STANFORD
UNIVERSITY

DOCKET
08-WHCE-1
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December 16, 2009

To: **California Energy Commission**

Subject: **Docket No. 08-WHCE-1: Guidelines for Combined Heat & Power**

Dear Commissioners:

I applaud California's efforts to take action to reduce greenhouse gas emissions under AB32 and other enabling legislation, however I believe the guidelines proposed for enactment of AB1613 under this docket will be counterproductive to this effort.

These standards can cause more natural gas use and GHG emissions than if modern gas fired grid power plants and on-site heat production are used instead.

In the most basic argument, combined heat and power (CHP) plants with an efficiency of 62% (HHV) will use 6% more natural gas and generate 6% more GHG than what state-of-the-art grid gas fired power plants and on-site gas fired boilers can already achieve today for balanced heat and power loads. This is shown in the top box in Figure 1. Evidence of the availability of this equipment:

Natural Gas Combined Cycle Gas Turbine power plants of 54% efficiency (HHV) are currently available from General Electric Co. (GE H System:http://www.ge-energy.com/prod_serv/products/gas_turbines_cc/en/h_system/index.htm). The Inland Empire Power Facility in southern California permitted by the CEC over five years ago uses the GE H system and the facility is expected to operate at an efficiency of 59.8% LHV, which is approximately 54% HHV:
http://www.energy.ca.gov/sitingcases/inlandempire/compliance/2005-06-10_FINAL_ANALYSIS.PDF

Natural gas boilers and hot water heaters with an 85% or better efficiency are currently commonly available from a number of sources as indicated in the Initial Statement of Reasons under this docket.

A single efficiency standard for CHP is insufficient to assure a reduction in GHG- the standard should vary with the balance of heat and power loads at each site.

The bottom two boxes in Figure 1 show how varying balances of heat and power loads result in different overall efficiencies using the same equipment. Given this the use of a single efficiency standard for CHP is not sufficient to assure that GHG will be reduced using CHP compared to alternatives. Instead, efficiency guidelines that vary with the relative balance of heat and power loads for each site should be used.

Furthermore, in setting those varying standards a technology should not be incentivized for merely equaling alternatives, but only for exceeding them. And should not the incentive be greater for higher performance? For balanced heat and power loads which could be met with a grid based 54% NGCCGT and site located 85% boiler (66% overall efficiency) a 66% efficient CHP unit should get no incentive. And would not a 70% efficient CHP unit be better than a 67% plant and deserve greater incentive?

Technologies change and the standards should allow for this.

It should be expected that technologies will change and so figures in the guidelines should not be fixed, but should instead be tied to the Most Energy Efficient Technology (MEET) currently available for both CHP and SHP at the time of plant permitting.

These standards could bypass and undermine the intent of the Renewable Portfolio Standard

Unfortunately, all of the provisions above only apply to the use of the best *natural gas* powered systems currently available for meeting heat and power loads, which in and of itself may be counter-productive to the intent of AB32 and the RPS to reduce GHG emissions. Unless the standards require decommissioning of an equivalent capacity of existing lower efficiency fossil fuel power plants it is likely that much of the installation of any new distributed CHP will not actually displace less efficient fossil fuel fired energy equipment already in service. Instead it could displace the installation of new high efficiency gas fired and renewable power plants that would have met that load growth under the 33% RPS.

For example, instead of 3,300 MW of new future power demands being met by a combination of 2,200 MW of 54% grid NGCCGT and 1,100 MW renewables for power and 85% boilers for on-site heat, these guidelines could result in 3,300 MW of 62% CHP being installed. At balanced heat and power loads 62% CHP would actually result in 25% more GHG emissions than the use of the separate heat and power mix above under the RPS. There have been no studies or figures in the promulgation of these guidelines that address this serious issue.

Energy Distribution Line Losses- Affect Both Power and Natural Gas

If electrical distribution line losses are to be counted against the efficiency of grid power based SHP options then transportation line losses in natural gas distribution should be counted against the efficiency of the distributed CHP option. This has not been discussed in the analysis thus far.

Combined Heat & *Cooling*…another option that should be considered

Energy use in buildings accounts for a very large portion of the energy consumed in the state, and most of the energy consumed in buildings is for heating, ventilating, and air conditioning. While measures such as AB1613 strive to reduce GHG from the external energy supplies that operate these systems, and other measures seek to increase building energy efficiency to reduce the demand from these systems, there is a very large sector of the energy process in between the two that is largely being overlooked. A part of the energy process that in many cases represents the single largest and most cost effective way to reduce the use of fossil fuel and generation of GHG. This is heat recovery and renewable thermal energy production.

Renewable thermal energy production, such as heat recovery from cooling systems, ground source heat pumping, solar hot water production, and other sources offers huge potential benefits, perhaps paralleling the magnitude of renewable electricity production, in helping reduce GHG emissions and our dependence on fossil fuel. While residential rooftop solar hot water heaters and home sized heat pumps might come to mind the same technologies and applications are possible at utility scale and should be considered at commercial and industrial sites before incentives to perpetuate the use of fossil fuel through gas fired cogeneration are provided. Simply requiring that these options be examined before incentives to deploy CHP are provided may yield surprisingly large benefits (lower cost, GHG emissions, and water use) to those considering changes or expansion to their energy systems.

In many locations conducive to CHP installation there may already exist a central cooling system or potential for one. As outlined in my March 13 letter to interested parties in a CARB hearing under this proceeding the potential for economic heat recovery on a large scale from existing cooling systems or ground source heat exchange can provide dramatic savings in cost, GHG emissions, and water use- another key challenge for the state.

Figure 2 provides an example of how this works if 50% of a required heating load can be provided through heat recovery from the cooling system. In this example heat normally discharged out cooling towers is instead rerouted to meet concurrent heat demands at the complex that are otherwise being met with CHP or boilers. In this example natural gas use and GHG emissions are 19% lower than a 62% CHP, with water savings greater than 50%. This is not just theory but is being put into practice in more and more places in the world. Stanford University is employing these principles to achieve similar levels

of savings in energy use, GHG emissions, and water use. More information on this is available at http://sustainable.stanford.edu/climate_action.

Heat Recovery/Renewable Thermal Energy + RPS = 40% better than CHP

When both 50% heat recovery and a 33% RPS are factored in the reductions in gas use and GHG grow to 40% over CHP as shown in Figure 3, and water savings will grow as well.

Don't foreclose better solutions by promoting CHP before fully understanding the issues

Unfortunately CHP and heat recovery are mutually exclusive because when heating loads are met with renewable sources the waste heat from a CHP power plant is not required or usable. Therefore CHP installations will foreclose the opportunity for heat recovery at sites where it is practical for many years. Given that the wide-scale potential for heat recovery in the state is not currently quantified or understood we should not adopt regulations that foreclose these potentially much better solutions until they are understood. So as not to foreclose better opportunities either with grid based SHP or even better SHP based heat recovery schemes the guidelines under AB1613 should be far stronger and require a technology-neutral engineering assessment of the best ways to meet combined heat and power, *and cooling*, loads at a site before incentives are offered for a specific technology such as CHP, at a specific one-size-fits-all efficiency such as 62%.

For all of the above reasons I recommend that these proposed guidelines not be adopted and that these proceedings be continued until the points herein are investigated and resolved. I believe that only then can the positive intent of AB32 and AB1613 be achieved with respect to combined heat and power and GHG reductions. We owe it to ourselves and future generations to find and craft the best solutions.

Sincerely,

Joseph Stagner, P.E.
Executive Director- Sustainability and Energy Management
Stanford University

Figure 1

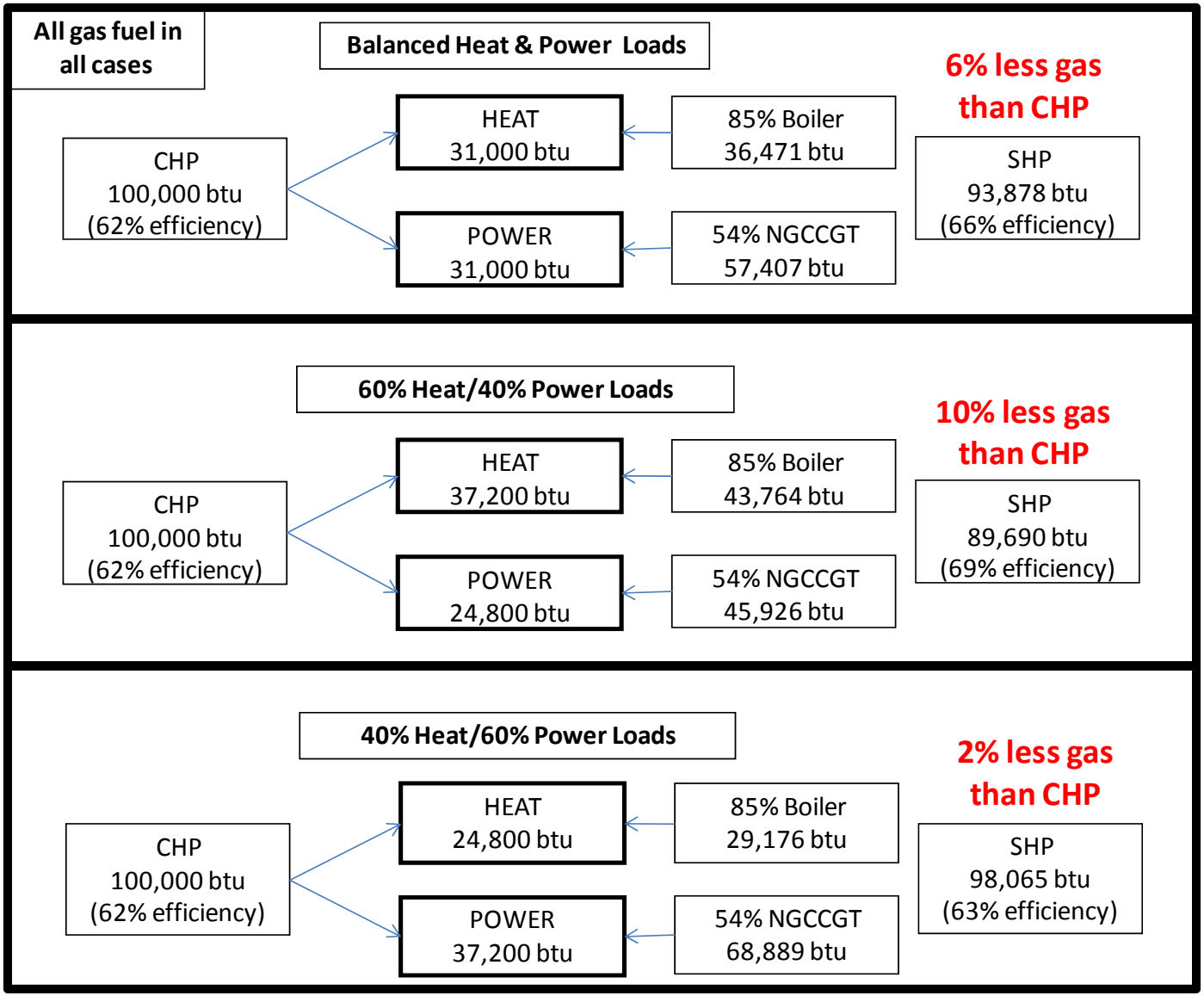

All gas fuel in all cases
Balanced Heat & Power Loads
6% less gas than CHP
CHP 100,000 btu (62% efficiency)
HEAT 31,000 btu
POWER 31,000 btu
85% Boiler 36,471 btu
54% NGCCGT 57,407 btu
SHP 93,878 btu (66% efficiency)
60% Heat/40% Power Loads
10% less gas than CHP
CHP 100,000 btu (62% efficiency)
HEAT 37,200 btu
POWER 24,800 btu
85% Boiler 43,764 btu
54% NGCCGT 45,926 btu
SHP 89,690 btu (69% efficiency)
40% Heat/60% Power Loads
2% less gas than CHP
CHP 100,000 btu (62% efficiency)
HEAT 24,800 btu
POWER 37,200 btu
85% Boiler 29,176 btu
54% NGCCGT 68,889 btu
SHP 98,065 btu (63% efficiency)

Figure 2

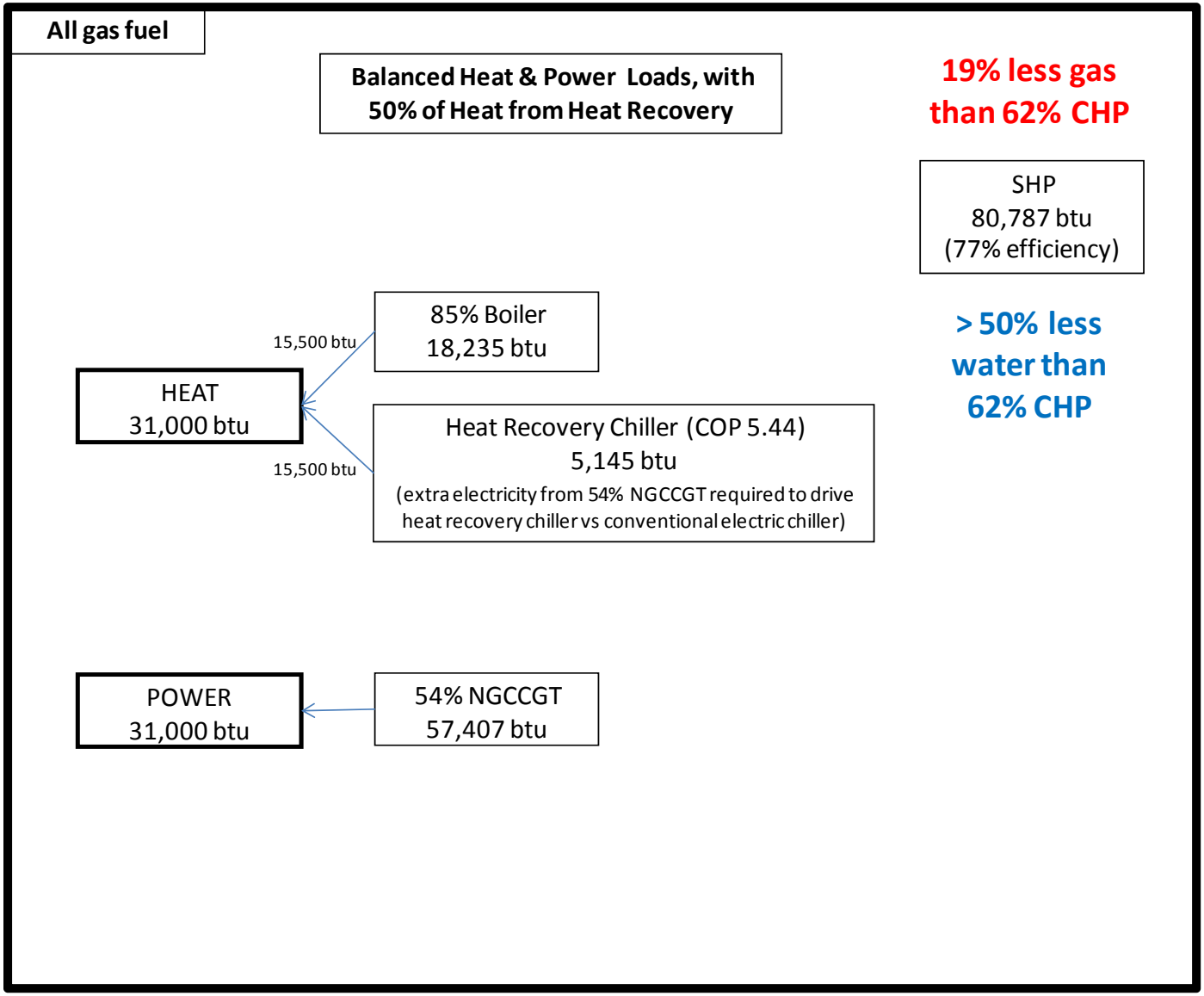
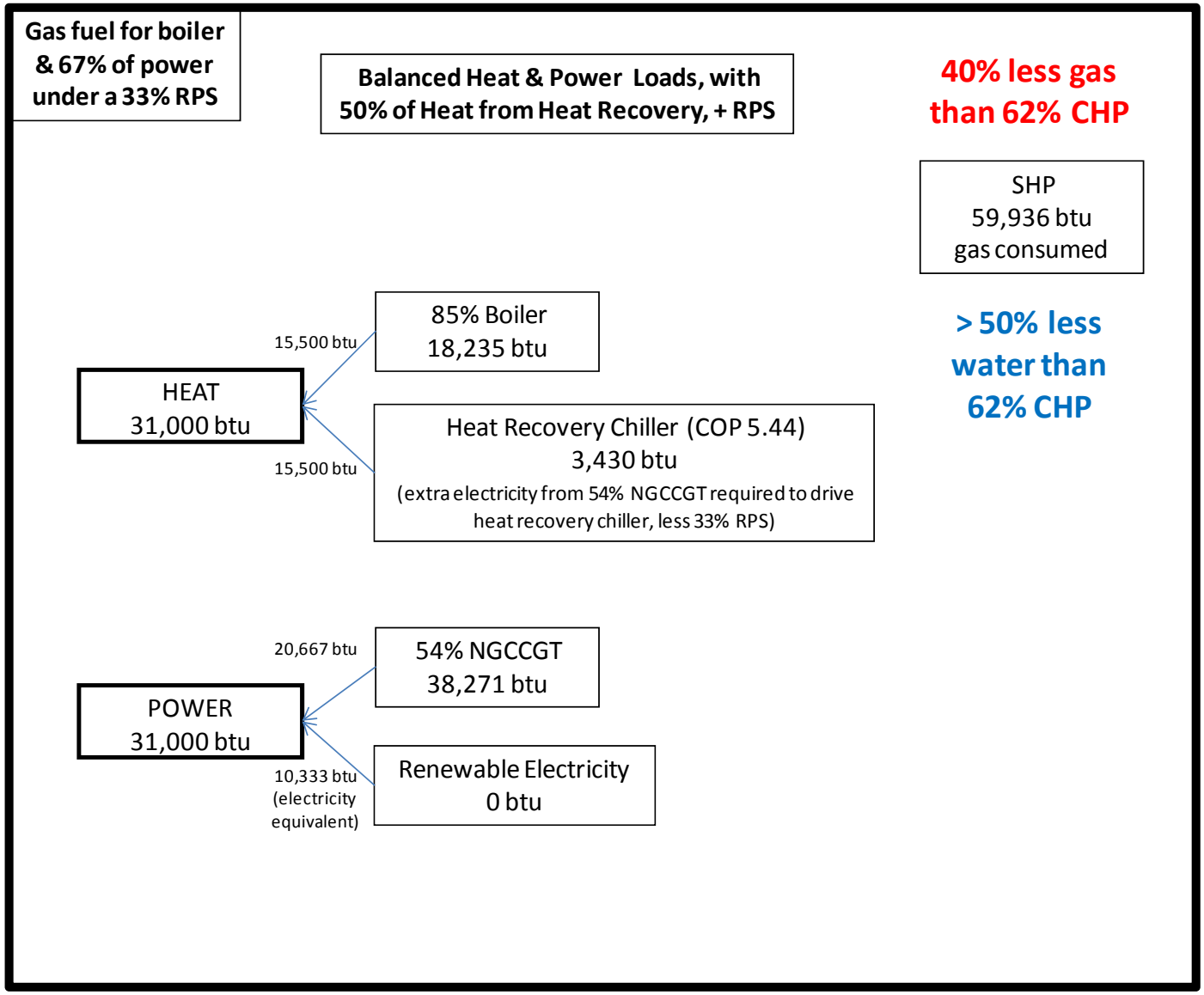

All gas fuel
Balanced Heat & Power Loads, with 50% of Heat from Heat Recovery
19% less gas than 62% CHP
SHP
80,787 btu
(77% efficiency)
> 50% less water than 62% CHP
85% Boiler
18,235 btu
15,500 btu
HEAT
31,000 btu
15,500 btu
Heat Recovery Chiller (COP 5.44)
5,145 btu
(extra electricity from 54% NGCCGT required to drive heat recovery chiller vs conventional electric chiller)
POWER
31,000 btu
54% NGCCGT
57,407 btu

Figure 3


Gas fuel for boiler & 67% of power under a 33% RPS
Balanced Heat & Power Loads, with 50% of Heat from Heat Recovery, + RPS
40% less gas than 62% CHP
SHP
59,936 btu
gas consumed
> 50% less water than 62% CHP
85% Boiler
18,235 btu
15,500 btu
HEAT
31,000 btu
15,500 btu
Heat Recovery Chiller (COP 5.44)
3,430 btu
(extra electricity from 54% NGCCGT required to drive heat recovery chiller, less 33% RPS)
20,667 btu
54% NGCCGT
38,271 btu
POWER
31,000 btu
10,333 btu
(electricity equivalent)
Renewable Electricity
0 btu