Utilizing CHP to Reduce Carbon Footprint in Low-GHG Utility Territories

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June 2014

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Agenda

- Typical Approach and Benefits of CHP
- The Problem in Low-GHG Utility Territories
- Options and Perspectives
- Case Study and Results

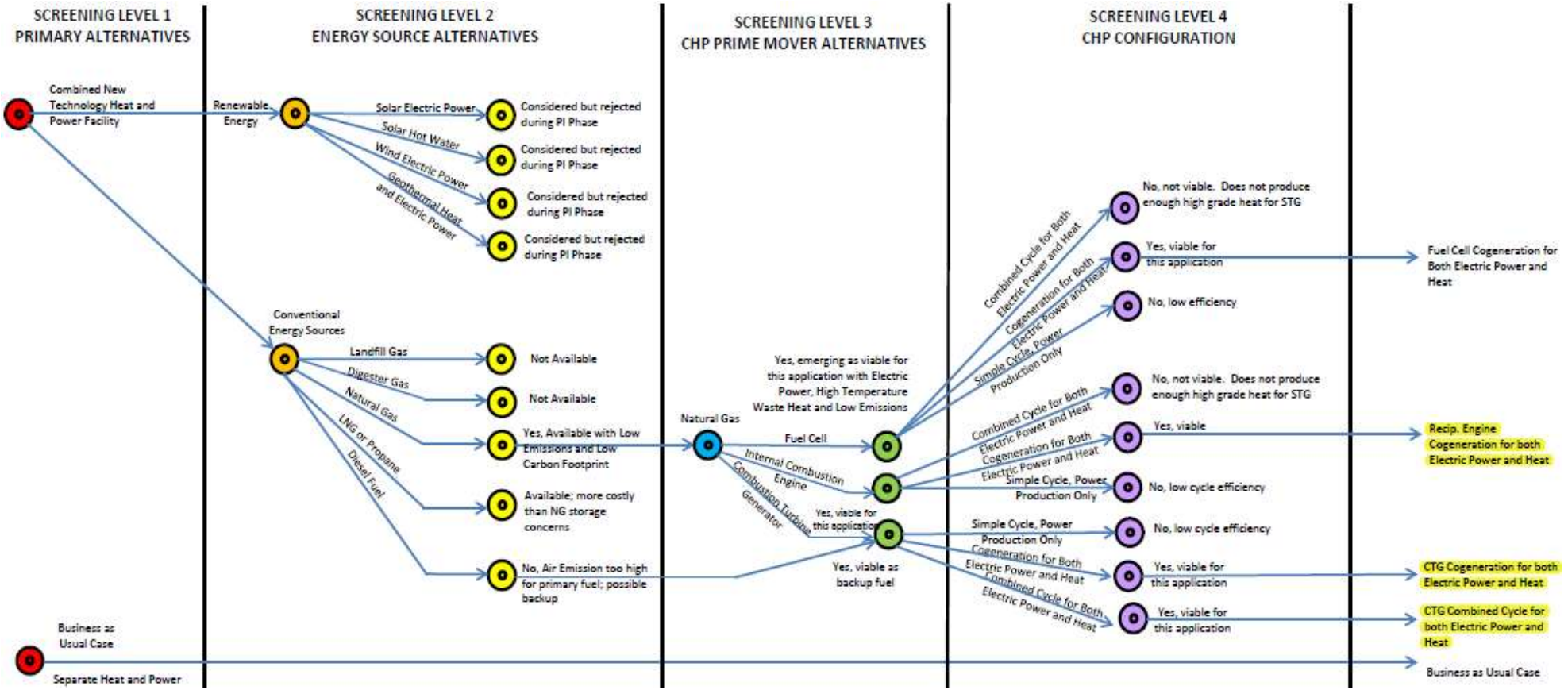
Typical Approach to Evaluating CHP

- Gather the campus/facility loads
  - Targets
  - Offsets

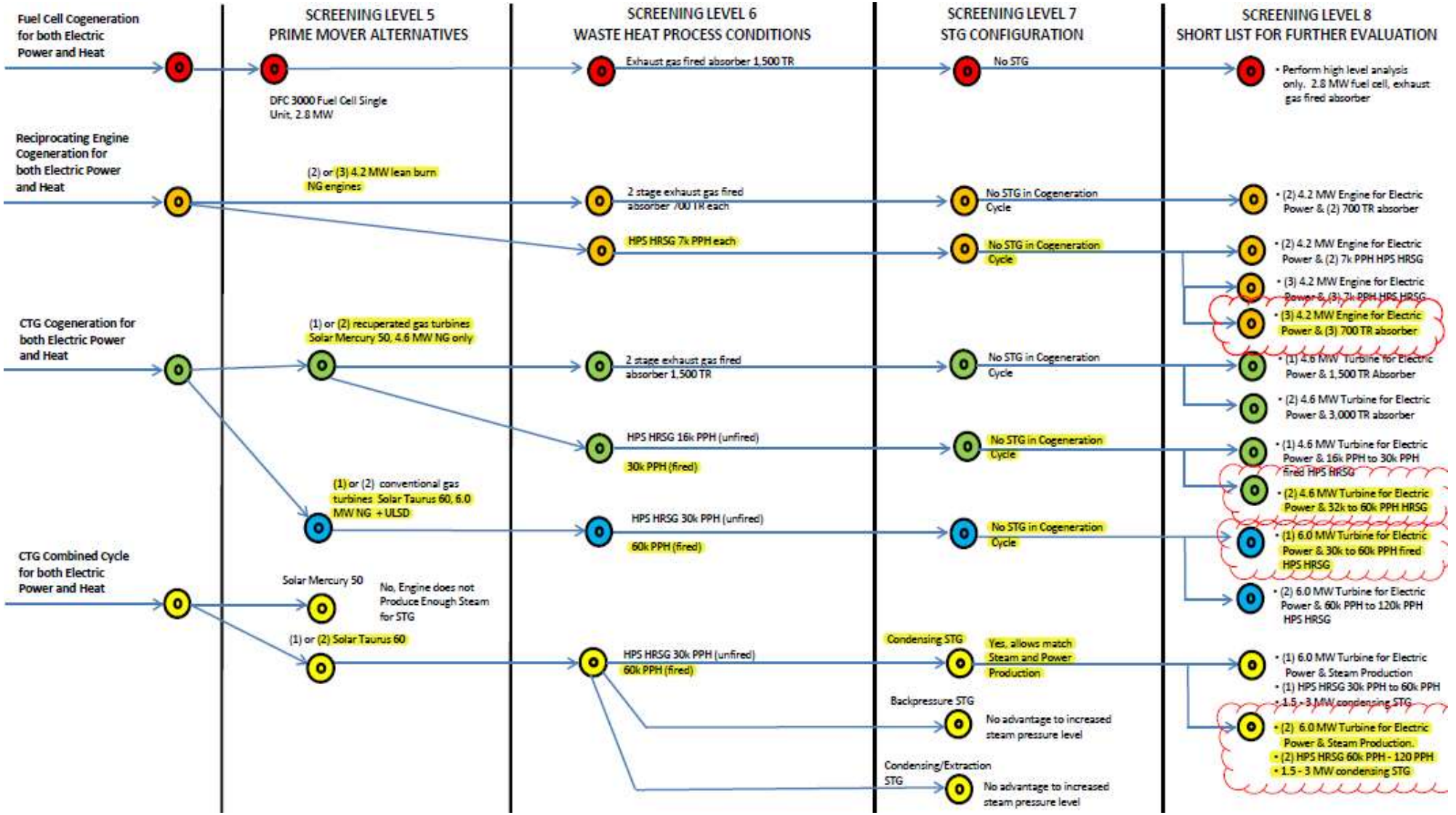
- Gather the current utility costs and tariffs
- Screen CHP technology options and configurations
- Shortlist to top 2-3 system options
- Evaluate and choose top option using “Decision Criteria”

- Build high-level energy model
- Run TCO/NPV analysis

Screening CHP Technology Options



Screening CHP Technology Options



Typical Decision Criteria

		OPTION #1	OPTION #2	OPTION #3	Units
COST ANALYSIS:					
First cost					M$
Utility Costs	Electricity				M$/Yr
	Gas				M$/Yr
O&M					M$
Regulatory / Permitting Costs					M$
Asset Write-Off Value					M$
TCO/NPV RESULTS					M$
SUSTAINABILITY:					
Energy Comparison					GJ
Carbon Emissions (Site)					mTons/yr
Carbon Emissions (Global)					mTons/yr
OPERATIONS:					
Utility Infrastructure Reliability					
Complexity of safety systems					
Site Master Plan impact					

Typical CHP Checklist of Benefits

✓ Improve campus utility resiliency

✓ Increase campus energy efficiency (CHP %)

✓ Lower cost of campus utility bills

✓ Lower cost of O&M staffing for centralization

❑ Lower carbon footprint vs. local utility provider

Today: not always the case! Why?

The Problem: Carbon Footprint for Select Clients

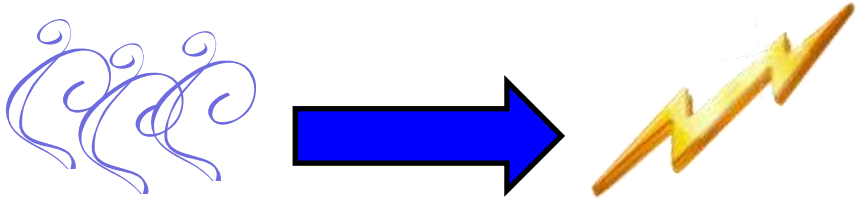
- × May not be able to increase GHG emissions
- × On-campus generation will usually increase local GHG
- ✓ When comparing CHP emissions to “dirty” utility providers, global GHG emissions may improve
- × What if utility provider claims to be more “green” than typical?

EPA Carbon Emission Comparison

- National average for utility providers
  - ~1300 lbs of CO_2 per MW-hr
- California average
  - ~ 650 lbs of CO_2 per MW-hr
- PG&E published rate (SF Bay Area Utility)
  - ***- 462 lbs of CO_2 per MW-hr***
- Typical CHP system configurations
  - 600-800 tons of CO_2 per MW-hr
  - Waste heat utilization is key

CHP Waste-Heat Utilization

- Only way to achieve comparable CO_2 rates is 100% waste-heat utilization
- CHP thermal energy used to offset thermal or electrical loads
- Offset strategy will be driven by site criteria and loads
- Using thermal energy to offset electrical is more favorable from a carbon emission standpoint



TAKEAWAY

- For low-GHG sites, equipment options used for waste-heat conversion must consider impact of carbon emission penalty
- Strategy for waste-heat utilization may change if site loads are understood and can accommodate different approaches

EPA Carbon Calculator (U.S. Rate)

CHP Results

The results generated by the CHP Emissions Calculator are intended for eductional and outreach purposes only; it is not designed for use in developing emission inventories or preparing air permit applications.

Annual Emissions Analysis

	CHP System	Displaced Electricity Production	Displaced Thermal Production	Emissions/Fuel Reduction	Percent Reduction
NOx (tons/year)	3.34	38.77	18.16	53.59	94%
SO2 (tons/year)	1.39	91.60	0.47	90.67	98%
CO2 (tons/year)	43,234	42,704	21,252	20,722	32%
Carbon (metric tons/year)	11,791	11,647	5,796	5,651	32%
Fuel Consumption (MMBtu/year)	739,051	476,056	363,284	100,288	12%
Acres of Forest Equivalent				5,651	
Number of Cars Removed				3,532	

Displaced Electricity Generation Profile: eGRID State Average All Sources 2010

Region Selected: US Average

This CHP project will reduce emissions of Carbon Dioxide (CO2) by 20,722 tons per year

This is equal to 5,651 metric tons of carbon equivalent (MTCE) per year

This reduction is equal to removing the carbon that would be absorbed by 5,651 acres of forest

OR

This reduction is equal to removing the carbon emissions of 3,532 cars

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EPA Carbon Calculator (CA Rate)

CHP Results

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Annual Emissions Analysis

	CHP System	Displaced Electricity Production	Displaced Thermal Production	Emissions/Fuel Reduction	Percent Reduction
NOx (tons/year)	3.34	5.96	18.16	20.79	86%
SO2 (tons/year)	1.39	4.66	0.47	3.74	73%
CO2 (tons/year)	43,234	17,718	21,252	(4,265)	-11%
Carbon (metric tons/year)	11,791	4,832	5,796	(1,163)	-11%
Fuel Consumption (MMBtu/year)	739,051	311,774	363,284	(63,994)	-9%
Acres of Forest Equivalent				(1,163)	
Number of Cars Removed				(727)	

Displaced Electricity Generation Profile: eGRID State Average All Sources 2010

Region Selected: California

The proposed CHP project will not reduce Carbon Dioxide emissions over the chosen conventional production alternative

This emissions change is equal to adding the carbon that would be absorbed by 1,163 acres of forest

OR

This emissions change is equal to adding the carbon emissions of 727 cars

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EPA Carbon Calculator (PG&E Rate)

CHP Results

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Annual Emissions Analysis

	CHP System	Displaced Electricity Production	Displaced Thermal Production	Emissions/Fuel Reduction	Percent Reduction
NOx (tons/year)	3.34	6.27	18.16	21.10	86%
SO2 (tons/year)	1.39	3.03	0.47	2.10	60%
CO2 (tons/year)	43,234	15,740	21,252	(6,243)	-17%
Carbon (metric tons/year)	11,791	4,293	5,796	(1,703)	-17%
Fuel Consumption (MMBtu/year)	739,051	281,732	363,284	(94,036)	-15%
Acres of Forest Equivalent				(1,703)	
Number of Cars Removed				(1,064)	

Displaced Electricity Generation Profile: eGRID State Average All Sources 2010

Region Selected: Pacific Gas & Electric Service Territory

The proposed CHP project will not reduce Carbon Dioxide emissions over the chosen conventional production alternative

This emissions change is equal to adding the carbon that would be absorbed by 1,703 acres of forest

OR

This emissions change is equal to adding the carbon emissions of 1,064 cars

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How Does PG&E Do It?

PG&E rate of 462 tons of CO_2 per MW-hr

PG&E Portfolio Asset Mix

- Nuclear 
- Hydro 
- Wind and PV 
- Utility-Grade Large Combined Cycle CHP

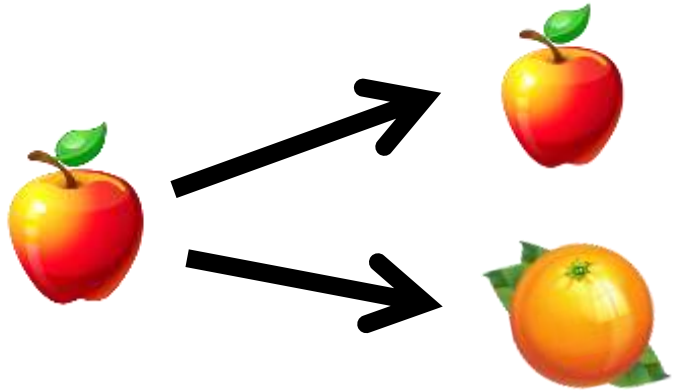
Other Utility companies **WILL** trend this direction in future

Why Not Stay Plugged Into the Utility?

1. Electrical costs increasing and forecasted to go higher
2. Achieve full CHP benefits for shared campus utilities
3. “Spark Spread” continually expanding
4. Future Carbon Cap & Trade costs – unknown risks

Carbon Comparison: CHP vs. Utility Provider

Are we really comparing apples to apples?



- For CHP offset kw-hrs, which assets are being displaced?

Which CO_2 rates should be used when comparing?

- Marginal rates? Base-loaded rates?
- Which assets are used for peaking and demand response?
- Which Utility carbon rates does local CHP truly offset?

Comparing Apples to Apples

PG&E Published Rates

- Portfolio Asset Mix
  - 462 lbs CO_2 per MW-hr
- eGrid Rate
  - 658 lbs CO_2 per MW-hr
- Base-loaded Large Combined Cycle Plants
  - 810 lbs CO_2 per MW-hr
- "Dirty" Must-run /peaking Assets
  - 944 lbs CO_2 per MW-hr

Comparing CHP to Utility base-load rate can be justified IF:

1. Campus loads are known and understood
2. Plant is designed for campus base-load
3. Campus shoulders/peaks are still served by Utility

Case Study: CHP in PG&E Territory

Major Equipment

Combustion Gas Turbine

Generator

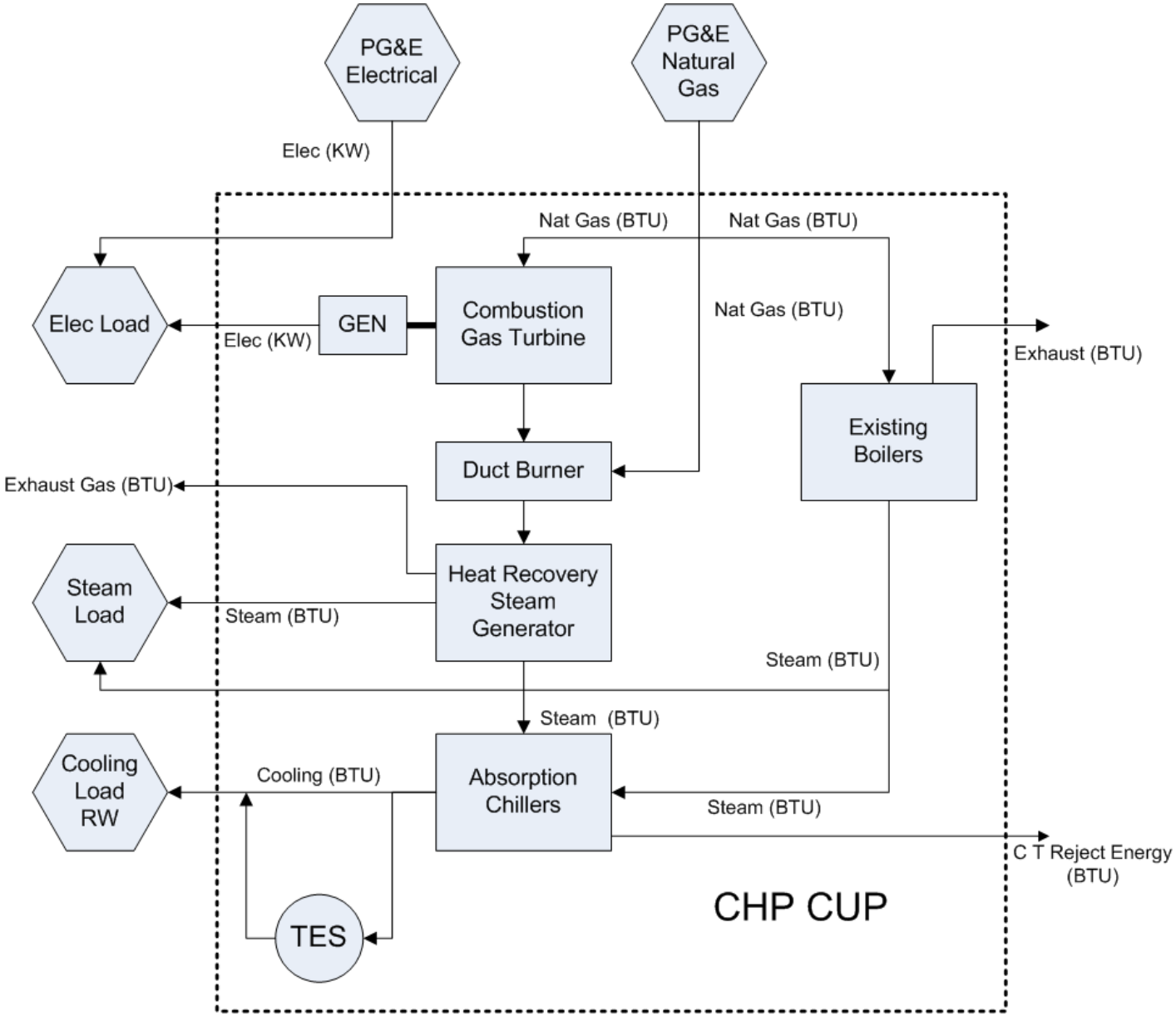
Duct Burner

Heat Recovery Steam Generator

Absorption Chillers

Existing Boilers

Thermal Energy Storage (TES)



Case Study: CHP System CO_2 Calculations

		Option 1 – BAU with PG&E			Option 2 – Onsite CHP T-70		
		CA eGrid 658 lbs / MWhr	PG&E Base-Load 810 lbs / MWhr	PG&E Must-run 944 lbs / MWhr	CA eGrid 658 lbs / MWhr	PG&E Base-Load 810 lbs / MWhr	PG&E Must-run 944 lbs / MWhr
Carbon Produced by PG&E for Non-Base Electric Load Coverage	lbs/hr	10,738	13,220	15,406	4,753	5,852	6,819
	ton/hr	4.88	6.01	7.00	2.16	2.66	3.10
	metric ton/year	**42,757**	**52,642**	**61,342**	**18,925**	**23,300**	**27,151**
Carbon Produced by Boilers for Heating Loads Coverage	lbs/hr	5,506	5,506	5,506	904	904	904
	ton/hr	2.50	2.50	2.50	0.41	0.41	0.41
	metric ton/year	**21,923**	**21,923**	**21,923**	**3,600**	**3,600**	**3,600**
Carbon Produced by New CHP for Heating and Cooling Base-Loads	lbs/hr				10,215	10,215	10,215
	lbs/year				89,482,800	89,482,800	89,482,800
	metric ton/year				**40,674**	**40,674**	**40,674**
Carbon Produced by Duct Burner for Heating Loads Coverage	lbs/hr				1,324	1,324	1,324
	ton/hr				0.60	0.60	0.60
	metric ton/year				**5,271**	**5,271**	**5,271**
Total Carbon Emission	**metric ton/year**	**64,681**	**74,565**	**83,265**	**68,471**	**72,846**	**76,697**
Carbon Comparison to BAU					**-5.86%**	**2.31%**	**7.89%**

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Case Study: CHP Benefits and Challenges

Benefits

- Annual projected energy savings ~$5M – Positive TCO
- Improved energy efficiency
- Increased campus resiliency for critical site facilities
- CHP serving base-loads while allowing for PG&E to serve peaks

Challenges

- Complex heating and cooling load profiles
- Infrastructure upgrades to facilitate distribution of energy
- Significant increase in local carbon emissions
  - Permitting strategies
- Slight increase in global carbon emissions

Summary and Recommendations

Lessons Learned

1. Utility decisions are rarely made on GHG alone
2. Understand the Utility being compared against
3. Understand and present global vs. local perspectives
4. Understand risk of energy rate forecasts in the future

Summary and Recommendations

Strategies for CHP in Low-Carbon Territories

1. Size CHP for base-load operations and utilize 100% thermal energy to achieve highest CHP efficiency
2. Campus peak loads can be served by “green” utility
3. “Apples to Apples” comparisons for carbon emissions
4. Evaluate and present other CHP benefits vs. carbon