Solutions for States
Energy, Economy & Environment

Navigating the Clean Power Plan: A Template for Including Combined Heat and Power in State Compliance Plans

At a Glance

The US Environmental Protection Agency's (EPA's) proposed Clean Power Plan establishes state-specific emissions targets for carbon dioxide emissions from existing power plants (EPA 2014a). The proposed plan allows states to use end-use energy efficiency as a primary means to comply with the emissions targets.

Combined heat and power (CHP) is an energy-efficient method of generating both electricity and useful thermal energy in a single, integrated system. Emissions reductions from CHP can be a key component of a state's strategy for cost effectively reducing emissions from its power sector. In a recent report, ACEEE found that more than 68 million megawatt-hours (MWh) of electricity could be saved nationwide in the year 2030 from installing new CHP, representing approximately 18 gigawatts (GW) of avoided capacity (Hayes et al. 2014). These energy savings could cut carbon dioxide emissions and offset the need for about 36 coal-fired power plants. These reductions in electricity consumption would help states reduce greenhouse gas emissions by approximately 46 million metric tons in 2030 (see EPA 2014b).

CHP could earn credit in a Clean Power Plan compliance plan in various ways, depending on how a state chooses to structure the plan. This template is designed to account for the various ways CHP might be treated and to act as a resource to help states document and claim emissions reductions as a compliance pathway for the Clean Power Plan. It includes:

1. A discussion of the guidance, precedent, and themes relied on to develop this template
2. A list of the components states should address in order to claim emissions reduction credit for CHP
3. Specific recommendations on how to address these components
4. A hypothetical case study of a state that includes adoption of CHP in its compliance plan

This work product is not intended as an exhaustive representation of what EPA or EPA regional offices will require for the inclusion of CHP in a Clean Power Plan compliance plan. Rather, it offers a conceptual framework on which to build. In drafting this document, we have relied on the provisions in the proposed rule as well as on guidance on and past precedent for the treatment of energy efficiency under other provisions of the Clean Air Act. The final rule could change, and EPA could opt to develop different processes for the treatment of energy efficiency.

Section 1: Guidance and Precedent Relied On to Develop This Document

At the time this document was developed, the Clean Power Plan was still a proposed rule that offered limited guidance on what a state's compliance plan will need to include (EPA 2014a). In Section VIII, Part C of the Clean Power Plan, EPA outlines four general criteria it will use to evaluate state plans and emissions reduction measures:

1. The plan as a whole is projected to achieve the emissions standard.
2. The emissions reductions from compliance measures are quantifiable and verifiable.
3. Each measure has a clear process of reporting on implementation.
4. The measures contained in the plan are enforceable.[1]

These criteria are similar to those EPA has used to judge the adequacy of a state implementation plan (SIP).[2] A SIP is a plan states are required to develop and submit to EPA to meet National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment.[3] The state compliance plan required under Section 111(d) for carbon pollution is not the same as a SIP, and Section 111(d) plans afford states greater flexibility in achieving compliance (James and Colburn 2015).[4] Still, some of the similarities between SIPs and 111(d) compliance plans may be informative. For example, in its guidance for the incorporation of energy efficiency measures into SIPs for NAAQS, EPA described how to ensure that end-use energy efficiency is enforceable, quantifiable, and verifiable; how to project the emissions impacts of an efficiency policy; and how to report on the implementation of that policy (EPA 2012a). We have reviewed several approved SIPs to understand how states have successfully documented and obtained emissions credit for energy efficiency policies, but states have yet to incorporate CHP into an approved SIP. Here, we rely on the guidance in the proposed rule and existing EPA guidance on documenting and crediting energy efficiency and CHP in SIPs to develop a recommended approach that states can use to include CHP in their Clean Power Plan compliance plans.[5]

The Clean Power Plan provides states with a great deal of flexibility, and the method outlined in this document is not the only one a state may use. We have followed EPA precedent to develop a conservative approach that may be more rigorous and complex than what is

[1] The text of the proposed Clean Power Plan was published in Volume 79 of the *Federal Register* on June 18, 2014 (EPA 2014a). Readers can access the complete text here: http://www.gpo.gov/fdsys/pkg/FR-2014-06-18/pdf/2014-13726.pdf. Section VIII, Part C can be found on page 34909.

[2] Although these four criteria are similar to the elements required in state implementation plans (SIPs) for National Ambient Air Quality Standards (NAAQS), "approvability criteria for [Clean Air Act] section 111(d) plans need not be identical to approvability criteria for SIPs" (EPA 2014a, 34909).

[3] The Clean Air Act requires EPA to set NAAQS for pollutants considered harmful to public health and the environment. These standards regulate six common air pollutants (known as "criteria pollutants"): ozone, particulate matter, carbon monoxide, nitrogen oxide, sulfur dioxide, and lead.

[4] The Regulatory Assistance Project (RAP) details the difference between 111(d) plans and SIPS and offers recommendations for states to take advantage of the flexibility afforded under 111(d) (James 2015).

[5] See discussion of CHP in EPA 2012a, Appendix I.

ultimately required for compliance. States may use much simpler options, and EPA will likely provide further guidance in the future on additional options.[6]

In the remainder of this section, we apply the established approaches and existing guidance to the four criteria above. This high-level discussion touches on several of the major themes that contribute to the recommended elements (Section 2), specific recommendations (Section 3), and example language (Section 4).

Projected Achievement of Emissions Standard

State compliance plans must show that included measures will reduce the emissions rates of regulated power plants to the required standard of performance. This means states that choose to include CHP in their compliance plans must demonstrate how CHP will contribute to its achievement of the emissions standard and by how much.

There are various ways in which CHP might figure in a state's compliance plan and help it achieve its emissions standard. The state could simply expand upon existing state and utility programs, or it could develop new initiatives. Program options could include one or more of the following:

- Implement a program or policy that results in CHP deployment such as an incentive, feed-in tariff, rebate, or other financial assistance program for CHP targeted at utility customers
- Include CHP as an eligible resource in a state energy efficiency resource standard (EERS) or renewable portfolio standard (RPS)
- Develop an annual CHP target that requires utilities to obtain a certain percentage of annual sales from CHP in a given year or by a certain year
- Develop a market-based trading program that recognizes CHP
- Enter into bilateral contacts with third parties for CHP generation

More options than those listed here are possible. States should carefully evaluate the full set of available options and choose a structure that fits best within its current context.

What Are CHP Programs and Policies?

States have engaged a variety of policies and programs to support CHP. Here are a few examples.

Interconnection standards and procedures. Statewide technical standards that provide straightforward and streamlined procedures for connecting to the transmission and distribution network support CHP deployment.

Energy savings targets. Allowing CHP to qualify as an eligible measure in state energy savings standards (such as an EERS) can drive investments in CHP.

Financial assistance. Incentives, grants, and loan programs help eliminate barriers to CHP deployment.

Standby rates. Fair and equitable backup, standby, and supplemental power utility rates can encourage CHP.

Streamlined permitting. "Fast-track" air permitting for qualified systems and output-based emissions standards can encourage CHP deployment and more fairly calculate CHP's efficiency benefits.

Technical assistance. Assistance for engineering or feasibility studies helps reduce expenses and overcome the upfront costs of installing a CHP system.

[6] See Colburn, James, and Shenot 2015 for a discussion of simpler approaches.

In their Clean Power Plan compliance plan submissions, states may be able to claim credit for emissions reductions attributable to both new and existing CHP systems. For an existing system that dispatches to the grid, a state might seek credit for increasing the hours of operation or switching the system to a lower-carbon fuel. It appears EPA intends to credit existing renewable energy systems, but it is not clear if existing CHP systems will receive the same treatment. For more information on the treatment of existing and new CHP in the Clean Power Plan and various approaches to calculating emissions reductions, see ACEEE 2014, Appendix C.[7]

To determine how much CHP will contribute to the achievement of the emissions standard, each state will need to develop a reasonable estimate of the energy savings or avoided emissions it expects to achieve with CHP. These projections will vary by state, sector, and the operating characteristics of the system, such as the power-to-heat ratio and how much it is scheduled to run. States can obtain operational and performance data for various types of CHP technologies from agencies such as the EPA Combined Heat and Power Partnership and the US Department of Energy's (DOE's) CHP Technical Assistance Partnerships (TAPs).[8] States may work with their affiliated TAP or private consultants to produce a potential study that discusses the application of CHP technologies in their state; this would provide useful data for compliance planning.[9] To develop an estimate of expected energy savings, EPA recommends starting with local energy experts and agencies, including public utility commission staff and state or local energy offices that may help in this regard (EPA 2012a).[10]

ICF International has published estimates of technical and economic potential for CHP under several scenarios on a state-by-state basis (ICF 2013a), and this may offer useful guidance to states. In a recent report, ACEEE adapted ICF's technical potential estimates and estimated effective electricity savings (MWh) resulting from the expected installation of new, cost-effective CHP systems by 2030 in each state (Hayes et al. 2014). States may wish to use these potential estimates as a starting point, possibly adjusted on the basis of past experience, a recent potential study, the adoption of new policies, or a conservative estimate. In Section 4 of this document, we provide a sample calculation for quantifying electricity savings from CHP for states' consideration. These estimates can later be trued up with actual savings, a process that generally involves direct measurement of CHP system output using an approved metering technology.

The state is also required to ensure that forecasted emissions reductions actually occur within the designated time frame. One way to ensure this is to adopt measures that will have lasting effects on emissions. The technical lifetime of a CHP system is generally 15 to 20 years,

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[7] For more discussion on different categories of CHP in the context of the Clean Power Plan, see Spurr 2015.

[8] Operational and performance data are available from EPA CHP Partnership 2015a. More information about EPA's CHP Partnership (2015c) is available at: http://www.epa.gov/chp/. More information about DOE's CHP TAPs (DOE 2015) is available at: http://energy.gov/eere/amo/chp-technical-assistance-partnerships-chp-taps.

[9] An example of such a study, prepared in 2010 for the state of Maryland by the US DOE Mid-Atlantic Clean Energy Application Center (2010), is available at http://energy.maryland.gov/empower3/documents/MarylandCHPMarketAnalysis.pdf.

[10] See EPA 2012a, Appendix I, p. 12.

depending on variations in technology and application. The state should take action to ensure that CHP systems continue to operate at expected efficiencies and anticipated run times. The latter may be more difficult as utilization of CHP fluctuates with seasonal and/or production demand and with variations in energy price. CHP systems are likely to operate at high capacity factors after they are built to maximize the upfront investment. One way states can help assure the CHP system remains economical to run is to design a program that incentivizes continued operation with performance-based payments. Capital incentives for installation ($/kW) will ensure that CHP systems are constructed and operational, while incentives for performance ($/kWh) will help ensure that systems operate at or near the capacity factor assumed in an emissions reduction estimate. Binding legislation or regulations can also ensure that programs to support CHP stay in place over time. For example, a state that currently does not have an EERS or RPS could consider establishing these policies as frameworks for ensuring long-term continuity.

Quantifiable and Verifiable Emissions Reductions

State plans must detail how emissions reductions will be quantified and verified. According to SIP guidance, in order for a measure to be considered "quantifiable," it must have a measureable, replicable effect on emissions (EPA 2012a). The Clean Power Plan contemplates methods for quantifying the impact of an efficiency policy by measuring energy savings and converting those savings into an emissions impact. In the case of CHP, more than one methodology for quantifying emissions savings from CHP may be permissible (EPA 2012b). Energy savings and emissions reductions may be quantified and verified through direct measurement or another technically sound method that is both reliable and replicable. We recommend that a state identify a protocol for verifying the electricity savings and associated emissions reduction from CHP.

In general, CHP reduces power sector emissions by shifting electric load away from conventional power plants to the CHP unit (typically near the point of use) while moderately increasing fuel consumption at the CHP unit. Due to the avoided transmission and distribution losses and the overall efficiency of cogenerating heat and power, CHP results in primary fuel savings. Overall fuel savings can be determined by subtracting the fuel used to power a CHP site's electrical and thermal generation from the fuel that would have been used to provide the same energy services with separate heat and power (i.e., central station generation and onsite thermal generation).

The EPA Combined Heat and Power Partnership has published a simple methodology for calculating fuel savings and carbon dioxide emissions savings from CHP (EPA 2012b). Based on this method, the EPA developed a CHP Emissions Calculator, an online tool to help states estimate emissions impacts from a particular CHP project or group of projects (EPA CHP Partnership 2015d). EPA's calculator may be useful to states in estimating CHP emissions savings, although some critical assumptions are required.

More recently, EPA released the Avoided Emissions and Generation Tool (AVERT), another online instrument that can be used to estimate the energy and emissions characteristics of displaced grid power (EPA 2015). AVERT provides a more sophisticated approximation of

avoided central station generation and performs emissions displacement calculations based on historical hourly emissions rates for electric-generating units for 10 regions of the country.

States should consider using software capable of modeling the effects of CHP on electricity consumption from the grid. A variety of key variables need to be considered when devising methods for modeling emissions reductions from CHP. The nature of the generation from the electricity grid that the CHP system is avoiding is one of the most important factors in accurately calculating energy and emissions savings from CHP. Without dispatch modeling, characteristics of displaced grid electricity can be reasonably approximated using Emissions and Generation Resource Integrated Database (eGRID) heat rates and emissions factors for the electric grid of the subregion where a given CHP system is located. The EPA CHP Partnership recommends selecting the eGRID subregion all fossil generation emission factor and heat rate for baseload CHP systems (i.e., those operating at least 6,500 hours annually) or the non-baseload emission factor and heat rate for CHP systems operating fewer than 6,500 hours annually (EPA 2012b).[11]

Process for Reporting on Plan Progress and Corrective Actions

For a measure to be deemed acceptable for inclusion in a state compliance plan, it should include a process for reporting its performance and implementation to EPA. One option is to set up a system for measuring the output of individual CHP systems using meters at the facility level. Facilities would report measured output data back to the agency responsible for monitoring the implementation of the CHP program or policy. States should monitor progress, which can be done by direct measurement, and report the results to EPA biennially (EPA 2014a, 34837).

Enforceability

The exact meaning of enforceable in the context of the Clean Power Plan is still uncertain.[12] In spite of this uncertainty, some general principles are likely applicable if a measure is ineffective and fails to achieve the emissions reductions it is supposed to. Methods to establish that a measure is enforceable to EPA's satisfaction might include the authority to levy penalties or force corrective action, or an obligation on the state's part to make up any shortfall (EPA 2014a, 34909). Therefore, if a measure is to be federally enforceable, a state would likely need to commit to evaluating its effectiveness. Establishing enforceability has historically involved demonstrating that a measure is mandatory and that legal authority has been granted by legislation and/or regulations to the relevant governing body (EPA 2012a).

In general, a key to enforceability is having a responsible party that will face penalties or find additional emissions reductions to compensate for a shortfall. A measure may be federally enforceable when the state or affected power plants are directly obligated by law to implement it. However it is possible that measures could be enforceable against third parties, such as utility companies or individual CHP system owners who may be responsible for operating a certain number of hours per year. States must consider where they want this obligation to fall and

[11] On 6/8/2015 the author corrected the wording of this sentence originally published on 6/2/2015.

[12] EPA sought comment on this issue in the Clean Power Plan (EPA 2014a, 34909).

should consult the final rule for additional guidance. One option for states to consider is to shield CHP system owners from federal enforceability by agreeing to meet any shortfall in anticipated emissions reductions through other energy efficiency policies or measures as part of a larger portfolio. Including a diverse portfolio of measures in a state compliance plan reduces the risk of failing to reach the emissions goal. While some elements of a portfolio may underperform, others may overperform, helping to safeguard states from concerns about enforceability.

Section 2: Combined Heat and Power Template Components to Include in State Plans

The following list outlines seven overarching template components and a series of corresponding subcomponents that a state should consider addressing when incorporating CHP in a Clean Power Plan compliance plan. Although various levels of rigor may be required, depending on the approach adopted, ACEEE recommends that these elements be included to give the plan the best chance of being accepted by EPA. In the sections that follow this list, we provide more detailed guidance on filling in the template inputs and a case study with language for a hypothetical compliance plan.

Brief Overview of CHP Compliance Measure

- Description of CHP measure, including the roles of state agencies
- Time line for the CHP compliance measure, effective date, and any obligated sectors (industrial, commercial, governmental)
- CHP's role in the state's overall plan

Discussion of Measure Technology

- History of CHP in the state
- Manner in which CHP will yield emissions reductions at affected electric generating units (EGUs)
- Common assumptions surrounding CHP

Quantification of Emissions Benefits Potential

- Methodology for calculating the electricity savings attributable to CHP
- Equation for calculating electricity savings
- Data assumptions and sources
- Potential effects of CHP on emissions

Implementation

- Status of CHP in the state
- Existing frameworks for CHP implementation
- Entities involved in implementation

Monitoring and Reporting

- Process by which CHP will be monitored and evaluated
- Entities responsible for monitoring CHP compliance (facility, utility, state agency, federal agency, and so on)
- Sources of relevant data collected from monitoring (fuel input, net MWh output, net useful heat output, and so on)
- Process for overseeing and reporting on CHP

Enforcement

- Entities legally responsible in the case of noncompliance, failure to implement, or emissions reduction shortfall
- Entities with the jurisdiction to enforce CHP compliance measure
- Process for enforcing CHP compliance measure
- Corrective actions available in case of emissions reduction shortfall, and shortfall remedies

Verification and Quantification

- Verification process for electricity savings attributable to CHP
- Entities responsible for verifying that electricity savings have occurred
- Process for reporting verified electricity savings
- Process to be used in quantifying energy savings and emissions reductions

Section 3: Instructions and Recommendations for Addressing Template Components

This section contains detailed instructions and specific questions we recommend that states consider addressing in their compliance plans. Following this is a hypothetical in which we provide example responses to these instructions and questions for the state of Mississippi. This example does not represent any commitment or intention on the part of Mississippi; rather, it illustrates the process by which Mississippi or any other state could effectively incorporate CHP as part of its compliance plan.

Brief Overview of CHP Compliance Measure

Description of CHP compliance measure, including the roles of state agencies. Briefly describe the CHP facility, program, or policy for which the state is seeking credit, the process that led to the measure's taking effect, the entities involved in evaluating CHP compliance options and setting parameters, and how this process may have been amended in the present context.

The time line for the CHP compliance measure, effective date, and obligated sectors (industrial, commercial, governmental). Discuss when the CHP measure will go into effect and electricity savings will begin to be counted. If adopting a new CHP policy or program, include which customer class the program or policy targets.

CHP's role in the state's overall plan. Briefly describe the status of the measure in the overall plan. Include how the measure will be enforced relative to other measures, and the role the measure will have in achieving the overall required emissions reductions.

Questions to consider for this section:

- What is the status of CHP deployment in the state?
- What commitments have state or local governments made under the policy/program?
- How might CHP program administration and enforcement need to change to ensure that the energy savings claimed are being achieved?[13]

Discussion of Measure Technology

The state's history on implementation of CHP. Include some description of the existing CHP capacity in the state and any existing laws, policies, or programs relevant to CHP deployment. A description of existing capacity may include information on system size, range, fuel, site, and sector. Refer to any prior studies detailing historic electricity savings or emissions reductions attributable to CHP programs or policies.

The manner in which the CHP compliance measure will yield emissions reductions at affected EGUs. Explain the measure and how emissions reductions are expected to occur. Discuss how CHP

[13] Many of these questions are addressed above, but we list them here as well for completeness.

shifts electric load away from conventional power plants and burns less fuel overall to reduce electricity consumption and emissions from electricity generation at affected EGUs.

The common assumptions surrounding CHP. Discuss the common assumptions the state may depend on for quantification purposes. Assumptions could be related to CHP system, size ranges, technologies, fuel types, or system efficiencies. A description of how savings from CHP systems will be rewarded may be included, as well as documentation of the typical energy savings seen with the implementation of CHP policies and programs.

Questions to consider for this section:

- What sectors/entities does this compliance measure apply to?
- What, if any, existing CHP policies or programs are modified or replaced?
- How will the CHP compliance measure reduce EGU emissions?
- Are there any reports or studies describing how CHP impacts emissions in the state?

Quantification of Emissions Benefits Potential

The methodology used in calculating the electricity savings attributable to CHP. Describe any emissions benefits anticipated from the CHP compliance measure and the high-level methodology used to arrive at them.

The general equation used in calculating electricity savings. You may base the emissions benefits potential of CHP on an equation that takes into account forecasts of new CHP installations, as well as a baseline of what electricity consumption would be without implementation of the proposed CHP compliance measure. Another approach might be to rely on energy savings estimates provided by utilities or published estimates of state CHP potential such as those conducted by ICF International or ACEEE (ICF 2013a; Hayes et al. 2014). The simplest approach could be to obtain or commission a potential study that includes a forecast of associated savings for compliance purposes. If a state wishes to conduct its own calculation, we suggest the following method as a possible basis for estimating the energy savings from CHP:

Step 1. Determine total electricity output (MWh) from the CHP measure (either a single system or a fleet of systems in the state).

Step 2. Determine a discounted portion (%) of electrical output that should be attributed to a CHP measure as "avoided generation" from the grid. In spite of being highly efficient, CHP systems still generate some carbon dioxide emissions. Rather than credit 100% of the MWh generated as "avoided generation," a state can use the following steps to discount the amount of electricity generated by CHP for crediting purposes.

- *Step 2a.* Calculate an incremental CHP emissions rate for the CHP measure (either a single system or a fleet of systems in the state).

- *Step 2b.* Calculate a percentage by which the MWh of CHP generation should be discounted by comparing the incremental CHP emissions rate with the state's 2012 fossil emissions rate.

Step 3. The result of Step 2 is the percentage of CHP electric output that is eligible for credit. Multiply total electricity output (MWh) from Step 1 by the percentage from Step 2. This yields the projected electricity savings that should be credited to the CHP measure.

This is just an example, and other methodologies and calculations are possible. For example, some CHP programs may consider the total amount of electric output from CHP as equivalent to the amount of avoided grid generation. However this one-for-one approach does not account for the incremental increase in fuel use and incremental CO_2 emissions at the CHP facility.

Data assumptions and sources. Include detailed assumptions and any supporting documentation. Assumptions could include values for variables such as the estimated hours of operation for the measure, the efficiency of the avoided boiler, the average heat rate for the CHP measure and for the local grid, and fuel-specific emissions factors.[14] Assumptions could also include the effect of interstate electricity flows on the reduction of electricity generation from affected EGUs.[15] States should include detailed descriptions of any assumptions, default values, and/or modeling results with their submissions.

The potential effects of CHP on emissions. Your calculations should result in an estimate of the impact of the CHP compliance measure on electricity consumption and the associated EGU emissions. Document the level of reduced emissions expected from the measure by clearly showing how you arrived at your estimate. This may include attaching detailed spreadsheets or model results.

Questions to consider for this section:

- How will the state treat or make up for shortfalls in expected savings?
- What baseline forecast of energy use should be used to calculate electricity savings from the CHP compliance measure?
- What assumptions should be used in CHP compliance measure development?
- How will the effect of interstate electricity flows be accounted for?
- Where are data available for use in preparing an estimate?

Implementation

The status of CHP in the state. Explain the current processes for implementing the CHP compliance measure in the state, as well as what is necessary for proper program administration. This may include identifying the entities responsible for constructing and operating a CHP facility. If the compliance measure is the adoption of a policy or program, this may include identifying who is responsible for reviewing applications for program eligibility,

[14] The term "heat rate" is often used to express the efficiency of electric generators and is represented in terms of Btus of fuel consumed per kWh of electricity generated. The heat rate of a CHP system varies by type of fuel input and technology.

[15] We discuss this last issue later in this document.

approving or denying CHP projects, conducting site inspections, and reviewing monthly or annual operating data to ensure technical performance requirements are met.

The existing structures for CHP implementation. Describe the existing structures for CHP implementation, including who has authority over whom. Note whether it will be necessary to alter these structures in order to include the measure in the compliance plan submission.

The entities involved in implementation. List any federal, state, and local government agencies and private stakeholders involved in implementation or administration of the CHP compliance measure. Describe the level of responsibility that is assigned to each group.

Questions to consider for this section:

- What are the responsibilities of the parties involved?
- What structures for CHP construction or program administration already exist?
- Will resources need to be allocated to improve program implementation and administration?

Monitoring and Reporting

The process by which CHP will be monitored and evaluated. Provide specifics on the process the state will use to monitor electricity savings and emissions reductions. Include the protocols for monitoring and data collection. Some monitoring procedures and metering equipment may be consistent with and not additional to separate requirements for obtaining a valid air permit. Set explicit deadlines and time frames for reporting on CHP system performance.

The entities responsible for monitoring CHP compliance (system owner, utility, state agency, federal agency, and so on). Identify the parties responsible for compiling relevant data on compliance and CHP system or program performance. Include the parties with the legal authority to administer the compliance measure.

Sources of data from monitoring (e.g., fuel input, electricity output, useful heat output, and so on). Identify where data necessary for quantifying effects of CHP on greenhouse gas emissions will come from. Identify the parties who currently have access to the necessary data, and describe how the state will access and compile these data.

Process for overseeing and reporting on CHP. Identify a process to ensure that CHP performance is faithfully monitored. Include measures to ensure that affected EGUs regularly collect and report relevant data, and describe structures for regular reporting from local to state to federal entities.

Questions to consider for this section:

- What agencies will be charged with the task of monitoring implementation of the measure?
- Through what channels will reporting on implementation and enforcement take place?
- What will be the process for reviewing annual reporting data?
- What agency relationships are necessary to ensure accurate and efficient monitoring and enforcement?

Enforcement

The entities against which the compliance plan will be federally enforceable in the case of noncompliance, failure to implement, or an emissions reduction shortfall. Identify who is responsible for any shortfall in actual versus anticipated emissions reductions. The entities responsible to EPA in the case of an emissions reduction shortfall are not necessarily the same as those responsible for implementing the measure. States may consider taking on the responsibility for assuring the federal government that the emissions reductions claimed from CHP have actually occurred. Monitoring progress over time and having a plan in place to make necessary adjustments reduces the risk of an emissions reduction shortfall.[16]

The entities with the authority to enforce the CHP measure. Identify the entities charged with enforcing the measure. Identify regulations or legislation empowering the enforcing entity.

The process to be used in enforcing the CHP measure. Identify the structures and processes set in place to ensure that the measure is implemented and entities subject to the measure are acting within the requirements for compliance.

The corrective actions available in case of an emissions reduction shortfall, and shortfall remedies. Identify the action that will be taken if the CHP measure does not achieve the necessary emissions reduction. Explain how the overall plan will be reviewed and adjusted to correct the shortfall. Penalties for failure to comply might include the issuance of a plan for correction of noncompliance or levying of a fee for noncompliance.

Questions to consider for this section:

- Who has the jurisdiction to enforce the measure?
- What will be the process for enforcing the measure?
- What corrective actions may be necessary in order to remedy any shortfall?
- Who is responsible for remedying any shortfall?

Verification and Quantification

The verification process for electricity savings attributable to CHP. Outline the process for verifying that the energy savings and emissions reductions potential previously quantified actually occur. Explain how annual reporting data will be used to demonstrate savings.

The entities responsible for verifying that the stated electricity savings have occurred. Identify which entities (state agencies, EGUs, utilities, or third parties) have access to CHP performance data and who will be responsible for measuring energy savings.

[16] EPA requested comment on multiple options for handling enforcement, and we anticipate clear guidance on this issue in the final rule. Including a diverse portfolio of measures in a state compliance plan may reduce the risk of an emissions reduction shortfall.

The process for reporting verified electricity savings. Describe the process to be used in reporting verified emissions reductions to both the state and EPA.

The process to be used in quantifying energy savings and emissions reductions. Describe the process for calculating the 2030 emissions reduction attributable to the CHP measure. Identify how electricity consumption reductions will be translated into emissions reductions. This latter question could be the subject of an entire paper. Many approaches are possible, ranging from dispatch modeling at the most complex to a simple denominator adjustment reflecting MWh savings, as provided in the draft Clean Power Plan. In the latter approach, only MWh savings need be calculated, and these savings are factored into the state's emissions rate with no further emissions calculations needed.

Questions to consider for this section:

- Who will be responsible for verifying that the CHP measure is operating as mandated?
- How often will emissions reductions be calculated?
- How often will emissions reductions and energy savings be reported?
- How will emissions reductions be quantified?

Section 4: Sample Case Study for Combined Heat and Power in a State Compliance Plan

For the purpose of demonstration, we have developed a hypothetical scenario based on the real processes and institutions of the state of Mississippi. This example does not represent any commitment or intention on Mississippi's part, but illustrates how Mississippi or any other state could effectively incorporate CHP as part of its state compliance plan. In this scenario, Mississippi has established a goal of increasing CHP capacity from its current capacity by the year 2030 and is seeking credit for the implementation of this program in its Clean Power Plan compliance plan submission.

Adoption and Implementation of a Statewide Energy Savings Target for Combined Heat and Power

The following represents a hypothetical submission by the Mississippi Department of Environmental Quality (MDEQ) to EPA Region 4 for the crediting of new combined heat and power requirements in reducing greenhouse-gas emissions from EGUs under the provisions of the Clean Power Plan.[17] This hypothetical scenario was created solely by ACEEE with no contribution from any agency from the state of Mississippi.

Brief Overview of the CHP Compliance Measure

CHP reduces power sector emissions by shifting electric load away from conventional power plants to the CHP unit. With the establishment of a goal to increase CHP capacity by approximately 40% from the current 514 MW by 2030, the state will reduce the electricity consumption of electric generating units in Mississippi.[18]

The Energy and Natural Resources Division of the Mississippi Development Authority (MDA), in cooperation with the Mississippi Department of Environmental Quality (DEQ) and the Mississippi Public Service Commission (MSPSC), shall determine the percentage of annual electricity sales each retail supplier shall obtain from CHP resources based on a study of the potential for CHP in the suppliers' service territories.[19] As part of achieving this goal to increase CHP capacity, retail electricity suppliers shall provide financial assistance to customers installing and operating CHP systems. All retail electricity suppliers have filed plans for meeting CHP energy savings requirements. All plans were approved by the state as of June 1, 2016, and are effective January 1, 2017.

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[17] To condense this demonstration, we have omitted certain elements that may be required. Specifically, we have not included all calculations, modeling, technical support documents, and other supporting materials that may accompany a formal compliance plan submission.

[18] This is a hypothetical goal that could be implemented in Mississippi through either administrative or legislative action. Each state will need to identify the best means by which to implement the compliance measure, depending on its specific circumstances. For example, in Mississippi, the Mississippi Development Authority administers the state's existing CHP program and may be the best entity to implement the goal. The Mississippi Public Service Commission does not have jurisdiction over all electric service providers in the state.

[19] States will need to conduct a target-setting exercise based on available data (such as existing CHP capacity) and a study of potential savings from new CHP installations.

The implementation of the Statewide Energy Savings Target for CHP has been included by the state of Mississippi in its Clean Power Plan compliance plan submission as a state commitment. The enforcement of the requirements will remain the sole authority of the state. Any shortfalls in forecasted emissions reductions shall be enforced against the state, should EPA see fit to do so. If necessary, the state will enact other measures as appropriate to rectify any lapse in emissions reductions herein attributed to the statewide adoption and implementation of the Statewide Energy Savings Target for CHP. MDA's Energy and Natural Resources Division has the authority to implement and administer the program, and electricity service providers shall have retail autonomy to perform all tasks otherwise associated with the program, with regulatory approval where applicable.

Discussion of Measure Technology

Mississippi has experience developing CHP projects in the state. There are currently 20 CHP units representing approximately 514 MW of existing operating CHP capacity in the state (ICF 2013b). The first CHP system in Mississippi came online in 1951; it is owned by the Transcontinental Gas Pipeline Corporation. The largest system (approximately 168 MW) is a natural gas combustion turbine owned by Mississippi Power and operating at the Chevron Oil Refinery. Of the 514 MW of installed capacity, 484 MW, or about 94%, was installed prior to the year 2000. The most recent installation was the Jones County Poultry Digester, a 1.5 MW farm-scale biogas system installed in 2010. Existing capacity primarily serves Mississippi's pulp and paper (57%) and refining (31%) industries.

CHP is eligible for a low-interest loan through one of the state's existing programs, the Energy Efficiency Revolving Loan Fund, which MDA administers to encourage the implementation of a broad list of energy efficiency measures, including CHP. However no CHP project has applied for a loan through the program to date. The Statewide Energy Savings Target for CHP does not replace this MDA-administered loan program, though these programs may have a compounding effect.

Nationally, CHP has provided cost-effective energy savings for decades. Through a reduction of electricity consumption at industrial, commercial, and government facilities, a corresponding amount of electricity generation is avoided from fossil fuel–fired EGUs. According to a 2012 EPA and DOE analysis, the existing 82 gigawatts (GW) of installed CHP capacity in the United States saves 1.8 quadrillion Btus each year, which is about 2% of US annual energy use. These energy savings are calculated to result in a reduction of 240 million metric tons of CO_2 emissions each year (EPA and DOE 2012).

Specific to Mississippi, a 2013 analysis conducted by ICF International for the American Gas Association found 274 MW of natural gas–fueled CHP potential in the state with a simple payback of 5 to 10 years. The study found an additional 1,086 MW of natural gas–fueled CHP potential with a simple payback greater than 10 years. State policies and incentive programs such as the Statewide Energy Savings Target for CHP will improve the return on investment for financing CHP systems and increase the economic potential for CHP in Mississippi. A 2016 potential study, completed for the state by the DOE's Southeast CHP TAP, evaluated the

potential impact of the proposed policy.[20] The study found the Statewide Energy Savings Target for CHP would result in at least 200 MW of additional installed capacity by 2030.

The Statewide Energy Savings Target for CHP creates an obligation for all retail electricity providers to acquire CHP certificates equal to a set percentage of annual retail electricity sales (MWh).[21] Qualified CHP units generate certificates that are sold to obligated electricity providers, creating an incentive for Mississippi's commercial, industrial, and governmental customers to install energy-efficient CHP systems and reduce energy use in the state. Certificates from CHP are counted toward the electric providers' CHP savings requirement. The following summarizes some of the eligibility requirements systems must meet to qualify for the program:[22]

- Eligible systems shall not supply more than 25 MW and one-third of their power back to the grid.
- Eligible equipment shall include reciprocating engines, combustion turbines, steam turbines, micro-turbines, and fuel cells.
- Qualifying units are nonrenewable-fueled systems. This program operates in conjunction with a separate renewable portfolio standard that covers renewable-fueled CHP.
- The system must be placed in operation after June 1, 2014.
- Qualifying systems must achieve a combined electric and thermal efficiency of at least 60% higher heating value (HHV).
- A percentage of MWh electric output will qualify for crediting based on a prorated credit for CHP, described below.
- 1 MWh of eligible electricity output = 1 CHP certificate.

Quantification of Emissions Benefits Potential

In order to develop a preliminary estimate of the potential emissions benefits attributable to the implementation of a Statewide Energy Savings Target for CHP, the state of Mississippi has elected to use the following approach for a CHP quantification methodology:

Step 1. Determine total electricity output (MWh) from CHP measure (either a single system or a fleet of systems in the state).

[20] This is a hypothetical study.

[21] The state of Mississippi does not presently have such a policy. A similar policy structure exists in Massachusetts, where an Alternative Portfolio Standard (APS) sets a statewide savings target for generation from alternative energy sources (including CHP) as a percentage of electricity sales. The policy outlined here is also similar to a policy recommended by FVB Energy to the Minnesota Department of Commerce (FVB Energy 2014).

[22] Most states define the attributes of CHP systems that are eligible in their portfolio standards. EPA's CHP Partnership provides guidance on CHP program design features and key policy considerations of CHP in portfolio standards (EPA CHP Partnership 2015b). This guidance may be useful to states pursuing a policy option similar to the one presented here. These attributes are for demonstration purposes only and do not represent a recommendation for how individual programs should be structured. For example, a state may allow CHP technologies other than those listed in this example to be eligible.

The Statewide Energy Savings Target for CHP is expected to result in the installation of 200 MW of CHP electric generating capacity by 2030 in Mississippi. We assume that a fixed amount of capacity is installed each year starting in 2017, such that the state would reach 200 MW by 2030. This new capacity is expected to generate 1,401,600 MWh of annual electricity output in the year 2030.

Step 2. Determine a discounted portion (%) of electrical output that should be attributed to a CHP measure as avoided generation from the grid.[23]

- *Step 2a.* Calculate an incremental CHP emissions rate for the CHP measure (either a single system or a fleet of systems in the state).

$$= \frac{\left(CHP\ fuel\ input * Fuel\ emission\ factor - (\frac{Useful\ thermal\ output}{Boiler\ efficiency} * Fuel\ emission\ factor)\right)}{CHP\ electricity\ output\ (MWh)}$$

$$= \frac{\left(14{,}906{,}016\ MMBtu * 116.9\ lbs/MMBtu - (\frac{5{,}801{,}012\ MMBtu}{80\%} * 116.9\ lbs/MMBtu)\right)}{1{,}401{,}600\ MWh}$$

$$= 638\ lbs./MWh$$

- *Step 2b.* Calculate a percentage by which the MWh of CHP generation should be discounted, by comparing the incremental CHP emissions rate with the 2012 fossil emissions rate.[24]

$$= 1 - Incremental\ emissions\ rate/2012\ fossil\ emissions\ rate\ adjusted\ for\ T\&D\ losses$$
$$= 1 - (\frac{638}{1185} * (1 - 7\%))$$
$$= 49.9\%$$

Step 3. Multiply total electricity output (MWh) from Step 1 by the percentage from Step 2. The result yields the projected electricity savings that should be credited to the CHP measure.

$$= Total\ electricty\ output\ (MWh) * Prorated\ credit\ for\ CHP\ (\%)$$
$$Eligible\ electricty\ output\ (MWh) = 1{,}401{,}600 * 49.9\%$$
$$Eligible\ electricity\ output\ (MWh) = 699{,}320$$

Using the above quantification methodology, and assuming the target is achieved each year from 2017 until 2030, the state of Mississippi estimates the potential total electricity savings attributable to the adoption and implementation of the Statewide Energy Saving Target for CHP

[23] Appendix A of this document provides more detail on Step 2 of this calculation.

[24] According to EPA, Mississippi's 2012 fossil emissions rate is 1,185 lbs./MWh. Emissions rates can be accessed in EPA's "Clean Power Plan State Goal Visualizer" spreadsheet.

to be 699,320 MWh by the year 2030. In addition, the state has entered into a memorandum of understanding (MOU) with other states in the electric region specifying that all savings attributable to the implementation of the program will be claimed by the state of Mississippi.

These energy savings were added to the denominator of Mississippi's current emissions rate for affected EGUs (1,185 lbs./MWh) as net zero emissions generation (0 lbs./MWh) in order to estimate the potential effect on the attainment of the state's 2030 standard of performance target. This calculation found a potential 19 lbs./MWh reduction in emissions rate attributable to the adoption and implementation of the Statewide Energy Savings Target for CHP.

Implementation

Program implementation will be the responsibility of MDA's Energy and Natural Resources Division. Commercial, industrial, and governmental customers will submit applications for certification of qualifying CHP units to MDA. Retail electricity suppliers are responsible for obtaining CHP certificates equal to the set percentage of its sales. The Department of Energy (DOE) allocated additional funding to MDA and other energy offices for Clean Power Plan implementation, and MDA will allocate $200,000 of its annual budget for program administration and management for FY 2017.[25]

Monitoring and Reporting

MDA's Energy and Natural Resources Division will monitor and report on the program. MDA will review applications for qualifying CHP units, and site inspections will be periodically performed. Metering of all fuel inputs and energy outputs are required, and all eligible projects must install MDA-approved metering equipment. Facilities will report metered data annually to MDA no later than February 15 of each calendar year. MDA will then compile and report the annual totals to MDEQ in an annual compliance report no later than March 15. MDEQ will track the progress of all measures contained in this plan submission, as well as the emissions rates of all affected EGUs, and compile and submit a report on the previous year's progress to the General Assembly, Governor's Office, and EPA Region 4 headquarters no later than July 1 of each calendar year.[26]

Enforcement

The enforcement of the rule will remain the sole authority of the state. Any shortfalls in forecasted emissions reductions shall be enforced against the state, should EPA see fit to do so. MDA's Energy and Natural Resources Division will maintain the authority to enforce the program in accordance with the rule. Should an electricity service provider fail to obtain the CHP certificates required to meet the Statewide Energy Savings Target for CHP, an alternative compliance payment will be collected. If the target established by the program fails to meet the level of savings assumed in the calculation of potential benefits contained herein, or if any other lapses in implementation occur that cause the electricity savings and emissions reduction attributable to the CHP program to fall short of those claimed in this compliance plan, MDEQ,

[25] This is a hypothetical allocation.

[26] This process does not reflect current practices. It is a suggestion of what EPA may require of a state to show that the state is faithfully executing plan progress monitoring.

working with MDA, as well as the MSPSC, will reevaluate the provisions contained in this submission and enact the necessary measures to make up the shortfall. Alternative compliance payments collected through the program may be used to address the shortfall.

Verification and Quantification

In order to verify that the electricity savings estimated from the implementation of the CHP program occur, actual savings obtained through direct measurement of CHP system output using an approved meter technology will be compared and trued up with earlier estimates. All electricity savings found using these methods will be credited to the state of Mississippi.[27] MDA will be responsible for conducting regular oversight of facility metering equipment, calibration, and data collection procedures. Working with MDA, MDEQ will report to the Mississippi General Assembly, Governor's Office, and EPA Region 4 headquarters on the level of verified electricity savings biennially, no later than July 1 of the calendar year, beginning in 2017.

[27] The state has entered into a memorandum of understanding (MOU) with all states in the same electric region to ensure that no double counting due to electricity imports/exports occurs.

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Appendix A. Calculation for Program Savings in 2030

Step 2a: Incremental CHP emissions rate (lbs./MWh)

Total annual CHP capacity in 2030 (MW)	200
CHP annual capacity factor (hours)	7008
Average CHP fleet efficiency	71%
Average CHP heat rate (MMBtu/MWh)	10.6
Annual CHP fuel input (MMBtu)	14,906,016
Annual CHP fleet electricity output (MWh)	1,401,600
Annual CHP fleet thermal output (MMBtu)	5,801,012
Fuel-specific CO_2 emissions factor (natural gas) (lbs./MMBtu)	116.9
Estimated efficiency of displaced boiler	80%

$$Incremental\ CHP\ emissions\ rate\ (lbs/MWh)$$

$$= \frac{\left(CHP\ fuel\ input * Fuel\ emission\ factor - (\frac{Useful\ thermal\ output}{Boiler\ efficiency} * Fuel\ emission\ factor)\right)}{CHP\ electricity\ output\ (MWh)}$$

Where

- CHP fuel input (MMBtu) = CHP electricity output (MWh) * CHP heat rate (MMBtu/MWh)
- Fuel emission factor is a specific CO_2 emissions factor for a particular type of fuel (116.9 lbs./MMBtu for natural gas).
- Useful thermal output (MMBtu) = CHP fuel input (MMBtu) * CHP system efficiency (%) – CHP electricity output (MWh) * 3.412 (MMBtu/MWh)[28]
- Boiler efficiency (%) is a default value (such as 80%) or a measured or known boiler efficiency value.
- CHP electricity output (MWh) = CHP capacity (MW) * Estimated hours of operation

$$Incremental\ CHP\ emissions\ rate\ (lbs/MWh)$$

$$= \frac{\left(14{,}906{,}016\ MMBtu * 116.9\ lbs/MMBtu - (\frac{5{,}801{,}012\ MMBtu}{80\%} * 116.9\ lbs/MMBtu)\right)}{1{,}401{,}600\ MWh}$$

$$Incremental\ CHP\ emissions\ rate\ (lbs/MWh) = 638$$

[28] Conversion factor of 1 MWh = 3.412 MMBtu

Step 2b: Prorated MWh Credit for CHP (%)

2012 fossil emissions rate for Mississippi (lbs./MWh)	1,185
2012 fossil emissions adjusted for T&D losses	1,274

$$Prorated\ credit\ for\ CHP\ (\%) = 1 - Incremental\ CHP\ emissions\ rate/2012\ Fossil\ Emissions\ Rate\ adjusted\ for\ T\&D\ losses$$

Where

- 2012 fossil emissions rate adjusted for T&D losses = 2012 fossil emissions rate/1 – T&D loss percentage
- We assume a 7% transmission and distribution loss. A typical loss can be 6–7%, and on peak days, the loss can be up to 20%.[29]

$$Prorated\ credit\ for\ CHP\ (\%) = 1 - 638/1274$$

$$Prorated\ credit\ for\ CHP\ (\%) = 49.9$$

For every MWh generated, 49.9% will qualify for credit as eligible electricity output. Insert this value into the formula in Step 3 on page 19 to determine eligible electricity output.

[29] eGRID lists estimated T&D losses for each of the five US interconnect power grids on p.19 of its Technical Support Document for the 9th edition of eGRID available online: http://www.epa.gov/cleanenergy/documents/egridzips/eGRID_9th_edition_V1-0_year_2010_Technical_Support_Document.pdf.