contract or LEO.

Variable avoided rates may make it harder for CHP to hedge the risk of energy rates and may decrease the revenue of CHP resources; consequently, variable avoided rates may make QFs with CHP less attractive.

Another change that may make it harder for CHP to compete with other QFs is consideration of competitive solicitations to determine avoided costs. This change would give states the flexibility to set avoided costs of energy and/or capacity rates using competitive solicitations.

FERC Order No. 2003, *Standardization of Generator Interconnection Agreements and Procedures*[249]

In June 2022, FERC issued a Notice of Proposed Rulemaking (NOPR), "Improvements to Generator Interconnection Procedures and Agreements," which builds upon FERC Order No. 2003. With the proposed reforms, FERC seeks to address interconnection queue backlog, improve certainty, and prevent undue discrimination against new technologies.[250]

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[247] FERC Order No. 872, *Qualifying Facility Rates and Requirements Implementation Issues Under the Public Utility Regulatory Policies Act of 1978*, 2020, ferc.gov/sites/default/files/2020-07/07-2020-E-1.pdf.
[248] McGuireWoods, "FERC Issues Final PURPA Rule to Increase State Flexibility, Modify the Mandatory Purchase Obligation, Establish New LEO Standards, and to Reform the 'One-Mile Rule,'" July 21, 2020, mcguirewoods.com/client-resources/Alerts/2020/7/ferc-issues-final-purpa-rule.
[249] FERC Order No. 2003, *Standardization of Generator Interconnection Agreements and Procedu*res, 2003, ferc.gov/sites/default/files/2020-06/order-2003.pdf.
[250] FERC, *Improvements to Generator Interconnection Procedures and Agreements*, 2022, federalregister.gov/documents/2022/07/05/2022-13470/improvements-to-generator-interconnection-procedures-and-agreements.

FERC Order No. 2222, *Participation of Distributed Energy Resource Aggregations in Markets Operated by Regional Transmission Organizations and Independent System Operators*[251]

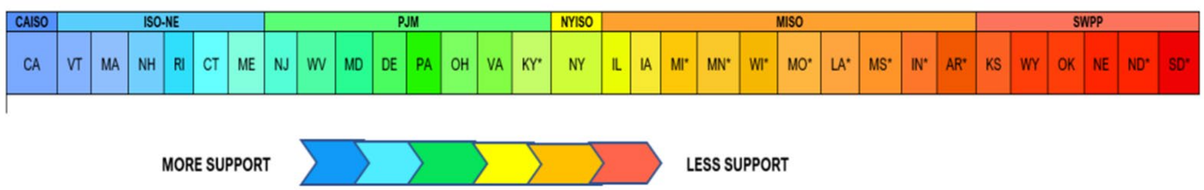
This order does not include any specific call-out to CHP or synchronous generators.

FERC Order No. 2222 requires all independent system operators and regional transmission operators to allow aggregators of distributed energy resources (DERs), including CHP, to participate in wholesale energy markets. The order removes barriers preventing DERs from competing in energy markets. The order creates a pathway that will allow assets to receive compensation for providing grid services such as energy production, capacity, and ancillary services.

FERC Order No. 2222 may have the potential to enable CHP systems to participate in wholesale electricity markets. Participating in markets may provide an additional value stream for CHP owners and DER aggregators. However, the value brought by FERC Order No. 2222 will be contingent on the ISO or RTO design, support, and ability to integrate distributed energy resource aggregation (DERA) onto their grids.

For instance, depending on the RTO electricity market design, DERs participating in ancillary service markets may not be eligible to participate in other markets such as the capacity market. This may remove opportunities for CHP systems to receive benefits for the energy services they provide in addition to ancillary support. Owners or developers looking to participate in electricity markets through FERC Order No. 2222 will need to develop strategies that will maximize value while considering the market design of an ISO/RTO.

Furthermore, the relative support for DERAs may affect the benefits received from FERC Order No. 2222. The research team determined the support for DERAs within each RTO/ISO and state as shown in Figure C-1. Three of four key states noted as complying with DOE CHP recommendations, California, Vermont, and Virginia, show relatively high support for DERAs. (Utah in the Northwest Power Pool is not shown.)



Source: *Research team insights. FERC Order No. 2222: Implementation Plans Create Risks, FERC Order No. 2222: Impacts & Implications Challenges, and Growth Opportunities for Market Players.*

Figure C-1. FERC Order No. 2222 implementation: support for DERAs in selected states and RTOs/ISOs.

[251] FERC Order No. 2222, *Participation of Distributed Energy Resource Aggregations in Markets Operated by Regional Transmission Organizations and Independent System Operators*, 2021, [ferc.gov/sites/default/files/2021-03/E-1.pdf.](ferc.gov/sites/default/files/2021-03/E-1.pdf)

FERC Order No. 842, *Essential Reliability Services and the Evolving Bulk Power System*[252]

Issued on February 15, 2018, FERC Order No. 842 requires that all newly interconnecting generating facilities install, maintain, and operate equipment that will provide primary frequency response as a condition of interconnection. The order amends pro forma interconnection agreements by including operational requirements that also would provide primary frequency response. Order No. 842 is generally applicable to all newly interconnecting generating facilities that pursue large-generator interconnection agreements or small-generator interconnection agreements and existing generating facilities that require the submission of a new interconnection request.

Order No. 842 exempts CHP facilities that are sized to serve on-site loads and have no capability to export from prescribed operating requirements of the order. In response to the initial NOPR for Order No. 842, the Electricity Consumers Resource Council (ELCON) and the American Petroleum Institute (API) requested further exemption and/or special accommodation for CHP systems. One of the main arguments was that requiring primary frequency response in all CHP facilities without considering operational conditions and the needs of the manufacturing process could jeopardize the reliability, safety, and efficiency of both the manufacturing process and the primary frequency response operations. Furthermore, ELCON and API requested that the language of the order be revised to exempt mandatory primary frequency response in industrial CHP units.

In agreement with ELCON and API's concerns centered on the operational efficiency, reliability, and safety of CHP with the implementation of primary frequency response, FERC responded by stating that the exemption of industrial CHP units and other similarly situated forms of industrial behind-the-meter generation is warranted.

FERC Order No. 1000, *Transmission Planning and Cost Allocation*[253]

FERC Order No. 1000 establishes a framework for addressing the barriers of transmission development in the United States. The order aims to increase coordination of regional transmission development, develop a fair means to meet cost obligations for the development of transmission assets, and promote and incentivize cost-effective projects. Although CHP systems are not directly mentioned in the order, the implementation of CHP could contribute to FERC Order No. 1000 compliance.

The order requires transmission providers "to evaluate alternatives that may meet the needs of the region more efficiently or cost effectively [than local solutions]." The regional processes must give "comparable consideration of transmission and non-transmission alternatives…."[254] With strategic implementation, CHP could be considered as an alternative transmission asset. Thus, CHP could provide benefits such as deferred capital investments for transmission.

In April 2022, FERC issued a NOPR proposing significant reforms to the regional transmission planning process and cost-allocation requirements. Through the NOPR, FERC intends to "explore more effective and longer-term regional transmission planning."[255]

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[252] FERC Order No. 842, *Essential Reliability Services and the Evolving Bulk Power Syste*m, 2018, ferc.gov/sites/default/files/2020-06/Order-842.pdf.

[253] FERC Order No. 1000, *Transmission Planning and Cost Allocation*, referenced on November 4, 2022, ferc.gov/electric-transmission/order-no-1000-transmission-planning-and-cost-allocation.

[254] Scott Hempling, *Non-Transmission Alternatives: FERC's 'Comparable Consideration' Needs Correction*, scotthemplinglaw.com/wp-content/uploads/2021/06/FERC-Order-1000-1.pdf.

[255] FERC, *Explainer on the Transmission Notice of Proposed Rulemaking*, referenced on November 4, 2022, ferc.gov/explainer-transmission-notice-proposed-rulemaking.

FERC 18 CFR Part 35, Docket No. RM22–14–000, ***Improvements to Generator Interconnection Procedures and Agreements***

This document was reviewed for this report.

FERC 18 CFR Part 40, Docket No. RM22–12–000, ***Reliability Standards to Address Inverter-Based Resources***

This document was reviewed for this report.

APPENDIX D. OUTREACH INTERVIEW GUIDES AND QUESTIONNAIRES

This section contains example interview questions the research team used in discussions with stakeholders, including the Federal Energy Regulatory Commission (FERC), utilities and regulators, vendors and developers, and research organizations.

Wherever possible we probed for details regarding how existing rules and procedures affecting CHP interconnection may vary for different capacity ranges (e.g., <250 kW, <1 MW, 10 to 20 MW, 20 MW and above up to 150 MW).

1. Interconnection process

   a) How are combined heat and power (CHP) projects handled in the existing process?

      - If your process captures the overall number of days as part of your interconnection process, would you be willing to share anonymous data about CHP interconnection timelines and costs?

   b) How many of the CHP applications make it through to construction in a typical year?

   c) Is CHP (or any non-inverter-based generator) treated differently and/or is it a subset of a distributed energy resource (DER)? If so, please explain why.

      - Has your state and utility adopted IEEE 1547 as the standard for interconnection?

   d) Are you aware of any CHP interconnection customers expressing dissatisfaction with the length of interconnection processing time?

   e) Have you ever encountered any CHP interconnection projects that went through disputes?

      - If so, was your dispute resolution process effective to resolve the issues in a timely manner?

2. Please tell us about your requirements for monitoring, protection, and metering for CHP

   a) Do your interconnection rules explicitly include control and protection requirements for CHP per IEEE 1547?

   b) Do your interconnection rules specify that telemetry and/or direct transfer trip (DTT) are required for certain projects, such as a certain capacity level, and could these requirements include CHP?

   c) Do you have a standard default cost guide for telemetry and/or DTT requirements?

   d) Is there a particular type of DTT communication method (e.g., fiber optic cable, telephone lines, or radio signals) that must be used for CHP interconnection projects for projects above a certain capacity?

      a. Who is responsible for coordinating the installation, and who owns the communications?

3. Do your standard interconnection agreements include clearly defined standby, supplemental, and/or departing (stranded) rate structure used for CHP projects?

    a) If so, how are the rates applied in a typical year?

    b) If not, how is the rate structure for CHP projects assessed on a case-by-case basis?

4. What is the status of grid modernization on your distribution system? (e.g., two-way power flow, forward-looking grid planning)

    a) Has your utility considered how interconnecting CHP (e.g., natural gas or renewable fuel fired nonvariable resources) could support grid flexibility and resource adequacy?

    b) How would your utility plan on achieving the next level integration of CHP to increase grid flexibility?

5. What is your opinion on best practices for CHP interconnection?

6. Are there any important topics missing in these questions that you think the US Department of Energy (DOE) should consider in response to the congressional request?

Appendix D-2. Vendor Questionnaire

The following is an excerpt of the information provided to vendor stakeholder groups:

Attached is a document with preliminary barriers identified for your reference. Please answer the questions in this Word document and take as much space as necessary.

☐ Check if you are willing to have your company identified in the report as a respondent.

☐ Check if you are willing to have your company identified in the report regarding a particular barrier you present.

In response to the following questions, you are encouraged to describe your experience (both positive and negative) as it relates to CHP projects using real examples and include references where necessary.

1. What are the main challenges you've seen with interconnecting CHP to the grid (either at the transmission or distribution level)?

2. How important is net metering as it applies to CHP development project decisions?

3. What is your opinion on the best practice for resolving any of the challenges above?

4. Have you seen a well-defined interconnection process that is available to CHP developers? In your experience do CHP projects have their own track in the interconnection rules? If so, could you explain how the CHP track is different from other distributed resources?

5. What has your experience been with standby, supplemental, and/or departing (stranded) rates that are used for CHP? Are you aware of how the aforementioned is being calculated, and whether or not the details of those calculations are available to developers?

   Furthermore, are standby rates, reservation fees, and demand ratchets being fairly applied to CHP projects? Express your thoughts on this topic.

6. Have you seen interconnection rules explicitly include control and protection requirements, telemetry requirements, and operation and maintenance requirements for CHP? Do you believe these requirements are being applied fairly to CHP? Is there any gray area?

7. In your experience, are utility capacity maps available to developers? If so, what level of detail do they provide and how often are they updated?

8. What has your experience been with the difference between the original utility cost estimates for required interconnection upgrades for CHP, compared with the final negotiated/actual installed upgrade costs? If these have been applied, do they add appreciably to the total cost of the CHP project?

9. Are there any important topics missing that you think should be considered in the DOE response to Congress?

10. In general, how would you describe and rate the entire interconnection process of CHP projects?

Appendix D-3. Research Organization Questionnaire

The following is an excerpt of the information provided to research organization stakeholder groups ahead of interviews to brief them on the purpose of the interview:

At the end of the questions section, there is a table with preliminary barrier topics identified for your reference.

Please answer the questions in this Word document and take as much space as necessary.

☐ Check if you are willing to have your company identified in the report as a respondent.

☐ Check if you are willing to have your company identified in the report regarding a particular barrier you present.

Please reply by February 3, 2023.

In response to the following questions, you are encouraged to describe your experience (both positive and negative) as it relates to CHP projects using real examples and include references where necessary. If you do not know/have an answer just leave answer blank.

1. What are the interconnection processes that you have encountered or studied?

   a) How are CHP projects handled in these processes?

   b) Is CHP (or any non-inverter-based generator) treated differently and/or is it a subset of a DER in the processes?

c) Which CHP applications trigger utility studies? Do you have an estimate of the time and cost of the interconnection process in these cases?

d) Are you aware of any CHP interconnection customers expressing dissatisfaction with the length of interconnection processing time?

e) Have you ever encountered any CHP interconnection projects that went through disputes? If so, was the dispute resolution process effective to resolve the issues in a timely manner?

2. Please tell us monitoring and metering requirements for CHP.

   a) What control and protection requirements for CHP are needed?

   b) Have you seen interconnection rules explicitly include control and protection requirements, telemetry requirements, and operation and maintenance requirements for CHP?

   c) Do you have a sense for costs assessed to projects that include telemetry and/or DTT requirements (a range is acceptable)?

   d) Is there a particular type of direct transfer trip (DTT) communication method (e.g., fiber optic cable, telephone lines, or radio signals) preferred to be used for CHP interconnection projects for projects above a certain capacity?

3. What has your experience been with standby, supplemental, and/or departing (stranded) rates that are used for CHP? In your opinion, how should these rates be structured?

4. What are the impacts of grid modernization on CHP interconnection? (e.g., two-way power flow, forward-looking grid planning)

   a) How could interconnecting CHP (e.g., natural gas or renewable fuel fired non-variable resources) support grid flexibility and resource adequacy?

   b) Have you seen the benefits of CHP being considered to support grid flexibility industry wide? What is your view on CHP?

5. What is your opinion on best practices for CHP interconnection?

6. Are there any important topics missing in these questions that you think the DOE should consider in response to the congressional request?

7. How can capacity maps help CHP developers? What are the recommended details to include in the maps?

8. How can CHP be accounted for in system planning processes within utilities?

9. What are the main challenges you've seen with interconnecting CHP?

10. What is your opinion on the best practice on resolving any of the challenges for CHP interconnection?

Appendix D-4. FERC Interview Guide

The following shows an excerpt of the guidelines that were utilized to ensure effective interview discussions with FERC.

Initial interview discussion points

- FERC NOPR "Improvements to Generator Interconnection Procedures and Agreements" item 30 states, "Delayed interconnection study results or unexpected cost increases can disrupt numerous aspects of generating facility development, including project financing and the ability to obtain a power purchase agreement."
- FERC NOPR "Reliability Standards to Address Inverter-Based Resources" item 12 states, "Synchronous generation resources can provide voltage support during voltage disturbances." Issue with applying statement like this to the distribution side?
- FERC Order No. 2222—CHP is a DER that may be bundled with solar, storage, and other DERs by aggregators to the benefit of the bulk energy system (agree?)
- Possible implications of multiple state bans of natural gas appliances on the interstate gas pipeline (e.g., will pro-rated maintenance and operational costs for the interstate natural gas infrastructure go up for states that still use natural gas 10 years from now)

FERC follow-up discussion

1. Overview of all barriers

   a) Initial reactions

   b) Does FERC have any feedback on the barriers presented? Any additions or contentions?

2. Interconnection process

   a) Under the *Small Generator Interconnection Agreement*, does FERC perceive the regulatory framework to be consistent across all generator resources? If not, in what ways may they differ?

3. Interconnection agreements

   a) FERC Order 872

   b) FERC Orders 842 and Order 2222, in a way, acknowledge the potential benefits that all DER sources, including CHP, can provide to the grid (e.g., frequency response, ancillary services, energy/capacity support, etc.) Are there additional benefits to the system FERC sees CHP providing to the grid?

   c) How does FERC consider the benefits and costs when considering cost allocation?

4. Regulatory and policy barriers to CHP interconnection

   a) From research, one CHP barrier found is that CHP is not explicitly accounted for within interconnection rules and handbooks. This creates inconsistencies within interconnection agreements across entities and gives little structure to interconnection requirements for CHP. Is addressing such within the jurisdiction of FERC? If so how?

b) Considering the recent NOPRs on FERC and interconnection reform, what areas does FERC see potential for improved collaboration?

c) Is CHP perceived to be a technology needing additional provisions or considerations when considering interconnection queue reform?

APPENDIX E. IMPACTS OF FEDERAL ENERGY REGULATORY COMMISSION 2023 AND INTERSTATE RENEWABLE ENERGY COUNCIL 2023 ON THE COMBINED HEAT AND POWER MODEL GUIDANCE

Executive Summary

After the main body of this report was written, the Federal Energy Regulatory Commission (FERC) published Order No. 2023[256] with several reforms that could affect combined heat and power (CHP) interconnection, and the Interstate Renewable Energy Council (IREC) updated their *Model Interconnection Procedures* (MIP).[257] Although the guidance and requirements found in Order No. 2023 and the MIP largely align with the original model guidance proposed in the body of this report, these documents present new opportunities for advancing interconnection for CHP systems. Table E-1 provides a high-level implementation summary for recommended model guidance additions. Table E-2 and Table E-3 summarize additions to model guidance as implemented in light of FERC Order No. 2023 and the 2023 IREC MIP, respectively.

FERC Order No. 2023 summary

In 2023, FERC issued FERC Order No. 2023 to reform and streamline generator interconnection procedures. The objective of the order is to improve the generator interconnection process by reducing backlogs for projects seeking to connect to the transmission system, improve certainty in the interconnection processes, and ensure access to the transmission system for new technologies.[258] Where FERC has jurisdiction, or where states and utilities rely on FERC orders for interconnection process guidance and best practices, Order No. 2023 contains new provisions that can help facilitate CHP interconnections compared with prior industry model guidance. The new or revised interconnection rules and processes, technical requirements, and information-sharing requirements in Order No. 2023 could help remove barriers to interconnection encountered by all developers, including CHP developers.

IREC MIP 2023 summary

In the same year, IREC released an update to the MIP. IREC's model guidance provide utilities and regulators with a framework to facilitate the interconnection process efficiently. Key updates within the MIP include updated terminology, definitions, application forms, technical review screens, provisions to account for energy storage, and the adoption of IEEE 1547-2018.[259] The 2023 MIP provides guidance that could streamline and simplify the interconnection process by recommending development of a separate set of rules and technical screens for rotating machines to further simplify non-inverter-based resources interconnection.

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[256] Federal Energy Regulatory Commission, RM22-14-000, Order No. 2023, *Improvements to Generator Interconnection Procedures and Agreements,* 2023, www.ferc.gov/media/e-1-order-2023-rm22-14-000.

[257] Interstate Renewable Energy Council Inc, *Model Interconnection Procedures*, 2023, irecusa.org/resources/irec-model-interconnection-procedures-2023/.

[258] Federal Energy Regulatory Commission, "Explainer on the Interconnection Final Rule," ferc.gov/explainer-interconnection-final-rule#:~:text=2023%2C%20FERC%20adopted%20these%20reforms,transmission%20system%20for%20new%20technologies.

[259] Interstate Renewable Energy Council, *Improving State Interconnection Policies: New Model Rules to Accelerate DER Adoption*, September 2023, irecusa.org/wp-content/uploads/2023/09/2023-Model-Rules-Webinar-Slides_FINAL-9.6.23.pdf

Table E-1. High-level model guidance implementation of FERC Order No. 2023 and IREC MIP 2023

Subject area	High-level action items to implement FERC Order No. 2023 and IREC MIP 2023 in the original CHP model guidance
Interconnection rules and processes	• Include the revised pro forma *Small Generator Interconnection Procedures* (SGIP), *Small Generator Interconnection Agreement* (SGIA), *Large Generator Interconnection Procedures* (LGIP), and *Large Generator Interconnection Agreement* (LGIA), as set forth in Order No. 2023, and IREC 2023 in the list of provisions utilities and regulators should adopt (e.g., IEEE 1547-2018, UL 1741), as appropriate. • Include IREC MIP 2023 as model guidance utilities and regulators can use to develop a separate set of rules and technical screens for rotating machines to simplify non-inverter-based resource interconnection, including for fast-track procedures, while ensuring grid reliability and safety.
Requirements for monitoring, metering, and protection of CHP systems	• Include the revised pro forma SGIP, SGIA, LGIP, and LGIA, as set forth in Order No. 2023, in the list of provisions utilities and regulators should adopt, as appropriate, to improve interconnection rules while continuing to promote grid safety and reliability. • Include the revised pro forma SGIP, SGIA, LGIP, and LGIA, as set forth in Order No. 2023, in the list of provisions utilities and regulators should adopt, as appropriate, to provide clear timelines for processing interconnection applications.
Timely interconnection-related upgrade cost guide information and hosting capacity maps	• Include the revised pro forma SGIP, SGIA, LGIP, and LGIA, as set forth in Order No. 2023, in the list of provisions utilities and regulators should adopt, as appropriate, to require transparent, publicly available interconnection-related upgrade unit cost guides, hosting capacity information, and heat maps.

Review of Federal Energy Regulatory Commission Order No. 2023 and its Impact on CHP Model Guidance

Introduction

The research team prepared this appendix to contextualize the impact of Federal Energy Regulatory Commission (FERC) Order No. 2023 on the team's previously provided model guidance.

On July 27, 2023, FERC issued Order No. 2023 to streamline the generator interconnection process by mitigating interconnection queue backlogs, improving cost and timing certainty, and preventing undue discrimination for new technologies.[260] In doing so, FERC requires all public utility transmission providers to adopt the revised pro forma *Large Generator Interconnection Procedures* (LGIP), pro forma *Small Generator Interconnection Procedures* (SGIP), pro forma *Large Generator Interconnection Agreement* (LGIA), and pro forma *Small Generator Interconnection Agreement* (SGIA). The pro forma LGIP, SGIP, LGIA, and SGIA are standard documents all FERC-jurisdictional public utility transmission providers owning, controlling, or operating facilities used for transmitting electric energy in interstate commerce must keep on file and abide by for interconnecting generating facilities.[261]

[260] Federal Energy Regulatory Commission, Order No. 2023, *Improvements to Generator Interconnection Procedures and Agreements*, 2023, Page 5, https://www.ferc.gov/media/e-1-order-2023-rm22-14-000.

[261] National Law Review, *In Order No. 2023, FERC Takes Step in Reforming Transmission Grid Policies by Enacting Generator Interconnection Reforms*, 2023, https://www.natlawreview.com/article/order-no-2023-ferc-takes-step-reforming-transmission-grid-policies-enacting.

The interconnection of generating facilities larger than 20 MW is subject to the pro forma LGIP and LGIA, whereas the interconnection of generating facilities no larger than 20 MW is subject to the pro forma SGIP and SGIA. Systems no larger than 20 MW are typically interconnected at the distribution level and therefore are under the jurisdiction of state regulators and utilities. FERC designed the pro forma SGIP and SGIA to serve as useful models for state-level interconnection standards.[262] The pro forma LGIP and LGIA may also be used as models for state-level interconnection standards, although that is not their primary intended purpose.

FERC Order No. 2023 adopts revisions to all four pro forma documents, but the most significant revisions pertain only to the pro forma LGIP and LGIA. Considering that 88% of all US CHP systems are no larger than 20 MW, it is critical to note that most CHP systems are not required to comply with Order No. 2023's regulatory changes, as they are subject to the pro forma SGIP and SGIA rather than the pro forma LGIP and LGIA.[263] However, as described in this appendix, through its revisions to the pro forma SGIP and SGIA, FERC also sets forth important changes for integrating small CHP systems with the electric grid. Additionally, considering that some CHP systems are larger than 20 MW and thus subject to the pro forma LGIP and LGIA, the research team includes large-generator impacts in this appendix as well.

Altogether, FERC Order No. 2023 offers mostly positive outcomes for developers of CHP systems no larger than 20 MW, which are subject to the pro forma SGIP and SGIA. Primarily, the adopted reforms facilitate CHP interconnection by mitigating capacity constraints, minimizing study delays, and providing cost savings for interconnection customers. Meanwhile, the revisions of Order No. 2023 offer mixed outcomes for developers of CHP systems larger than 20 MW, which are subject to the pro forma LGIP and LGIA. Although some pro forma LGIP and LGIA reforms facilitate CHP interconnection by mitigating queue backlogs and providing developers with greater cost savings, transparency, and timing certainty throughout the study process, others impose additional upfront study costs and requirements. The sections that follow will describe the impact of Order No. 2023 on CHP development in greater detail for systems subject to the pro forma SGIP and SGIA and systems subject to the pro forma LGIP and LGIA.

Updates to the model guidance in light of FERC Order No. 2023

Based on its review of FERC Order No. 2023, the research team recommends minor additions to the model guidance. Overall, Order No. 2023 and the model guidance do not significantly overlap, but where there is overlap, Order No. 2023 adds value to the model guidance. Although Order No. 2023 and the model guidance may address similar subject areas, state regulators and utilities should separately consider the impacts of the original model guidance in this report and Order No. 2023 to CHP interconnection for their jurisdictions. The research team identified three subject areas in which there is overlap, thus presenting the opportunity to make minor additions to components of the interconnection barriers model guidance. These additions are summarized in Table E-2, shown in bold italic font, and described in further detail in the next section.

[262] National Association of Regulatory Utility Commissioners, *An Introduction to Interconnection Policy in the United States*, https://pubs.naruc.org/pub.cfm?id=5375FAA8-2354-D714-51DB-01C5769A4007.

[263] US Department of Energy, CHP Installation Database, *US Department of Energy Combined Heat and Power and Microgrid Installation Databases*, data as of December 31, 2022, doe.icfwebservices.com/chp.

Table E-2. Summary of additions to model guidance in light of FERC 2023

Subject area	Original model guidance language	Additions to model guidance
Interconnection		
Interconnection rules and processes	State regulatory agencies and utilities should • adopt the use of standards (e.g., IEEE 1547-2018, UL 1741) that simplify interconnection.	State regulatory agencies and utilities should • adopt ***the provisions*** of standards ***and regulations*** (e.g., IEEE 1547-2018; UL 1741; ***revised pro forma SGIP, SGIA, LGIP, and LGIP as set forth in FERC Order No. 2023*** [264]) that simplify interconnection.
Requirements for monitoring, metering, and protection of CHP systems	State regulatory agencies and utilities should • align interconnection rules to be consistent with IEEE 1547-2018 to ensure grid safety and reliability, and • provide clear timelines for processing CHP interconnection applications to support realistic project schedules for developers.	State regulatory agencies and utilities should • align interconnection rules to be consistent with ***standards and regulations*** (e.g., IEEE 1547-2018; ***revised pro forma SGIP, SGIA, LGIP, and LGIP as set forth in FERC Order No. 2023***) that promote grid safety and reliability, and • ***adopt the provisions of regulations (e.g., revised pro forma SGIP, SGIA, LGIP, and LGIP as set forth in FERC Order No. 2023)*** that provide clear timelines for processing interconnection applications to support realistic project schedules for CHP developers.
Timely interconnection-related upgrade cost guide information and hosting capacity maps	State regulatory agencies and utilities should • ensure interconnection rules require transparent, publicly available interconnection-related upgrade unit cost guides and hosting capacity information.	State regulatory agencies and utilities should • ensure interconnection rules require transparent, publicly available interconnection-related upgrade unit cost guides, hosting capacity information***, and heat maps.***

Detailed discussion of FERC Order No. 2023 impacts on CHP interconnection

The following sections describe FERC Order No. 2023 impacts on CHP interconnection in detail.

<u>Opportunities to simplify interconnection rules and processes and provide greater certainty to interconnection customers</u>

In its model guidance, the research team suggested that state regulatory agencies and utilities should provide more clear, standardized procedures and timelines for processing interconnection applications. The cluster and affected system study requirements set forth by FERC Order No. 2023 establish formal, streamlined procedures for reviewing and interconnecting generation facilities. FERC notes that such requirements will help to minimize study delays and provide greater timing and cost certainty, accountability, and transparency throughout the interconnection process. Additionally, Order No. 2023 eliminates the reasonable-efforts standard set forth in Sections 2.2, 3.5.4(i), 7.4, 8.3 of the pro forma LGIP and, in its place, adds Section 3.9 to the pro forma LGIP, which imposes penalties on transmission

[264] For entities under FERC jurisdiction, compliance with FERC orders (e.g., LGIP/LGIA) is required, not optional. For entities outside FERC jurisdiction, notably for projects 20 MW or less, which tend to be interconnected at distribution-level voltages, FERC orders (e.g., SGIP/SGIA) are optional but are recommended as industry best practice.

providers who fail to meet study deadlines. Such penalties will incentivize completing interconnection studies and processing applications within a clearly defined timeline. Although these requirements apply only to generators interconnected at the transmission level as part of the pro forma LGIP, they serve as a useful model for state regulators and utilities to evaluate at the distribution level as well.[265] The model guidance should be updated to account for this.

Opportunities to modify interconnection rules to ensure grid safety and reliability

As part of its model guidance, the research team also recommended that state regulatory agencies and utilities revise interconnection rules so that metering and protection requirements are consistent with the most cost-effective IEEE 1547 2018–compliant requirements to ensure grid safety and reliability for all resource additions. Relatedly, to safeguard system reliability, FERC Order No. 2023 revises the pro forma SGIA and pro forma LGIA to establish ride-through requirements for nonsynchronous generating facilities during abnormal frequency conditions and voltage conditions within the "no trip zone," as defined by North American Electric Reliability Corporation (NERC) Reliability Standard PRC-024-3. According to FERC,

> The existing *pro forma* SGIA and [*pro forma* LGIA] do not currently require non-synchronous generating facilities to be capable of continuing to inject current in a manner comparable to synchronous generating facilities during system disturbances. Thus, non-synchronous generating facilities often cease injecting current during transmission system disturbances through momentary cessation…Such behavior can pose significant risk to the reliability of the bulk-power system…This language requires non-synchronous generating facilities to configure or set their facilities to ride through disturbances and continue to support system reliability.[266]

Because ride-through requirements have the potential to enhance grid safety and reliability for resource additions, including inverter-based CHP, state regulators and utilities should revise interconnection rules to incorporate such requirements. The model guidance should be updated to account for this.

Opportunities to require publicly available, clear, and transparent interconnection-related information

Lastly, the research team's model guidance recommended that state regulatory agencies and utilities update interconnection rules to require publicly available, clear, and transparent interconnection-related upgrade unit cost guides and hosting capacity information. Similarly, FERC Order No. 2023 revises the pro forma LGIP to require transmission providers to publicly post available information pertaining to generator interconnection (e.g., heat maps) and update such information within 30 calendar days of each cluster study. Justifying the adoption of this requirement, FERC stated,

> Interconnection customers currently lack substantial information prior to entering the interconnection queue, which is valuable in determining whether to proceed with a proposed generating facility…The information that we require transmission providers to provide to prospective interconnection customers will allow such customers to learn about available interconnection capacity, as well as other metrics that reflect the impact of the addition of a proposed generating facility to the

[265] Although the pro forma SGIP is intended to serve as a model for state regulators and utilities to reform generator interconnection at the distribution level, state regulators and utilities are not barred from and should consider implementing reforms described in the pro forma LGIP. Nevertheless, state regulators and utilities are not required to abide by the pro forma LGIP.

[266] Federal Energy Regulatory Commission, Order No. 2023, *Improvements to Generator Interconnection Procedures and Agreements*, 2023, Page 1098, https://www.ferc.gov/media/e-1-order-2023-rm22-14-000.

> transmission provider's transmission system at a particular point of interconnection..”[267] This requirement only applies to generators interconnected at the transmission level as part of the *pro forma* LGIP, yet it serves as a useful model for state regulators and utilities to evaluate at the distribution level as well.[268]

The model guidance should be updated to account for this.

Conclusion

As described previously and outlined in Table E-2, in light of FERC Order No. 2023, the research team recommends minor additions to the model guidance. Although the majority of its revisions pertain to the pro forma LGIP and LGIA, which most CHP systems are not subject to,[269] Order No. 2023 also adopts impactful changes to the pro forma SGIP and SGIA regarding the study of alternative transmission technologies, modeling requirements, and performance requirements. For both small and large CHP systems, Order No. 2023 makes considerable strides to mitigate queue backlogs and provide developers with greater cost savings, transparency, and timing certainty throughout the study process. However, additional requirements for CHP systems subject to the pro forma LGIP and LGIA also set forth higher study costs and processes (e.g., initial cluster study deposits, commercial readiness deposits, withdrawal penalties, affected system study process). Although these higher costs may affect CHP business plans, they are designed to streamline the queue and provide clarity on interconnection timelines.

IREC *Model Interconnection Procedures* 2023

The research team's review of the *IREC Model Interconnection Procedures* (MIP) 2023[270] suggests minor changes to the original model guidance in this report relative to the IREC MIP 2019 used to develop it. The research team determined that MIP 2023 is relevant to the interconnection barriers model guidance as shown in Table E-3, with suggested additions shown in bold italic font.

Specifically, in IREC MIP 2023, grounding screens are specified, and rotating generators are differentiated from inverter-based resources. This demonstrates that the interconnection process for rotating machines can be different from inverter-based resources; therefore, separate technical requirements and screens may be necessary to simplify and facilitate their interconnection. Differentiating between rotating and inverter-based resources could help mitigate the findings supporting the original model guidance in this report regarding fast-track procedures.[271] By differentiating between rotating machines and inverter-based resources, MIP 2023 indirectly supports the idea that state interconnection rules, which tend to focus on inverter-based generation resources such as PV in developing fast-track interconnection procedures, might need to develop parallel fast-track procedures for rotating machines (i.e., CHP units that are not packaged with an inverter) that are different from inverter-based fast-track procedures.

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[267] Federal Energy Regulatory Commission, Order No. 2023, *Improvements to Generator Interconnection Procedures and Agreements*, 2023, Page 120, https://www.ferc.gov/media/e-1-order-2023-rm22-14-000.

[268] Although the pro forma SGIP is intended to serve as a model for state regulators and utilities to reform generator interconnection at the distribution level, state regulators and utilities are not barred from and should consider implementing reforms described in the pro forma LGIP. Nevertheless, state regulators and utilities are not required to abide by the pro forma LGIP.

[269] Although there may be relatively few large CHP projects subject to LGIP, the total capacity contributions of such large projects in aggregate are not trivial. Sixty-eight percent of all CHP capacity comes from projects larger than 100 MW.

[270] Interstate Renewable Energy Council Inc, *Model Interconnection Procedures*, 2023, irecusa.org/resources/irec-model-interconnection-procedures-2023/.

[271] See for instance Table 4-2, subject area #3.

Additionally, the two following changes in IREC MIP 2023 could have potential impacts on CHP interconnection, though no change to the original model guidance is needed:

1. In the original model guidance in this report, a fast-track process is recommended, which is included in both MIP 2019 and MIP 2023. However, the eligibility for a fast-track process is updated in the 2023 edition. In MIP 2019, "certified inverter-based DERs that have a Nameplate Rating of 50 kilowatts (kW) or less and an Export Capacity of 25 kW or less" are eligible, whereas in MIP 2023, "certified inverter-based Generating Facilities that have a Nameplate Rating of 25 kilowatts (kW) or less" are eligible. This new MIP 2023 guidance limits the eligibility of micro-CHPs larger than 25 kW for the fast-track process. Furthermore, this report recommends inclusion of non-inverter-based micro-CHPs as eligible DERs for a fast-track process,[272] whereas both MIP editions focus on certified inverter-based DERs.

2. Also relevant to CHP interconnection is a change to the capacity to be used in system impact studies in IREC MIP 2023. MIP 2023 clarifies that for system impact studies, if the DER limits export, exporting capacity should be used for the system impact study rather than the nameplate rating. This is a positive step toward facilitating the interconnection of CHPs with limited export capacity, provided necessary safeguards are in place.[273]

Table E-3. Summary of additions to model guidance in light of IREC MIP 2023

Subject area	Original model guidance language	Additions to model guidance
Interconnection		
Interconnection rules and processes	State regulatory agencies and utilities should • adopt the use of standards (e.g., IEEE 1547-2018, UL 1741) that simplify interconnection, • develop fast-track programs to reduce longer-timeline activities such as modeling and studies where possible while maintaining grid safety and reliability, and • revise interconnection rules to allow for consideration of cost-effective alternatives to interconnection requirements.	State regulatory agencies and utilities should • adopt the use of standards (e.g., IEEE 1547-2018, UL 1741) that simplify interconnection, • develop fast-track programs to reduce longer-timeline activities such as modeling and studies where possible while maintaining grid safety and reliability, • revise interconnection rules to allow for consideration of cost-effective alternatives to interconnection requirements, and • ***develop a separate set of rules and technical screens for rotating machines to further simplify non-inverter-based resources interconnection, such as through a noninverter fast-track process.***

[272] Where non-inverter-based CHPs may have different fast-track eligibility requirements than inverter-based CHP

[273] Safeguards include reverse power protection (Device 32R), minimum power protection (Device 32F), and relative distributed energy resource ratings. For more information, please refer to IREC MIP, pp. 40–41. irecusa.org/resources/irec-model-interconnection-procedures-2023/.