CHP's Potential to Reduce GHG Emissions in California

CEC Workshop on CHP

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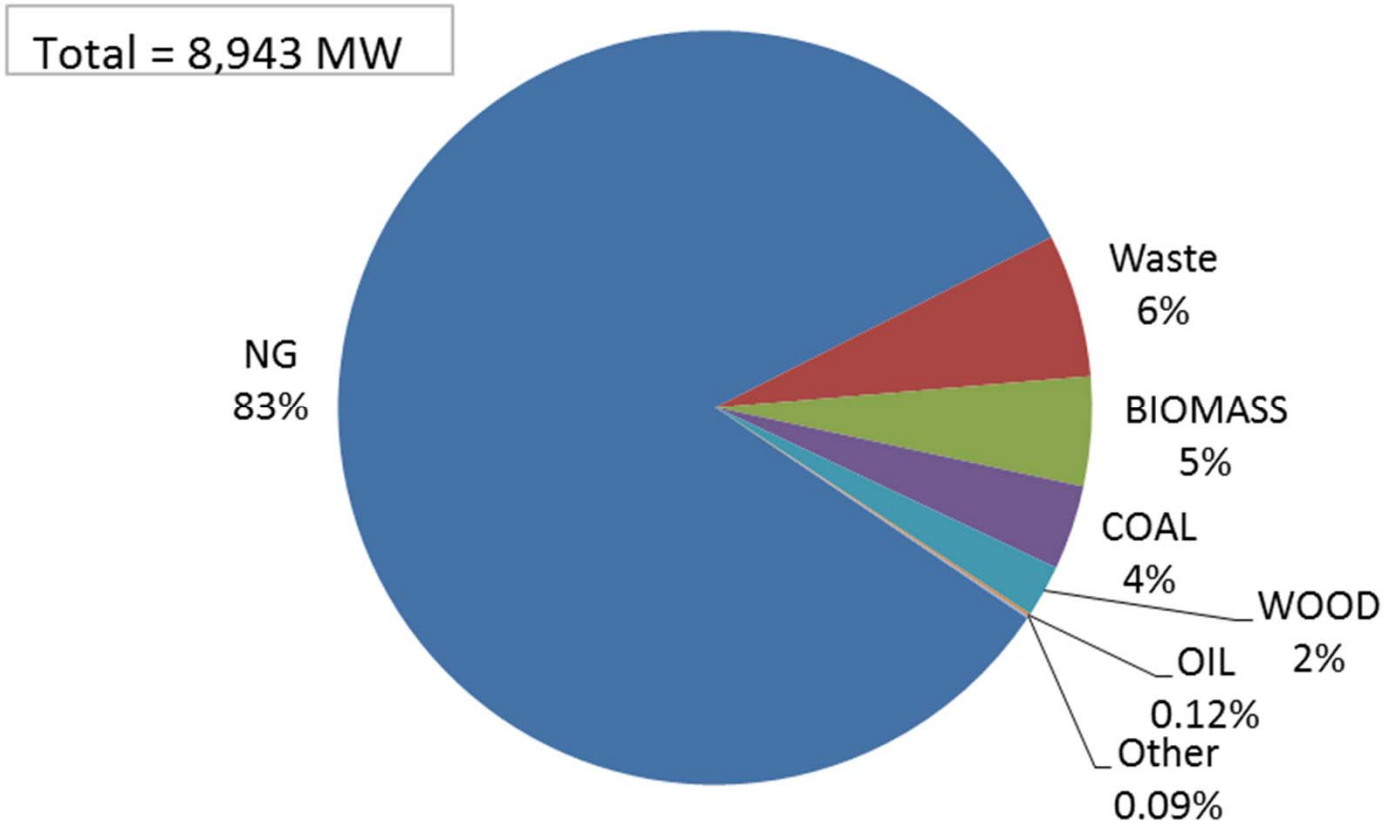
U.S. EPA
CHP Partnership

Overview

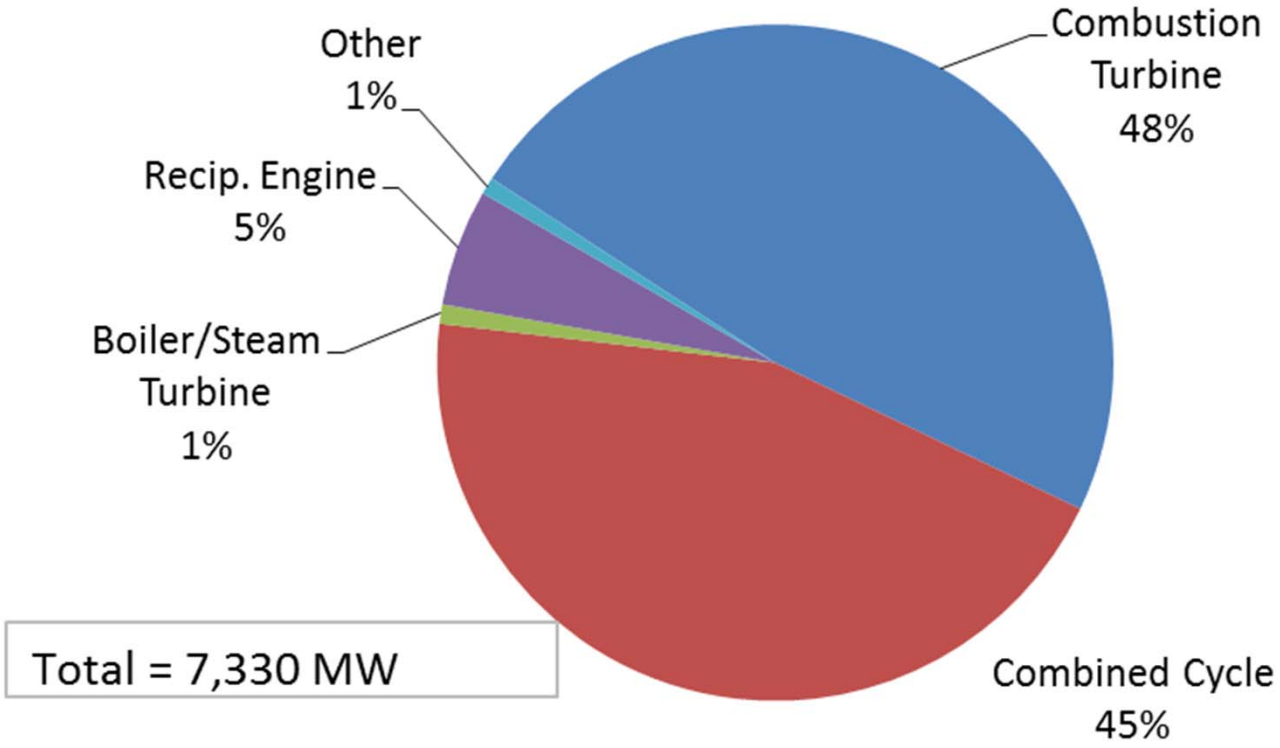
- U.S. EPA asked ICF to review a paper presented at the CRRI Annual Western Conference in June 2013.
- "Evaluating the GHG Performance of CHP Systems: A Summary for Californian Policymakers" by Sonika Choudhary, Sam Wade and Ray Williams.
- ICF's review highlights a few different assumptions, some additional context, and some topics for additional research, and presents the results in a different format.

California CHP Capacity by Fuel 2013



Source: DOE/ORNL CHP Database

CA Natural Gas CHP by Technology - 2013



Source: DOE/ORNL CHP Database

CA Gas CHP by Size and Technology – 2013

Prime Mover	<1 MW	1-5 MW	5-20 MW	20-100 MW	>100 MW	Grand Total
Combustion Turbine	2	112	445	1,819	1,136	3,514
Combined Cycle		8	63	947	2,261	3,280
Boiler/Steam Turbine	1	3	5	59		68
Recip. Engine	124	158	88	40		410
Microturbine	27	1				28
Fuel Cell	15	10				25
Waste Heat Recovery		4				4
Other	2					2
Grand Total	171	296	601	2,865	3,397	7,330

Source: DOE/ORNL CHP Database

CA CHP Electricity Sales to Grid – 2013

For systems for which data are available, the following shares of capacity report some sales to the grid:

- Combustion turbine systems - 93%
- Combined cycle systems - 76%
- Reciprocating engine systems - 44%
- Microturbines - 13%
- Fuel cells – 0%

Comparison of Key Assumptions

Choudhary/Williams

- Thermal utilization – 64% to 100%
- Efficiency of alternative boiler – 80% to 85%
- Performance degradation – none to 1%/yr for CHP system only.

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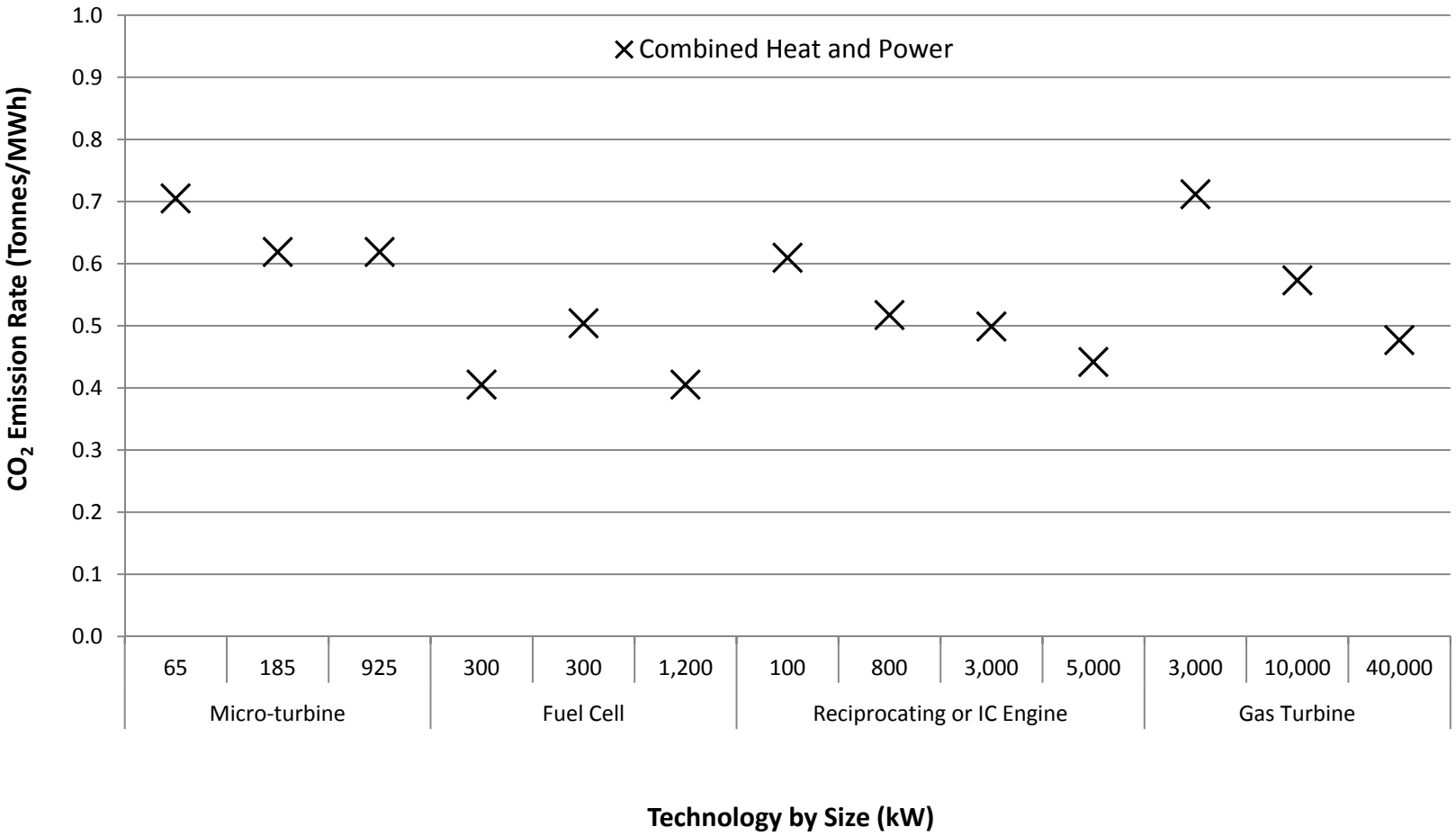
- Thermal utilization – 90%
- Efficiency of alternative boiler – 80%
- Performance degradation – none for all systems.

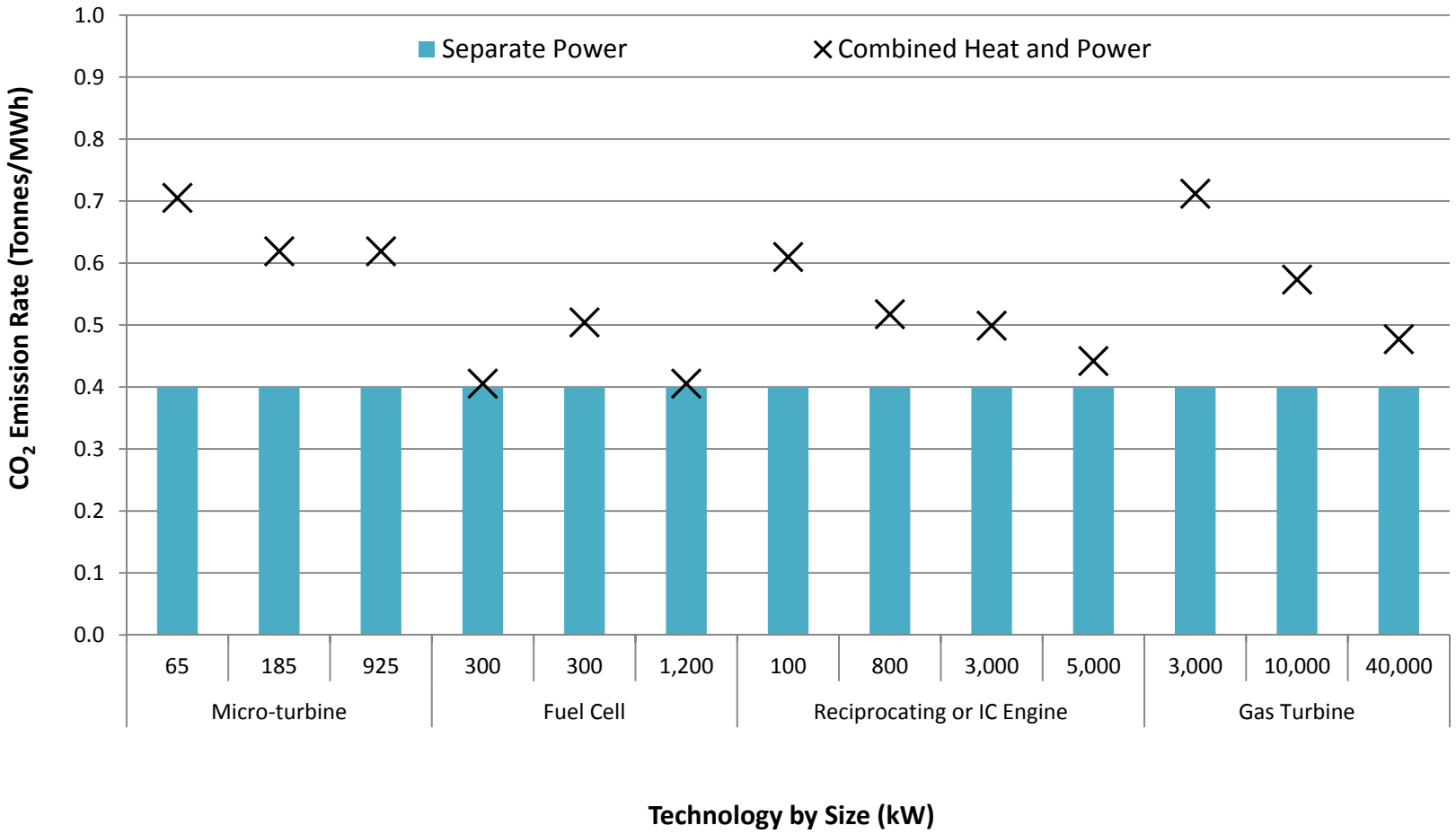
CO_2 Emissions From CHP Systems

Based on the same technology characteristics used in Choudhary, et al



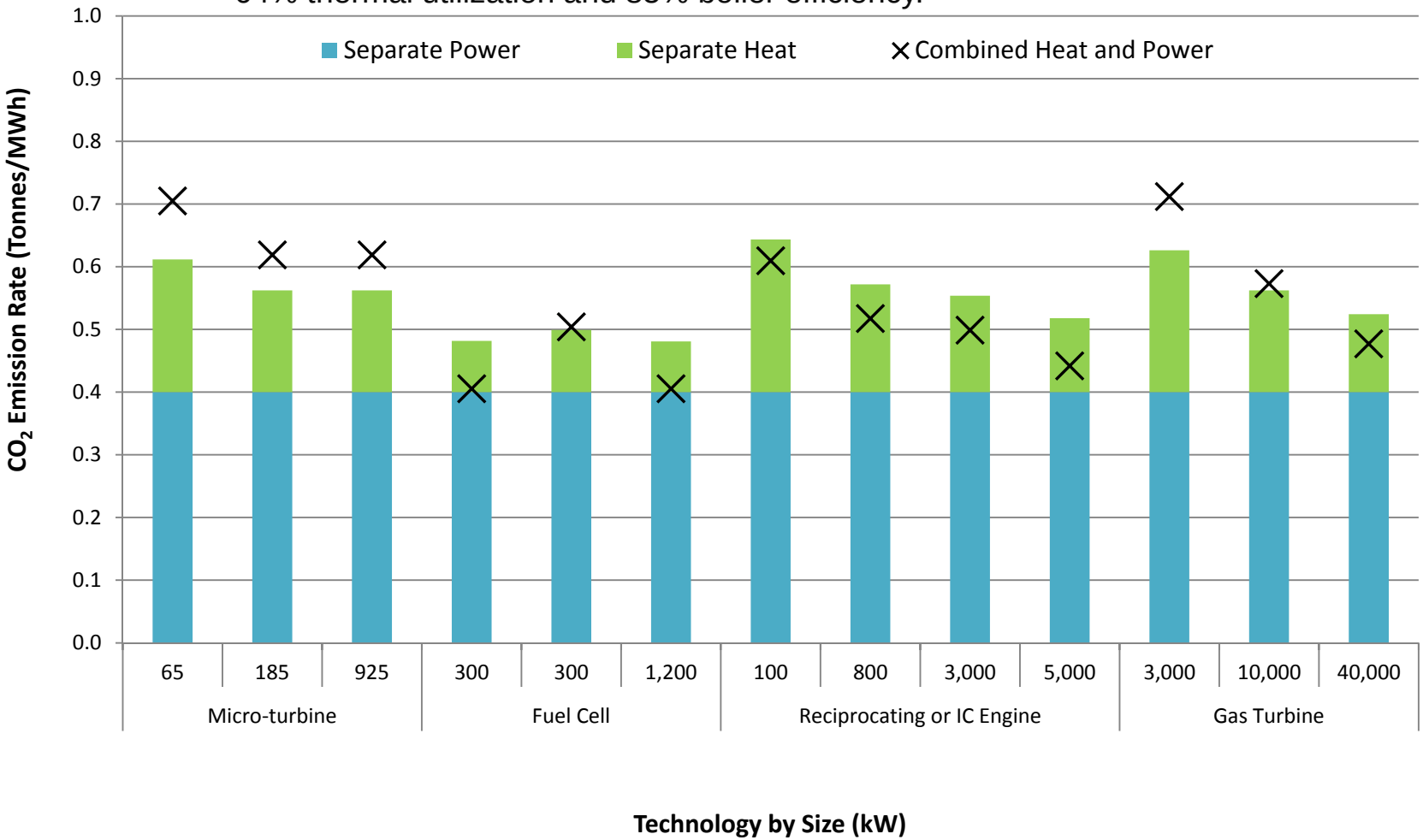
CO_2 Emissions From CHP Systems Compared to 2020 CA Marginal Grid Emissions

Based on the same technology characteristics used in Choudhary, et al



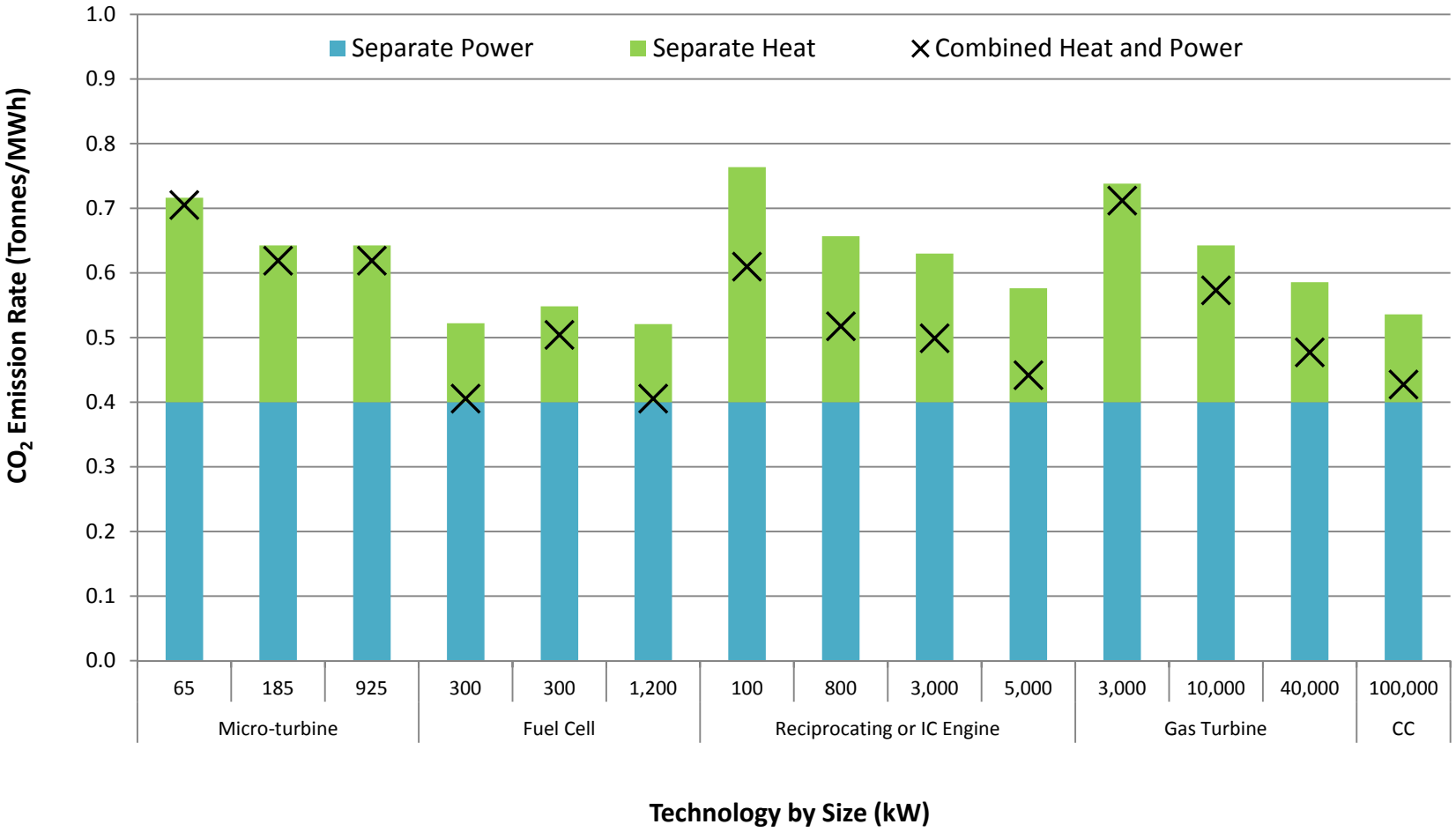
CO_2 Emissions From CHP Systems Compared to CA 2020 Marginal Grid/SHP

Based on the assumptions used in Choudhary, et al pessimistic case – 64% thermal utilization and 85% boiler efficiency.



CO_2 Emissions From CHP Systems Compared to CA 2020 Marginal Grid/SHP – Revised

Based on ICF Assumptions– 90% thermal utilization and 80% boiler efficiency.



Adjusting for the RPS

- Several studies, including Choudhary, et al and some earlier ICF studies show results based on discounting the marginal grid rate by 33% for behind-the-meter generation to account for the RPS.
- While this seems conceptually/directionally correct, there may be a better way to explicitly model this.
- This is a good area for further research.

Areas for Further Research

- Thermal utilization – better data on actual system performance by size and end use.
- Efficiency of avoided “boiler” – better data on boiler efficiency by size and application (including non-boiler alternatives).
- Marginal grid emission rates – definition of what is on the margin and modeling/analysis of marginal rates under different scenarios.
- Treatment of RPS

Conclusions

- Most CHP systems will be sized to meet baseload thermal demand thereby maximizing thermal utilization and CHP system economics while minimizing CO2 emissions. For an optimally sized CHP system, a thermal utilization of above 80% is a reasonable assumption. A sub-optimally sized system with reduced thermal utilization will be less efficient and result in lower GHG reductions, but would also be less likely to be built because of less favorable economics.
- An overly optimistic separate boiler efficiency assumption contributes to lower estimated GHG emissions for SHP when compared against a CHP system. Average separate boiler efficiency is typically between 75% - 80%.
- If heat rate degradation is taken into account, it should be applied consistently for both separate heat and power units and CHP.

Conclusions (cont.)

- Further analysis is warranted on the marginal avoided grid efficiency to ensure that it includes peaking units that will be needed on a daily basis to support fluctuating generation from renewable sources.
- The treatment of the RPS heat rate adjustment should be reviewed. In addition, the RPS adjustment only applies to behind-the-meter CHP systems, whereas the majority of generation is from larger generators that sell to the grid.
- The majority of existing California CHP is large combustion turbine and combined cycle systems that sell power to the grid. With typical boiler efficiency and thermal utilization values, these systems will be net GHG reducing compared to the 2020 California marginal grid emissions.

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