5.3.1 Combined Heat and Power

DESCRIPTION

The Combined Heat and Power (CHP) measure can provide ~~electric and natural gas~~ energy savings within the State of Illinois through the development and operation of CHP projects. This measure is applicable for Conventional or Topping Cycle CHP systems, as well as Waste Heat-to-Power (WHP) or Bottoming Cycle CHP systems. The measure will reduce the total Btu's of energy required to meet the end use needs of the facility. ~~Depending on the application, the saved Btu's can be converted into a combination of kWh and therms saved. In all cases estimates of the saved energy will account for any additional natural gasfuel utilized at the site in order to operate the CHP system.~~

It is recognized that CHP system design and configuration may be complex, and as such the calculation of energy savings may not be reducible to the equations within this measure. In such cases a more comprehensive engineering and financial analysis may be developed that more accurately incorporates the attributes of complex CHP configurations such as variable-capacity systems, and partial combined-cycle CHP systems. Where noted, the use of values that are determined through an external engineering analysis may be substituted by agreement between the participant, the program administrator and independent evaluator. This substitution of values does not eliminate ex post evaluation risk (retroactive adjustments to savings claims) that exists when using custom inputs.

This measure was developed to be applicable to the following program types: Retrofit (RF), New Construction (NC). If applied to other program types, the measure savings should be verified.

DEFINITION OF EFFICIENT EQUIPMENT

Conventional or Topping Cycle CHP is defined as an integrated system that is located at or near the building or facility (on-site, on the customer side of the meter) that utilizes a prime mover (reciprocating engine, gas turbine, micro-turbine, fuel cell, boiler/steam turbine combination) for the purpose of generating electricity and useful thermal energy (such as steam, hot water, or chilled water) where the primary function of the facility where the CHP is located is not to generate electricity for use on the grid. An eligible system must demonstrate a minimum total system efficiency of 60% (HHV)[1] with at least 20% of the system's total useful energy output in the form of useful thermal energy on an annual basis.

Measuring and Calculating Conventional CHP Total System Efficiency:

CHP efficiency is calculated using the following equation:

$$CHP_{Efficiency}(HHV) = \frac{\left[CHP_{thermal}\left(\frac{kBtu}{yr}\right) + E_{CHP}\left(\frac{kWh}{yr}\right) * 3.412\left(\frac{kBtu}{kWh}\right)\right]}{F_{totalCHP}\left(\frac{kBtu}{yr}\right)}$$

Where:

[1] Higher Heating Value (HHV): refers to the heating value of the fuel and is defined as the total thermal energy available, including the heat of condensation of water vapors, resulting from complete combustion of the fuel versus the Lower Heating Value (LHV) which assumes the heat of condensation is not available.

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Comment [HMJ1]: Per step 2, the utility savings claims vary by funding source.

Comment [ASB2]: Zuraski: For any time phrase "for properly accounting for" is used, must explain further. Chris: TRM addresses three needs. Need 1: In TRC screening, if increased gas use, must account for negative therms multiplied by avoided costs. Need 2: In Step 1, to determine if equipment is even eligible, we calculated source Btu savings. Need 3: For natural gas systems in Step 2, we explain how much utility can claim, always less then 100%. We assign penalty to account for increased gas use on site. Response: Describe up-front three circumstances that include phrase "properly accounted for" and provide approach.

Comment [HMJ3]: Unnecessary here as this is addressed later in measure. It is also vague in several respects.

Comment [HMJ4]: What does "will account for.." mean? In step 1, 2, and/or 3? In source screening? Savings claims? In TRC? Also, why is natural gas singled out, since CHP facilities can also run on biomass, biogas, coal, oil, propane. Presently, NG is most often the preferred fuel, but that could change.

Comment [ASB5]: What does it mean when it says we will account for any increased use of gas in site? Answer: increased gas needs to be addressed in TRC calculation and is partial offset to outside electric generation when allocating savings to utilities. Response: Add Footnote. If using any fuel besides natural gas or waste heat, need to do custom carbon equivalency calculation. Need to quantify net impact compared to what would have happened otherwise to baseline. Bottom line: ways in tables in Step 2 have been developed, assumed natural gas being used. If different fuel used, will require a custom cal. Zuraski: Need to make clear would apply to other sources of fuels other than natural gas. Must make clear in Step 2 that tables only apply to natural gas.

Comment [HMJ6]: Clarified this does not make project immune from policy adopted in 13-0077.

Comment [ASB7]: Response: Keep language.

$CHP_{thermal}$ = Useful annual thermal energy output from the CHP system, defined as the annual thermal energy output of the CHP system that is actually recovered and utilized in the facility/process.

E_{CHP} = Useful annual electricity output produced by the CHP system, defined as the annual electric energy output of the CHP system that is actually utilized to replace purchased electricity required to meet the requirements of the facility/process. The measurement of this term will be based on the "date of commercial operation" (DCO) method. In particular, the customer and Program Administrator decide on the DCO, preferably after the system has been tested and commissioned and the early bugs worked out with some steady state operation – perhaps several hundred hours until the first service shut-down is finished. The DCO starts the test clock for the program. ALL data from the DCO until the verification visit is used for the incentive calculation – minimum 2 weeks. Furthermore, ALL data from the DCO until the EM&V date is used for the evaluated savings – minimum 2 months. No exceptions, no data tossed. Downtime for any type of service or failure must be assumed to represent future operation. If distinct daytypes are observed (say weekend operation different from weekday) data are extrapolated to yearly based on the number of annual days of each daytype. For example if Sundays operate at 75% capacity but the other days consistently show 97% capacity on average, savings is Capacity x [(52*6*0.97)+(52*1*0.75)].

$F_{totalCHP}$ = Total annual fuel consumed by the CHP system. Fuel consumption will be based on metered data concurrent with the timeframe used for determining E_{CHP}.

For further definition of the terms, please see "Calculation of Energy Savings" Section below.

Waste Heat-to-Power or Bottoming Cycle CHP is defined as an integrated system that is located at or near the building or facility (on-site, on the customer side of the meter) that does one of the following:

- Utilizes exhaust heat from an industrial/commercial process to generate electricity (except for exhaust heat from a facility whose primary purpose is the generation of electricity for use on the grid); or
- Utilizes the pressure drop in an industrial/commercial facility to generate electricity through a backpressure steam turbine where the facility normally uses a pressure reducing valve (PRV) to reduce the pressure in their facility; or
- Utilizes the pressure reduction in natural gas pipelines (located at natural gas compressor stations) before the gas is distributed through the pipeline to generate electricity, provided that the conversion of energy to electricity is achieved without using additional fossil fuels.

Since these type of systems utilize waste heat as their fuel, they do not have to meet any specific total system efficiency level (assuming they use no additional fossil fuel in their operation – if additional ~~natural~~ fuel gas is used onsite, it should be properly accounted for). These systems may export power to the grid.

DEFINITION OF BASELINE EQUIPMENT

Electric Baseline: The baseline facility would be a facility that purchases its electric power from the grid.

Heating Baseline (for CHP applications that displace onsite heat): The baseline equipment would be the boiler/furnace operating onsite, or a boiler/furnace meeting the ~~definition of~~ baseline equipment

Comment [ICC Staff8]: Staff agrees with Navigant comments that clarity in how this is determined should be provided to reduce future contention.

"How this value is arrived at is not discussed in the workpaper. Guideance or rules should be given. Among customers and utilities there is often a desire to discount down-time during the early period of operation. However, there is not guarant that early problems will not persist. I suggest a measurement scheme based on "date of commercial operation" similar to what is used in PA. The customer and utility decide on the DCO, preferably after the system has been tested and commissioned and the early bugs worked out with some steady state operation – perhaps several hundred hours until the first service shut-down is finished. The DCO starts the test clock for the program. ALL data from the DCO until the verification visit is used for the incentive calculation – minimum 2 weeks. Furthermore, ALL data from the DCO until the EM&V date is used for the evaluated savings – minimum 2 months. No exceptions, no data tossed. Downtime for anytype of service or failure must be assumed to represent future operation. If distinct daytypes are observed (say weekend operation different from weekday) data are extrapolated to yearly based on the number of annual days of each daytype. For example if Sundays operate at 75% capacity but the other days consistently show 97% capacity on average, savings is Capacity x [(52*6*0.97)+(52*1*0.75)]"

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Comment [HMJ9]: What does "properly accounted for" mean? In step 1, 2, and/or 3? In source screening? Savings claims? In TRC?

Comment [HMJ10]: I don't see furnace listed in defining Fthermal later.

~~minimum~~ standard defined in the High Efficiency B~~b~~oiler (Section 4.4.10)/F~~f~~urnace (Section 4.4.11) measures of ~~the~~ this TRM.

Cooling Baseline (for CHP applications that displace onsite cooling demands): The baseline equipment would be the chiller (or chillers) operating onsite, or a chiller (or chillers) meeting the ~~definition of~~ baseline equipment ~~minimum~~ standard defined in the Electric C~~c~~hiller (Section 4.4.6) measure~~s~~ of ~~the~~ this TRM.

Facilities that use biogas or waste gas: ~~f~~Facilities that use (but are not purchasing) biogas or waste gas that is not otherwise marketable, whether they are using biogas or waste gas only or a combination of biogas or waste gas and natural gas to meet their energy demands are also eligible for this measure. If additional ~~natural gas~~fuel is purchased ~~to fuel the CHP system~~, then it ~~the additional natural gas~~ should be taken into account in the fuel savings calculations. Consumption of any biogas or waste gas that would not otherwise being wasted (*e.g.,* flared) will be accounted for in the overall net Btu~~TU~~ savings calculations the same as for purchased natural gas or other fuels.

Comment [HMJ11]: Does minimum standard here mean that the standard efficiency baseline listed under definition of baseline equipment in those measures should be used if the boiler/furnace is no longer operational or is new construction? If CHP is new construction, and thus there is no boiler/furnace operating, which baseline in the TRM measures is supposed to be used, hot water (80-82%) or steam (75-80%) boiler or furnace (80%)?

Comment [HMJ12]: I don't see furnace listed in defining Fthermal later.

Comment [HMJ13]: Added TRM section #s for clarity

Comment [ASB14]: Response: will add references.

Comment [HMJ15]: Added TRM section # for clarity

Comment [ASB16]: Response: will add references.

Comment [HMJ17]: What does "should be taken into account" mean exactly? What is fuel savings calculations? In step 1, 2, and/or 3? In source screening? Savings claims? In TRC?

Comment [HMJ18]: What does "will be accounted for" mean? In step 1, 2, and/or 3? In source screening? Savings claims? In TRC?

DEEMED LIFETIME OF EFFICIENT EQUIPMENT

Measure life is a custom assumption, dependent on the technology selected and the system installation.

DEEMED MEASURE COST

Custom installation and equipment cost will be used. These costs should include the cost of the equipment and the cost of installing the equipment. Equipment costs include, but are not limited to: prime mover, heat recovery system(s), exhaust gas treatment system(s), controls, and any interconnection/electrical connection costs.

The installations costs include labor and material costs such as, but not limited to: labor costs, materials such as ductwork, piping, and wiring, project and construction management, engineering costs, commissioning costs, and other fees.

Measure costs will also include the present value of expected maintenance costs over the life of the CHP system.

LOADSHAPE

Use Custom Loadshape. The loadshape should be obtained from the actual CHP operation strategy, based on the On-Peak and Off-Peak Energy definitions specified in Table 3.3 of "Section 3.5 Electrical Loadshapes" of the TRM.

COINCIDENCE FACTOR

Custom coincidence factor will be used. Actual value based on the CHP operation strategy will be used.

Algorithm

CALCULATION OF ENERGY SAVINGS

i) Conventional or Topping Cycle CHP Systems:

Step 1: (Calculating T~~t~~otal ~~a~~Annual ~~s~~Source ~~f~~Fuel ~~s~~Savings in Btus)

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The first step is to calculate the total annual source fuel savings associated with the CHP installation, in order to ensure the CHP project produces positive total annual source fuel savings (i.e., reduction in

source Btus) ~~demonstrate that CHP applications meet the statutory definition of efficiency necessary to be included in the Illinois EEPS programs~~:

$S_{FuelCHP}$ = Annual fuel savings (Btu) associated with the use of a Conventional CHP system to generate the useful electricity output (kWh, converted to Btu) and useful thermal energy output (Btu) versus the use of the equivalent electricity generated and delivered by the local grid and the equivalent thermal energy provided by the onsite boiler.

$= (F_{grid} + F_{thermalCHP}) - F_{total\ CHP}$

Where

F_{grid} = Annual fuel in Btu that would have been used to generate the useful electricity output of the CHP system if that useful electricity output was provided by the local utility grid.

$= E_{CHP} * H_{grid}$

Where

E_{CHP} = Useful annual electricity output produced by the CHP system, defined as the annual electric energy output of the CHP system that is actually utilized to replace purchased electricity required to meet the requirements of the facility/process. [2]

$= (CHP_{capacity} * Hours) - E_{Parasitic}$

$CHP_{capacity}$ = CHP nameplate capacity

= Custom input

Hours = Annual operating hours of the system

= Custom input

$E_{parasitic}$ = The electricity required to operate the CHP system that would otherwise not be required by the facility/process

= Custom input

H_{grid} = Heat rate of the grid in ~~b~~Btu/kWh, based on the average fossil heat rate for the EPA eGRID subregion and includes a factor that takes into account T&D losses.

For systems operating less than 6,500 hrs per year:

Use the Non-baseload heat rate provided by EPA eGRID for RFC West region for ComEd territory, and SERC Midwest region for Ameren territory. Also include any line losses.

[2] For complex systems this value may be obtained from a CHP System design/financial analysis study.

Comment [ICC Staff19]: Depending on whether a compromise can be reached on 2/10/15 call, this may end up being a non-consensus item for the Commission to resolve the different interpretations of the statute. There are differences of opinion regarding whether the statute change refers to site Btu savings versus source Btu savings. I modified language such that this source Btu savings requirement could be included in measure, but in a manner that does not involve referencing the statutory language (the interpretation of which is non-consensus).

Comment [ASB20]: Response: Good edit. Keep deletion.

Comment [HMJ21]: Boiler only? Furnace is defined earlier in the baseline section

Comment [HMJ22]: Should we allow for flexibility to use marginal average natural gas heat rate if necessary research is done to find a better value? Please provide reference link. Does this value change often? Is utility required to look up most recent value for every project? What if value changes between initial project application date and when project is getting final approval, is utility required to update to the most recent value?

Comment [ASB23]: Response: Addressed in Navigant's comments.

Comment [ASB24]: Response: Add to Hgrid the same type of language that was in CHP measure that will include citation and footnote with example. Send to Sam so he can do in GSHP as well.

Comment [HMJ25]: What should be used if not in Ameren or ComEd service territory (e.g., Nicor/Naperville example)?

Comment [ASB26]: Response: Addressed in Navigant's comments.

For systems operating more than 6,500 hrs per year:

Use the All Fossil Average heat rate provided by EPA eGRID for RFC West region for ComEd territory, and SERC Midwest region for Ameren territory. Also include any line losses.

$F_{thermalCHP}$ = Annual fuel in Btu that would have been used on-site by a boiler or heater to provide the useful thermal energy output of the CHP system.[3]

= $CHP_{thermal} \div Boiler_{eff}$

$CHP_{thermal}$ = Useful annual thermal energy output from the CHP system, defined as the annual thermal energy output of the CHP system that is actually recovered and utilized in the facility/process.

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$Boiler_{eff/Furnace\ eff}$ = Efficiency of the on-site boiler or~~OR~~ heater that is displaced by the CHP system or if unknown, the baseline equipment value stated in the High Efficiency B~~b~~oiler (Section 4.4.10) measure or furnace (provide citation) in the TRM.

= Custom input

$F_{total\ CHP}$ = Total fuel in Btus consumed by the CHP system

= Custom input

Step 2: (Savings ~~a~~Allocation to Program Administrators for Purposes of Assessing Compliance with Energy Savings Goals (Not for Use in Load Reduction Forecasting))

Savings claims are a function of the electric output of the CHP system (E_{CHP}), the used thermal output of the CHP system ($F_{thermalCHP}$), and the CHP system efficiency ($CHP_{Efficiency}$HHV). The percentages of electric output and used thermal output that can be claimed also differ slightly depending on whether the project was included in both electric[4] and gas[5] energy efficiency portfolio standard (EEPS)[6] efficiency programs, only an electric EEPS program or only a gas EEPS program. The tables below provide the specific percentages of electric and/or thermal output that can be claimed under each of those three scenarios.

1) For systems participating in both electric EEPS and gas EEPS~~s~~ programs:

CHP Annual System	Allocated Electric Savings	Allocated Gas Savings

[3] For complex systems this value may be obtained from a CHP System design/financial analysis study.
~~Ibid~~
[4] 220 ILCS 5/8-103; 220 ILCS 5/16-111.5B.
[5] 220 ILCS 5/8-104.
[6] As used in this measure characterization, EEPS programs are defined as those energy efficiency programs implemented pursuant to Sections 8-103, 8-104, and 16-111.5B of the Illinois Public Utilities Act. Technically, EEPS programs pertain to energy efficiency programs implemented pursuant to 220 ILCS 5/8-103 and 220 ILCS 5/8-104. However, for simplicity in presentation, this measure defines EEPS programs as also including those programs implemented pursuant to 220 ILCS 5/16-111.5B (these programs are funded through the same energy efficiency riders established pursuant to Section 8-103).

Comment [HMJ27]: What if not in Ameren or ComEd territory?
Please provide the link where these can be found.

Comment [HMJ28]: No furnace? Furnace is mentioned above in baseline section.

Comment [HMJ29]: Is this correct footnote? I added previous footnote in case it was correct and a reference link is provided in footnote regarding eGRID during updating

Comment [HMJ30]: If unknown? Does that mean new construction or the previous equipment failed?

Comment [HMJ31]: Is this correct? There are several different baseline efficiencies in boiler measure.

Comment [ASB32]: Use whatever baseline would be assumption under another program where there would be a retrofit. Response: no action.

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Comment [JH33]: Added language to help clarify that "savings" derived in this section should not be used for load reduction forecasting purposes under 16-111.5B.. not sure whether a small business would ever install CHP, but added language here just in case.

Comment [HMJ34]: Please clarify what exactly "included in" means. Does this mean funded by? It is possible that Ameren (dual fuel utility) could have single CHP program, but may not want to fund a particular project with electric budget (e.g., it could be exhausted for the year). Does that mean only gas "savings" get to be counted for the project and no electric? If yes, this seems to contradict the ICC Order in Ameren's Plan 2 docket 10-0568 that allows Ameren to claim electric savings for dual fuel savings measures who receive gas incentives as long as Ameren electric deliveries are reduced.
"The Commission directs Ameren to claim all electric (kWh) savings associated with measures installed for Ameren's combination electric and gas customers, including measures for which no electric incentive has been paid, as these savings reduce Ameren's deliveries. In addition, the Commission directs Ameren to claim all gas (therm) savings associated with measures installed for Ameren's combination electric and gas customers, including measures for which no gas incentive has been pa ...

Comment [HMJ35]: Added IPA electric program to footnote as well as EEPS. While IPA wouldn't use savings allocation values for load reduction forecasting (as clarified above, in the event CHP ...

Comment [HMJ36]: What does "participating in" mean? Is the funding for the upfront CHP study sufficient? Or does an actual incentive for project need to be provided as well?

Comment [ASB37]: Response: Has to do with which utility is going to claim the savings. Leave as is. Disputes can be handled later.

Efficiency (HHV)		
60%	65% of E_{CHP} (kWh)	No gas savings
>60% to 65%	65% of E_{CHP} (kWh) + one percentage point increase for every one percentage point increase in CHP system efficiency (max 70% of E_{CHP} in kWh)	No gas Savings
>65%	70% of E_{chp} (kWh)	2.5% of $F_{thermal}$ (useful thermal output of the CHP system) for every one percentage point increase in CHP system efficiency above 65%.

Example: System with measured annual fuel use efficiency of 70%: Electric savings (kWh) = 70% of E_{CHP} measured over 12 months, and Gas savings (therms) = 12.5% of $F_{thermal}$ measured over 12 months (70% - 65% = 5 X 2.5% = 12.5%)

2) For systems participating in only an electric EEPS program:

CHP Annual System Efficiency (HHV)	Allocated Electric Savings	Allocated Gas Savings
60%	65% of E_{CHP} (useful electric output of CHP system in kWh)	No gas ~~S~~savings
Greater than 60%	65% + one percentage point increase for every one percentage point increase in CHP system efficiency (no max)	No gas ~~S~~savings

Example: System with measured annual fuel use efficiency of 75%: Electric savings (kWh) = 65% + 15% = 80% of E_{CHP} measured over 12 months (15% = 1% for every 1% increase in system efficiency). No gas savings (therms).

3) For systems participating in only a gas EEPS program:

CHP Annual System Efficiency (HHV)	Allocated Electric Savings	Allocated Gas Savings
60% or greater	No electric savings	2.5% of $F_{thermal}$ (useful thermal output of the CHP system) for every one percentage point increase in CHP system

Comment [HMJ38]: subscript

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Comment [ICC Staff39]: Please clarify what exactly "participating in" means. Does this mean funded by?
Hypothetically, Ameren (dual fuel utility) could have single CHP program, but may not want to fund a particular project with electric budget (e.g., it could be exhausted for the year). Does that mean only gas "savings" get to be counted for the project and no electric? If yes, this seems to contradict the ICC Order in Ameren's Plan 2 docket 10-0568 that allows Ameren to claim electric savings from dual fuel savings measures that receive gas incentives as long as Ameren electric deliveries are reduced. "The Commission directs Ameren to claim all electric (kWh) savings associated with measures installed for Ameren's combination electric and gas customers, including measures for which no electric incentive has been paid, as these savings reduce Ameren's deliveries. In addition, the Commission directs Ameren to claim all gas (therm) savings associated with measures installed for Ameren's combination electric and gas customers, including measures for which no gas incentive has been paid, as these savings reduce Ameren's deliveries. However, electric (kWh) savings for measures installed for Ameren's gas-only customers should not be counted toward Ameren's electric savings goal as these savings do not affect Ameren's electric deliveries. Likewise, gas (therm) savings for measures installed for Ameren's electric-only customers should not be counted toward Ameren's gas savings goal as these savings do not affect Ameren's gas deliveries." 10-0568 Order at 29-30.

Comment [ICC Staff40]: Staff is concerned this does not encourage joint utility promotion, which was deemed by parties to be critical early in the process.
Further, Staff has concerns this might result in increased gas deliveries and no load reductions pertaining to the energy deliveries associated with any of the savings targets in the EEPS statutes. Nevertheless, Staff does not rule out signing on to a consensus approach if Staff is able to conclude that such an approach produces reasonable results and if such an approach is accepted by all other parties. Staff would not, all else equal, support such approach if utility performance-based incentives were in place.

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		efficiency above 60%.

Conventional or topping cycle CHP systems virtually always require an increase in the use of ~~natural gas~~fuel on-site in order to produce electricity. Different jurisdictions and experts across the country have employed and/or put forward a variety of approaches to addressing how increased on-site ~~gas~~fuel consumption should be reflected in the attribution of electric savings to CHP systems. Those approaches range from ignoring the increased ~~gas~~fuel use (i.e., no "penalty") to roughly 40-60% "penalties", depending on the CHP efficiency, based on the number of kWh that could have been produced had the increased ~~gas~~fuel Btu's been used on the grid (a grid "Btu equivalency"). Several other approaches produce results in between those two extremes. The approach reflected in the tables above is generally consistent with approaches recently put forward by the Southwest Energy Efficiency Project (SWEEP), Institute for Industrial Productivity (IIP) and others which essentially establish an electric savings "penalty" that is equal to the amount of kWh that could be produced by the electric grid with a "carbon emissions budget" that is equal to the emissions associated with the increased on-site ~~gas~~fuel consumption. The result of this "carbon equivalency" approach is a savings penalty that will typically range from 20% to 35%.[7] That result is also solidly in the middle of the two extremes discussed above.

There are also a variety of ways one could treat the potential for gas utilities' to claim savings from CHP projects in their EEPS portfolios. For projects in which a natural gas ~~utility~~ EEPS program is involved, the tables above treat savings from CHP installations in two steps: (1) a fuel-switch from electricity to natural gas (i.e., using more natural gas to eliminate the need to generate as much electricity on the grid); and (2) possible increases in CHP efficiency above a "benchmark" level. When both electric EEPS and gas EEPS programs are involved in a project, ~~the electric utility claims~~ all the savings associated with a fuel-switch up to a "benchmark" 65% efficient CHP system is allocated to electric. ~~The gas utility then claims a~~All the savings associated with increasing CHP efficiencies above that benchmark level is allocated to natural gas (e.g., if the CHP efficiency is 75%, ~~the gas utility claims~~ the natural gas savings associated with an increase in CHP efficiency from 65% to 75% is allocated to natural gas). That is consistent with the notion that CHP efficiency typically increases primarily by increasing use of the thermal ouput of the system (increasing the displacement of baseline gas use). For projects that involve only a natural gas ~~utility~~ EEPS program, the "benchmark" above which the gas utility can claim savings is lowered to 60%.

ii) **Waste-Heat-to-Power CHP Systems:**

ELECTRIC ENERGY SAVINGS:

$$\Delta kWh = E_{CHP}$$

Where

[7] Consider, for example, a hypothetical CHP system that produces 5 million kWh annually, consumes 50 million kBtu of gas annually to generate that electricity (i.e., electric efficiency of approximately 34.8% HHV), reduces on-site gas use for space heating by 26 million kBtu of gas (i.e., equivalent to approximately 81.5% CHP thermal output utilization displacing gas used in a 70% efficient space heating boiler) and has a total annual CHP efficiency of 70.6% HHV. In this example, the net increase in on-site gas use is 24 million kBtu. At a carbon dioxide emission rate of 53.06 kg/MMBtu for burning natural gas, that translates to an increase in on-site carbon dioxide emissions of 1404 tons per year. At an estimated marginal emission rate of 1.098 tons of carbon dioxide per MWh in Illinois, that is equivalent to electric grid production of approximately 1.28 million kWh, or penalty of about 25.6% of the CHP system's electrical output.

Comment [HMJ41]: Why is consistency with SWEEP and IIP more appropriate than consistency with past ICC Order 13-0499? Consistency is not strong rationale.

Comment [JH42]: List the others or remove

Comment [ICC Staff43]: What is carbon emissions budget? Why are we giving any significance to a "carbon emissions budget"? This should be clarified.

Comment [ICC Staff44]: Staff is concerned that the carbon equivalency approach used herein provides for electric savings that is not based on either reductions in electricity consumption or reductions in Btus used to produce electricity. If we understand correctly, if someone switched to a near zero emissions technology, they would get credit for a 100% reduction in electric savings even in the case where they were consuming the same amount of electricity and using nearly the same amount of Btus in fuel before and after the switch to CHP (we realize that some Btu reduction would be necessary to pass the Step 1 Btu reduction criteria). That is, from a consumption standpoint, there might not be any reduction in electricity consumption at all, but only a switch to a technology associated with less carbon emissions. Thus, the methodology has the potential to credit substantial reductions in electricity when no such reductions occur. We understand that the Btu based methodology initially proposed by DCEO (and adopted in docket 13-0499) had a similar potential to credit electricity reductions in cases where electricity consumption is not reduced, but the Btus necessary to produce such electricity are reduced. Of the two classes of errors, we believe the second is generally more acceptable given that the definition of energy efficiency in the statutes includes measures that reduce the total Btus of electricity and natural gas needed to meet the end use or uses, but does not explicitly include measures that reduce carbon emissions associated with electricity and natural gas needed to meet the end use or uses. Stated another way, the law provides no rationale for favoring a methodology based on "carbon equivalency" as opposed to a methodology based on "volatile organic compounds equivalency," "particulate matter equivalency," "SO2 equivalency," or other such equivalencies. ...

Comment [HMJ45]: Involved? Does this mean funded?

Comment [JH46]: Program Administrator, not just utility. DCEO has CHP program.

Comment [JH47]: Not sure "allocated to electric" is best wording, but trying to steer away from referencing utilities since DCEO operates programs too and Ameren is dual fuel utility.

Comment [JH48]: Does 'involve only' mean only funded by?

Comment [ICC Staff49]: Please provide rationale for crediting all to gas when on-site gas consumption is increasing.

E_{CHP} = Useful annual electricity output produced by the CHP system, defined as the annual electric energy output of the CHP system that is actually utilized to replace purchased electricity required to meet the requirements of the facility/process. The measurement of this term will be based on the "date of commercial operation" (DCO) method. In particular, the customer and Program Administrator decide on the DCO, preferably after the system has been tested and commissioned and the early bugs worked out with some steady state operation – perhaps several hundred hours until the first service shut-down is finished. The DCO starts the test clock for the program. ALL data from the DCO until the verification visit is used for the incentive calculation – minimum 2 weeks. Furthermore, ALL data from the DCO until the EM&V date is used for the evaluated savings – minimum 2 months. No exceptions, no data tossed. Downtime for any type of service or failure must be assumed to represent future operation. If distinct daytypes are observed (say weekend operation different from weekday) data are extrapolated to yearly based on the number of annual days of each daytype. For example if Sundays operate at 75% capacity but the other days consistently show 97% capacity on average, savings is Capacity x [(52*6*0.97)+(52*1*0.75)].

= Custom input

Comment [JH50]: This term is defined earlier… should same definition be used?

NATURAL GAS ENERGY SAVINGS:

$$\Delta Therms = F_{thermalCHP} \div 100{,}000$$

Where

$F_{thermalCHP}$ = Net savings in annual purchased fuel in Btu, if any, that would have been used on-site by a boiler or heater to provide some or all of the useful thermal energy output of the CHP system[8].

100,000 = Conversion factor for Btu~~/hr~~ to therms

Comment [HMJ51]: Furnace listed earlier in measure under baseline equipment.. is it applicable here?

Comment [HMJ52]: It is clear that $F_{thermalCHP}$ is expected to be less than or equal to zero. If and when it is less than zero, will that count as negative gas savings for the utility (ie., a reduction in savings attained from other programs)? Please clarify. The footnote states: "If additional natural gas or other purchased energy is used onsite, it should be properly accounted for." But it is not entirely clear what "properly accounted for means.

SUMMER COINCIDENT PEAK DEMAND SAVINGS

$$\Delta kW = CF * CHP_{capacity}$$

Where

CF = Summer Coincidence factor. This factor should also consider any displaced Chiller capacity[9]

= Custom input

$CHP_{Capacity}$ = CHP ~~-~~nameplate capacity

= Custom input

Comment [ASB53]: When you have waste-heat-to-power, you could have high grade heat converted to lower grade heat. Lower grade heat may have further use (not used before in facility). Does increased gas use count as negative gas use? You would be supplementing with gas so would need to be backed out of calculation. Step 2 is top cycling. We have not addressed negative gas use here. Response: Add footnote, two systems waste-heat-to-power that uses only the portion of waste heat that doesn't require additional fuel (natural gas consumption). Second system is the portion of the output that is associated with increased gas use. This will be treated as conventional system.

Comment [HMJ54]: Error
100,000 = Conversion factor for Btu/hr to therms
Should instead read
100,000 = Conversion factor for Btu to therms

Comment [HMJ55]: Please clarify what "it should be properly accounted for" means.

[8] In most cases, it is expected that waste-heat-to-power CHP ~~to energy~~ systems will not provide any new net useful thermal energy output, since the CHP system will be driven by thermal energy that was otherwise being wasted. If additional natural gas or other purchased energy is used onsite, it should be properly accounted for.

[9] ~~If additional natural gas is used onsite, it should be properly accounted for~~.

WATER IMPACT DESCRIPTIONS AND CALCULATION

N/A

DEEMED O&M COST ADJUSTMENT CALCULATION

Custom leveled ~~M~~maintenance costs that will be incurred for the life of the measure will be used**.** Maintenance costs vary with type and size of the prime mover. These costs include, but are not limited to:

- Maintenance labor
- Engine parts and materials such as oil filters, air filters, spark plugs, gaskets, valves, piston rings, electronic components, etc. and consumables such as oil
- Minor and major overhauls

For screening purposes, the US EPA has published resource guides that provide average maintenance costs based on CHP technology and system size[10].

COST-EFFECTIVENESS AND LOAD REDUCTION FORECASTING SCREENING

For the purposes of screening a CHP measure application for cost-effectiveness, changes in site energy use – reduced consumption of utility provided electricity and the net change in consumption of ~~natural gas~~fuel – should be used. In general, the benefit and cost components used in evaluating the cost-effectiveness of a CHP project would include at least the following terms:~~Where~~

Benefits: $E_{CHP} + \Delta kW + F_{thermal\ CHP}$

Costs: $F_{total\_CHP} + CHP_{COSTS} + O\&M_{COSTS}$

Where

CHP_{Costs} = CHP equipment and installation costs as defined in the "Deemed Measure Costs" section

$O\&M_{Costs}$ = CHP operations and maintenance costs as defined in the "Deemed O&M Cost Adjustment Calculation" section

MEASURE CODE: CI-HVC-**-V01-150601**

[10] "EPA Combined Heat and Power Partnership Resources" Oct 07, 2014, http://www.epa.gov/chp/resources.html

Comment [HMJ56]: Please provide a direct link to reference document.

Comment [JH57]: Should language be added here so it's clear what would be incorporated into the IPA forecasts for load reductions? Would a small business ever install CHP? If yes, below is suggested language:

Cost-Effectiveness Screening and Load Reduction Forecasting
For the purposes of forecasting load reductions due to CHP projects per Section 16-111.5B, changes in site energy use at the customer's meter – reduced consumption of utility provided electricity – adjusted for utility line losses (at-the-busbar savings), customer switching estimates, NTG, and any other adjustment factors deemed appropriate, should be used. For the purposes of screening a CHP measure application for cost-effectiveness, changes in site energy use – reduced consumption of utility provided electricity and the net change in consumption of natural gas – should be used. At a high level, the benefit and cost components used in evaluating the cost-effectiveness of a CHP project would include at least the following terms:

Comment [ASB58]: Response: Add the following: For the purposes of forecasting load reductions due to CHP projects per Section 16-111.5B, changes in site energy use at the customer's meter – reduced consumption of utility provided electricity – adjusted for utility line losses (at-the-busbar savings), customer switching estimates, NTG, and any other adjustment factors deemed appropriate, should be used.

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Comment [JH59]: Measure Code section should be added.

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