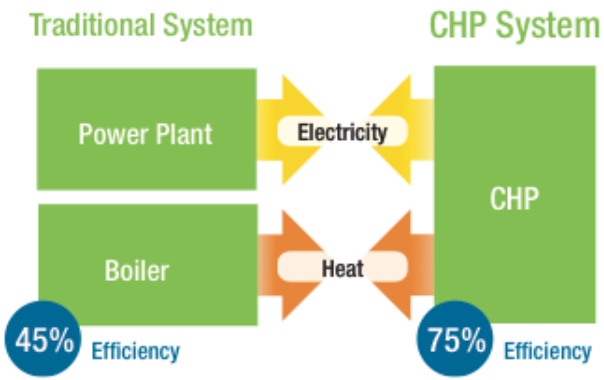
Combined Heat and Power In the USA*

8% of Generating Capacity and
12% of MWh Generated
and **Growing**



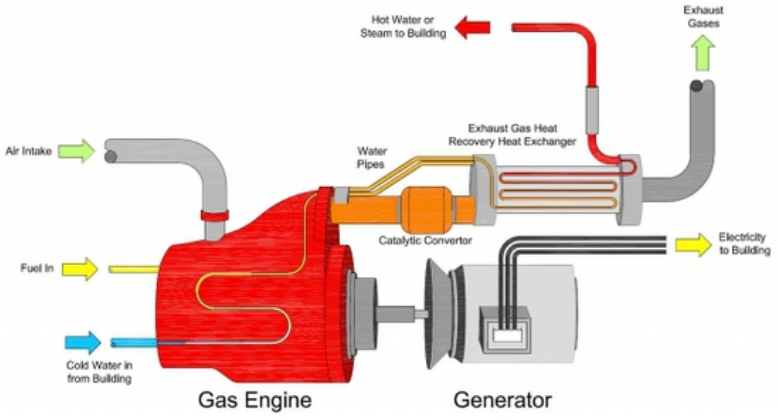
<u>Presentation Today</u>

- CHP technology evolution
- Why should utilities care?
- The CHP market in Florida
- Utility opportunities
  - New business models and rate designs
  - Compliance with the proposed Clean Power Plant rule

*Source: Combined Heat and Power: A Clean Energy Solution, August 2012. US Department of Energy with US Environmental Protection Agency.

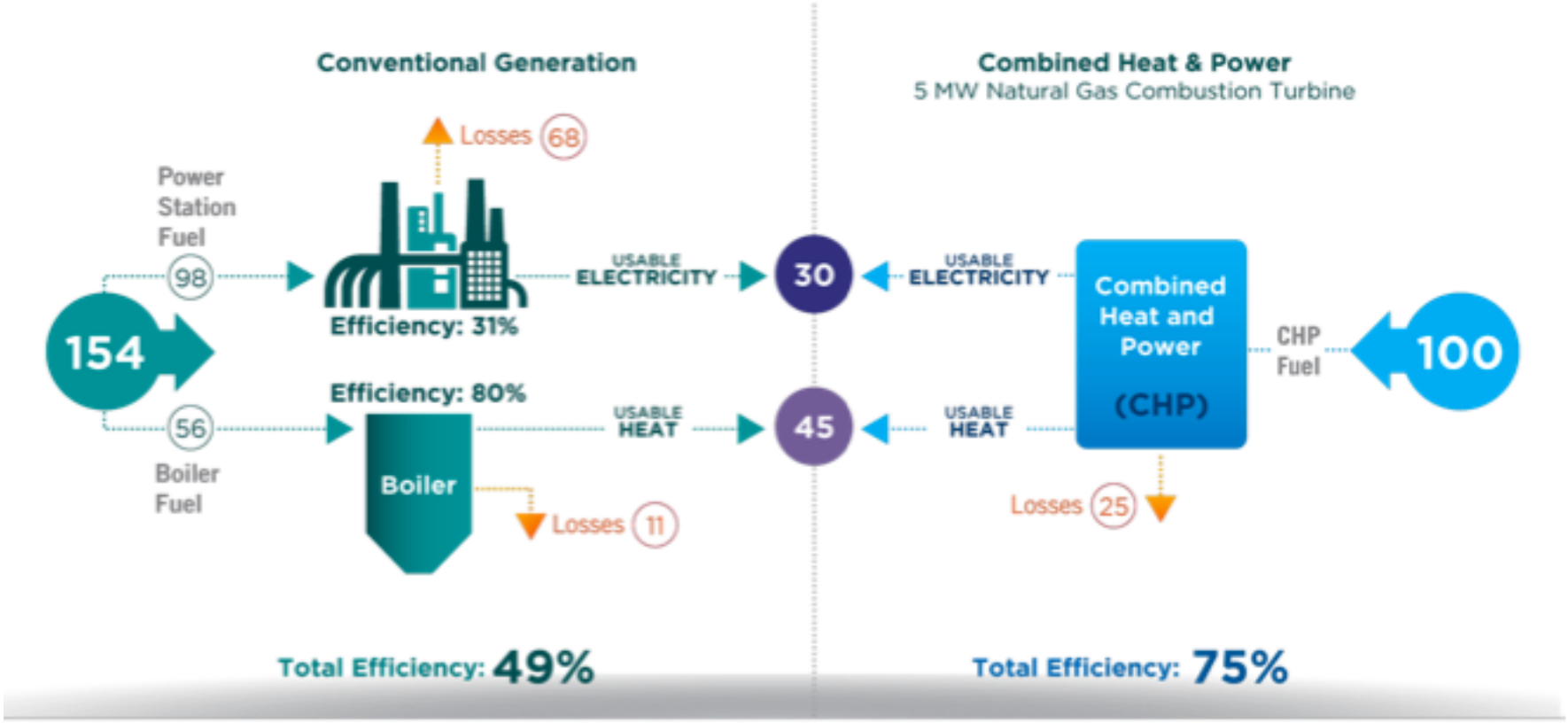
A Very Simple CHP Example

- Prime movers:
  - Reciprocating engines
  - Combustion turbines
  - Steam turbines
- CHP Makes:
  - Electricity
  - Cold water
    - Absorption or turbine chillers
  - Steam
  - Hot water



Exhaust – high temperature for steam
Jacket – close to boiling (absorption chiller)
Thermal manifold – blend to suit

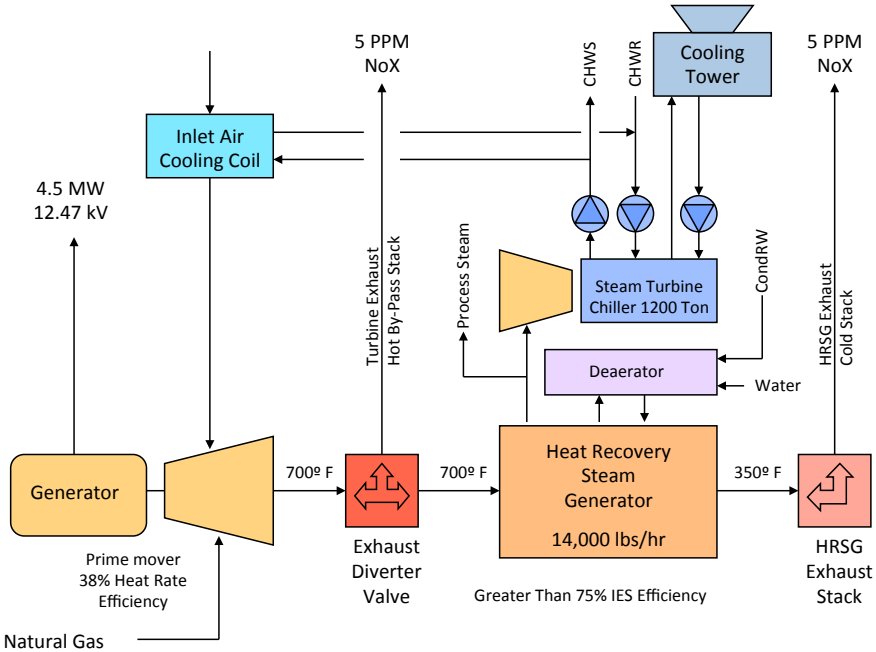
CHP Can Be Much More Efficient Than Combined Cycle



Source: The Opportunity for CHP in the United States, May 2013. Prepared by ICF International for the American Gas Association

CHP Used to Only Be Available As Custom Designed and Site Built

- System Integration
  - Prime over
  - Heat recovery
  - Parallel switchgear
  - Thermal manifold
  - Steam generator
  - Chillers
  - Diverters
  - Cooling
  - Monitoring
- On-site assembly
- Commissioning and testing
- Best suited for large industrial applications

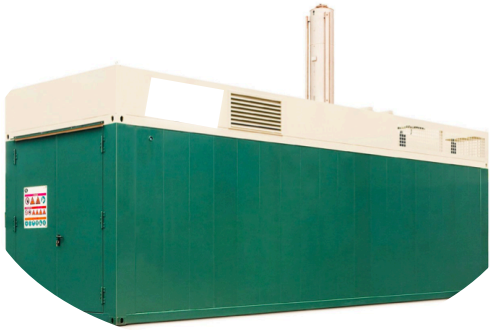


Example: Gas CT to HRSG turbine to steam turbine centrifugal chiller

Evolution -Now Plug and Play!

Smaller Packages, Factory Tested **and** Less Expensive

Then: Industrial scale, custom design, lengthy onsite commissioning and testing



Now: Commercial, institutional scale and residential scale , skid mounted sound enclosures, absorption chillers down to 5 tons, water and air cooled

Why Should Utilities Care?

- Customers Like It
  - Reduces energy costs
  - Improves reliability
    - Keeps running during blackouts, hurricanes
  - Price stability
- Utility problems and opportunities
  - Lost revenue potential
  - Low cost additional generation capacity
  - T&D congestion relief
  - EPA Clean Power Plant rule compliance
    - Better than PV in several ways…

700% More CO2 Reduction Per Dollar

And Less Intermittency Than Solar PV!

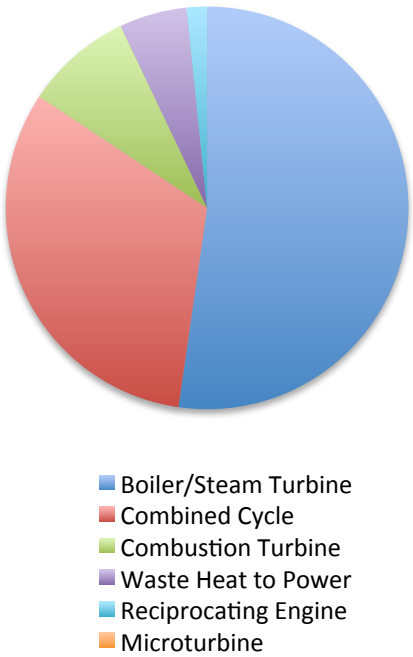
Category	10 MW CHP	10 MW PV	10 MW Wind	Combined Cycle (10 MV Portion)
Annual Capacity Factor	85%	22%	34%	70%
Annual Electricity	74,446 MWh	19,272 MWh	29,784 MWh	61,320 MWh
Annual Useful Heat	103,417 MWh_t	None	None	None
Footprint Required	6,000 sq ft	1,740,000 sq ft	76,000 sq ft	N/A
Capital Cost	$20 million	$60.5 million	$24.4 million	$10 million
Annual Energy Savings	308,100 MMBtu	196,462 MMBtu	303,623 MMBtu	154,649 MMBtu
Annual CO_2 Savings	42,751 Tons	17,887 Tons	27,644 Tons	28,172 Tons
Annual NOx Savings	59.4 Tons	16.2 Tons	24.9 Tons	39.3 Tons

Source: Combined Heat and Power: A Clean Energy Solution, August 2012. US Department of Energy with US Environmental Protection Agency.

Existing CHP Capacity in Florida

(Mid 2013)

Prime Mover	Sites	Capacity (kW)
Boiler/Steam Turbine	28	1,766,710
Combined Cycle	8	1,083,000
Combustion Turbine	13	291,445
Waste Heat to Power	5	183,206
Reciprocating Engine	15	55,205
Microturbine	1	60
Fuel Cell	0	0
Other	0	0
Total	70	3,379,626



Source: www.eea-inc.com/chpdata/States/FL.html. Combined Heat and Power Installation Database, updated 7/25/2013, ICF International for US Department of Energy

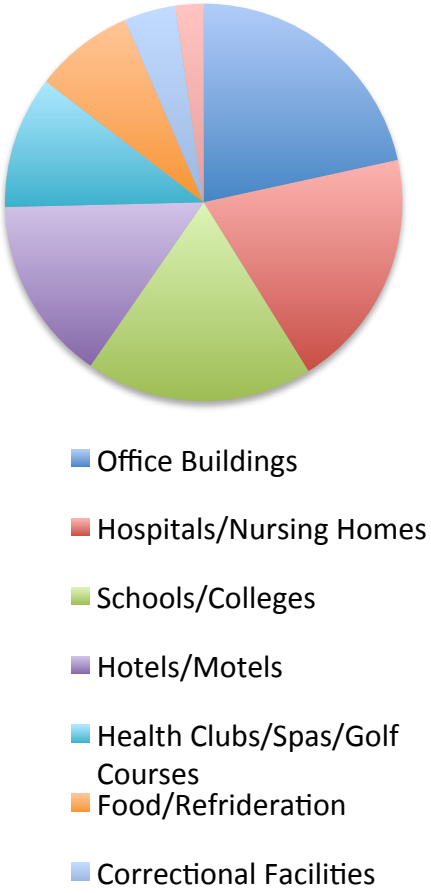
Florida's CHP Technical Potential 7.6 Gigawatts!

- Industrial
  - 2,364 Sites
  - 933 MW
  - 78% of sites < 5 MW
- Commercial/Institutional
  - 22,248 Sites
  - 6,699 MW
  - 90% of sites< 5 MW

Source: The Market for CHP in Florida, August 10, 2008. Energy and Environmental Analysis, Inc. an ICF International Company

Potential CHP Applications in Florida

Applications	% of Capacity Potential
Office Buildings	21.6%
Schools	15.2%
Hotels/Motels	15.0%
Nursing Homes	9.9%
Hospitals	9.7%
Golf Clubs	6.7%
Food Service	5.8%
Correctional Facilities	4.2%
Health Clubs/Spas	4.2%
Colleges and Universities	3.2%
Supermarkets	1.7%
Water/WW Treatment	1.1%
Commercial Laundries	0.6%
Refridgerated Warehouses	0.5%
Car Washes	0.3%
Museums	0.3%

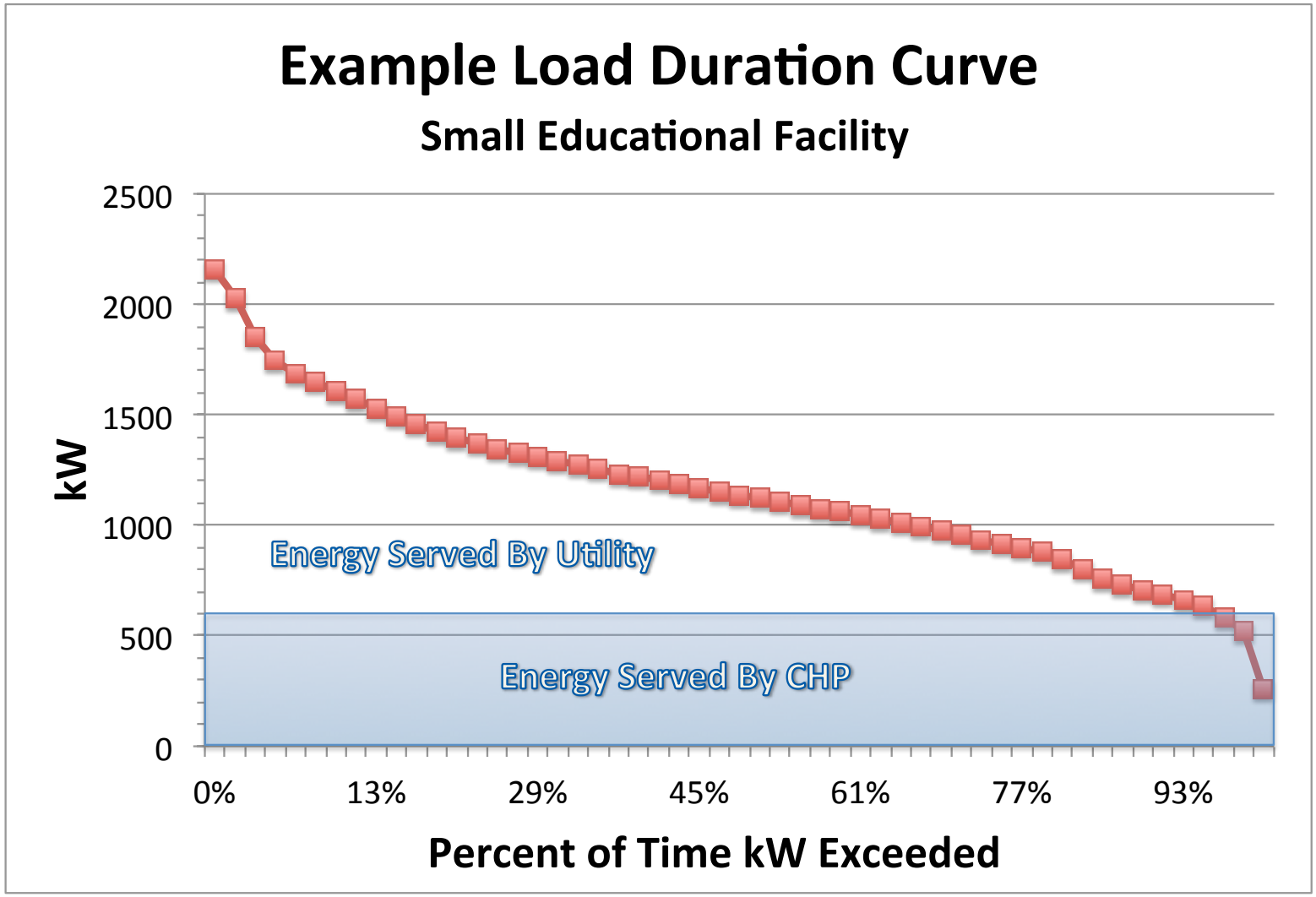


Source: The Opportunity for CHP in the United States, May 2013. Prepared by ICF International for the American Gas Association

CHP Planning and Operating Characteristics

- Designed not to have net energy or excess thermal output
  - Often results in less than optimal sizing
- Usually operates in parallel with grid
- CHP prime mover has high capacity factor
  - Availability guarantee >90% not uncommon
- Maintenance in low demand periods
- Forced outages whenever.

1 kW solar	1,500 kWh/yr. lost revenue
1 kW CHP	7,000 kWh/yr. lost revenue



What Does CHP Do to Utility Revenue and Capacity Requirements?

- Lost revenue from:
  - Sales displaced by prime mover
  - Sales lost for cooling heating
- Load factors could worsen
  - 95% CHP capacity factor guarantees available
  - CHP maintenance and forced outages still occur

Utility CHP Management Strategies

- Standby or supplemental rates
  - Some Florida utilities already have
- Straight fixed-variable cost allocation (SFV)
  - Current practices recover fixed costs in energy charges
- Different business models
  - Dual Metering
    - Protects franchise fees, taxes, T&D requirements
    - Explicit value pricing mechanism
  - Facility participation
    - Distribute capacity additions
    - Get into steam, chilled water, heat business
    - Contributes to Clean Power Plan compliance

Standby Charges Will Not Cure Revenue Erosion But Participation Can!

EXAMPLE - RETROFIT FOR HOSPITAL WITH CHILLED WATER AND STEAM*

Host/Utility Position	Utility Not Involved		Utility Owns CHP System** Retail Electric & 50% Shared Savings	
	No Standby Charges	With Standby Charges	Incremental Investment Case	Compared to Lost Revenue Case
IRR Tax-Exempt Host	17.6%	14.4%	14.4%	14.4%
IRR Taxable Host	23.9%	20.3%	17.8%	17.8%
Utility NPV Losses	($2,500,000)	($1,900,000)	$300,000	$2,800,000
IRR Utility***	na	na	9.2%	35.5%

*Recip. Engine, Net HR 7,921 Btu/kWh, 1200 kW Generator, 120 Ton Absorption Chiller, 50 HP Steam Generator, 5% Discount Rate, 20 years

** Utility rate bases prime mover, originates chiller and steam generator as DSM investment, host funds non-removable MEP facilities

*** Based on tax-exempt utility

Example: Co-Generation at Shands Hospital
(4 MW)

- Owned and operated by utility
- Hospital pays:
  - Retail rates on electric load
  - All natural gas consumption
  - Chilled water and steam
  - Facilities charge
- CHP sized to thermal needs
  - Excess electricity at times
- Generation a system resource
  - Contract heat rate

Utility Ownership Examples

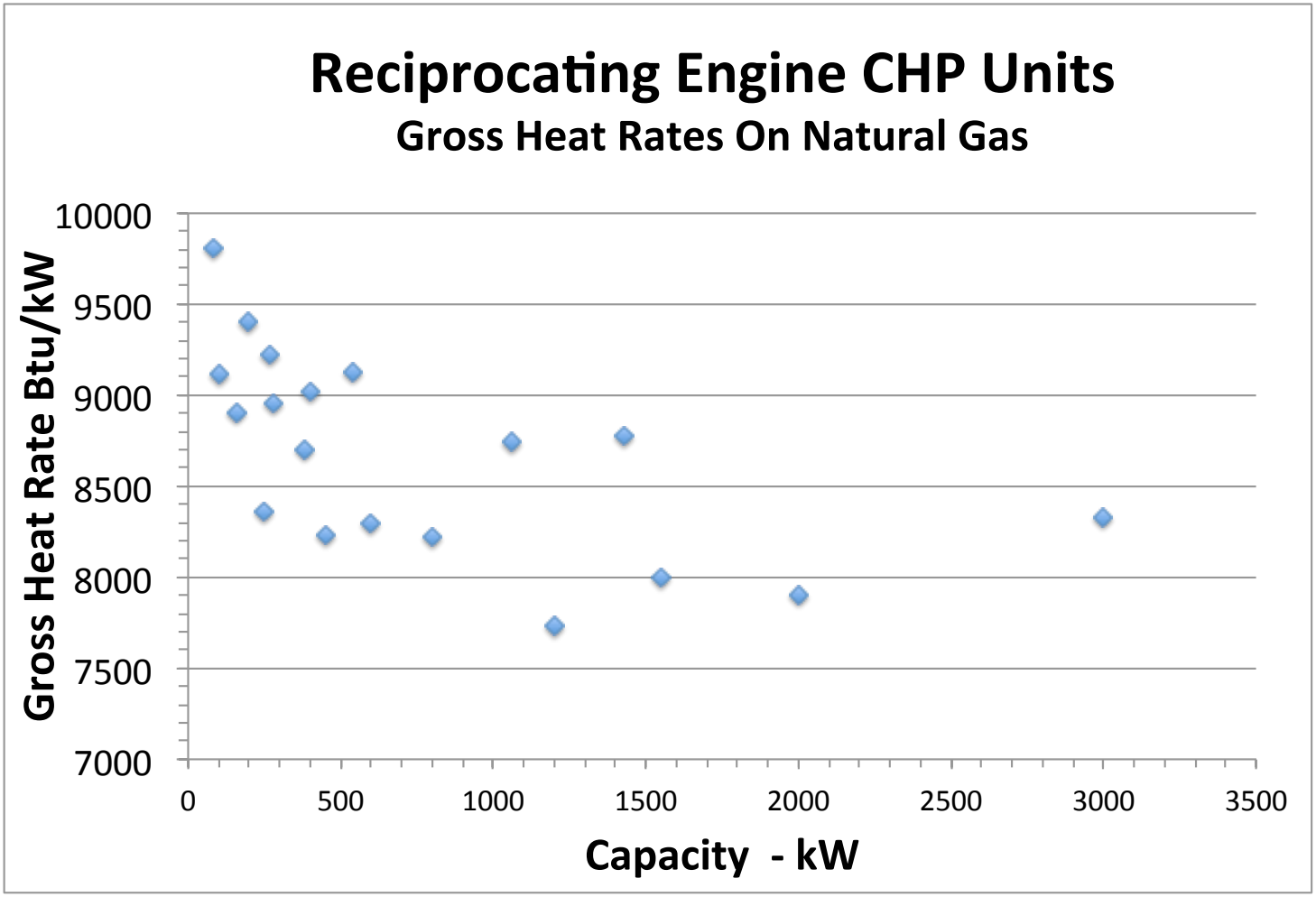
CHP Owner	MW
Missouri Joint Municipal Electric Utility Commission	14.4
Austin Energy Distributed Chilled Water & CHP	8.9
Gainesville Regional Utilities Chilled Water & CHP	4.4
Ameren Energy CHP	44
Duke Energy at University of Florida	46
Alabama Power – Four CHP Sites	537

Source: The Opportunity for CHP in the United States, May 2013. Prepared by ICF International for the American Gas Association

CHP Ownership Under EPA's Proposed Clean Power Plan Rule

- EPA embraces CHP as a utility abatement strategy
  - EPA's technical analysis employed 75% efficiency
- Utility ability to use as abatement will depend **entirely** on State Implementation Plan (SIP)
  - CHP prime mover heat rates not great
  - SIP DSM Provisions
- Carbon reduction credit accrues with:
  - Rebate?
  - Ownership?
  - Purchase of excess power?
- Utilities potentially need both CHP revenue and carbon credits

CHP Prime Mover Heat Rates Do Not CO_2/MWh
(By Themselves)



Conclusions

- Conventional utility revenue recovery does not work well with CHP
- Rate designs that will be revenue neutral will require either :
  - SFV cost allocations
  - Demand ratchets
  - Or both.
- Customers likely to perceive as onerous
- Re-positioning utilities to be in the electric, heat and "coolth" business may be a win-win solution.
- Anti-trust regulations may be a significant obstacle
- Florida's Clean Power Plan SIP policies on DSM will be critical to future utility involvement in CHP

Thank You For Your Time

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