DISTRIBUTED GENERATION FOR LARGE CUSTOMERS

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CAMPUSENERGY2015

OVERVIEW

- Market Influences for Distributed Generation
- Where it Works
- Utility Involvement
- Case Study: GRU – South Energy Center
- Questions & Answers

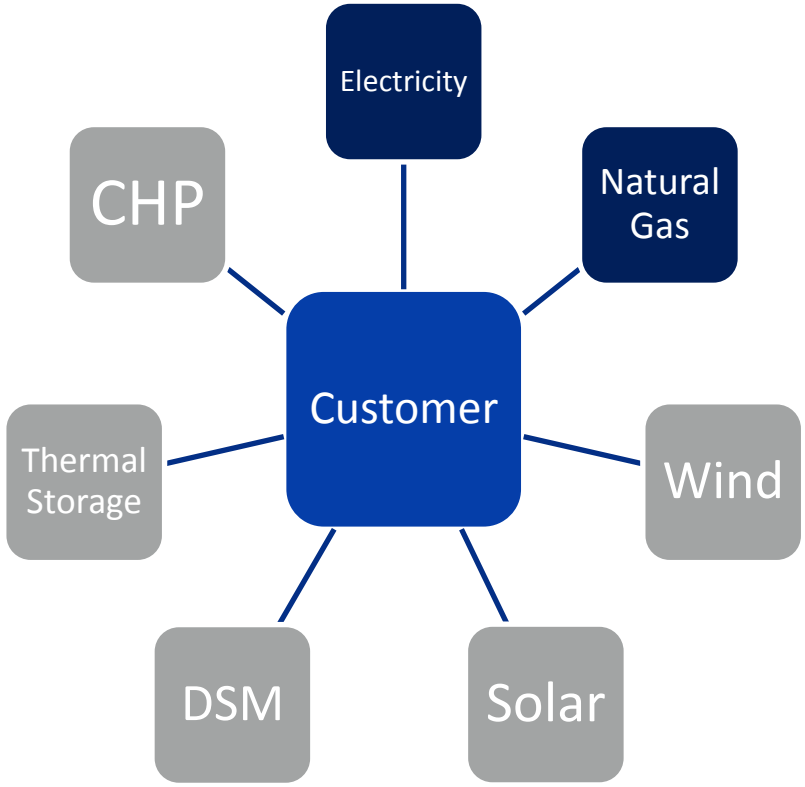
BURNS McDONNELL

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

MARKET INFLUENCES

ENERGY DELIVERY

Yesterday



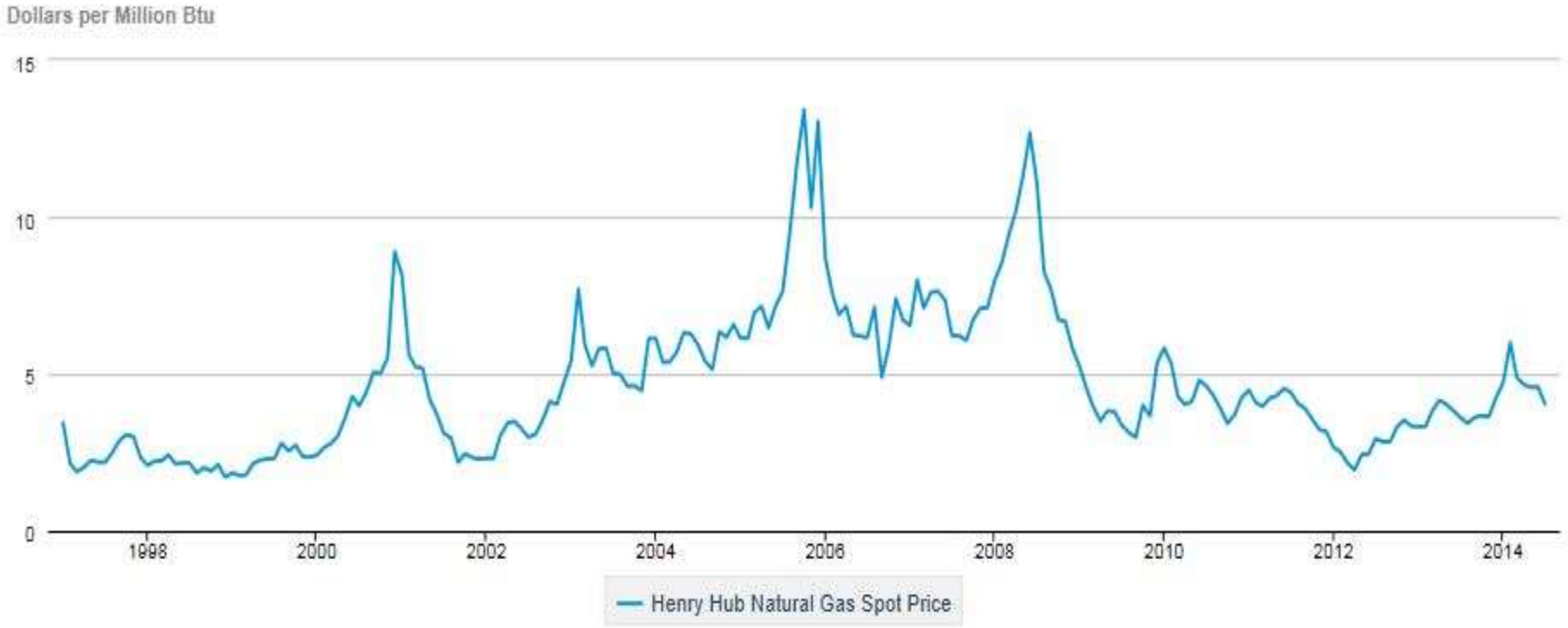
Tomorrow

MARKET INFLUENCES

- Over the past 5 years, several key market influences have led to an increased interest in the installation of:
  - Distributed Generation
  - Cogeneration
  - Combined Heat and Power (CHP)
  - Microgrids
- Market influences for onsite generation include:
  - Low natural gas costs and increasing electricity costs
  - Increasing costs to utilities (and central plants) for environmental compliance
  - Necessity of the availability of critical infrastructure in the event of natural or man-made disasters
  - Interest in maintaining manufacturing equipment uptime

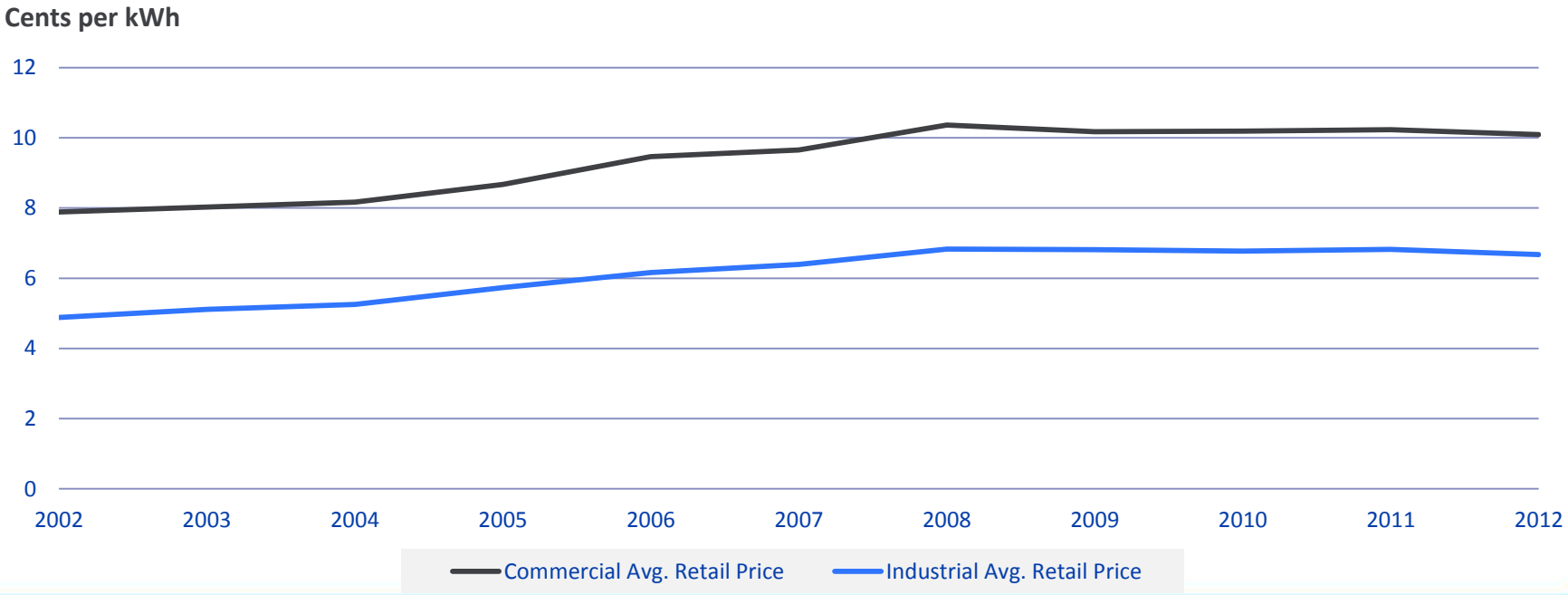
NATURAL GAS PRICES

- Historic highs in 2006 and 2008
- Average 2014 price: $4.78/MMBtu

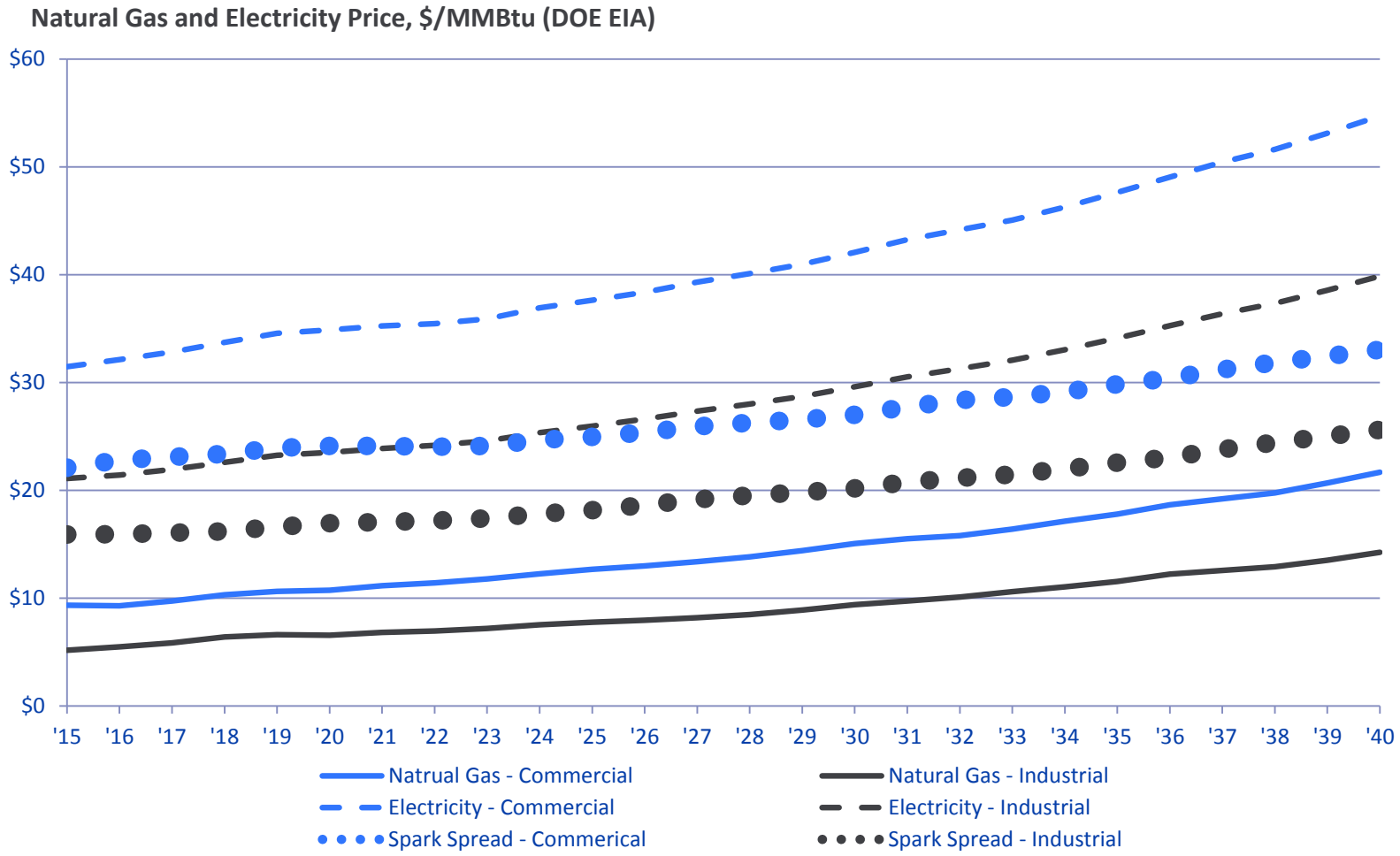


ELECTRICITY PRICES

- Historic highs in 2008
- Average 2014 price:
  - ¢10.50/kWh (commercial)
  - ¢6.91/kWh (industrial)



NATURAL GAS AND ELECTRICITY FORECASTS



EVOLVING ENVIRONMENTAL DRIVERS

- Clean Power Plan – Greenhouse Gas (GHG) Regulation
- Clean Air Interstate Rule (CAIR) – NO_X and SO_2 regulation to control $PM_{2.5}$
- New Source Review – All criteria pollutants
- Supreme Court Ruling on the Tailoring Rule

RECENT STORMS/UTILITY OUTAGES

WEATHER DROVE 80% OF ALL MAJOR OUTAGES BETWEEN 2003 AND 2012

- Most frequent weather-related causes for utility outages
  - 59% Storms and extreme weather
  - 19% Cold and ice storms
  - 18% Hurricanes and tropical storms
  - 3% Tornadoes
  - 2% Extreme heat and wildfires

Source: Think Progress “Extreme Weather Has Driven A Ten-Fold Increase In Power Outages Over The Last Two Decades"

WHERE IT WORKS

WHY CHP?

- Increases redundancy, reliability, and resiliency
- Efficiency
  - Coal plant: 30-40%
  - Combined cycle plant: 40-50%
  - CHP: 70-90%
- Emissions reductions
- Utility cost savings
- Emergency service

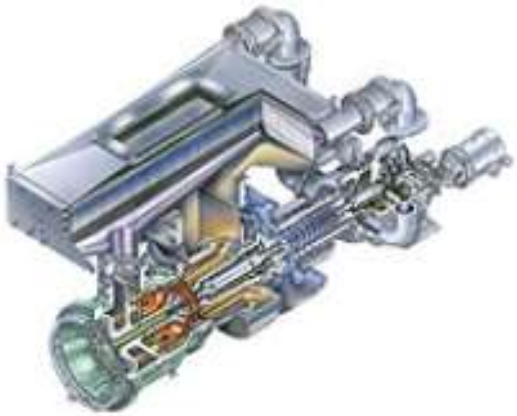
WHY CHP?

Combined heat and power (CHP) provides a source of power **and** thermal energy that may be **black started** as part of a **microgrid** at **greater efficiencies** and **economies** than traditional electric generating assets.

- Redundancy
  - Power source
  - Fuel diversity
  - Thermal source
- Resiliency
  - Ride through
  - Black start
- Reliability
  - High availability
  - React to fuel uncertainty

TYPICAL TECHNOLOGIES

- Gas turbines (4-50 MW)
- Reciprocating engines (2-18 MW)
- HRSGs (5,000 – 350,000 lbs/hr)
- Steam turbines (2-50 MW)

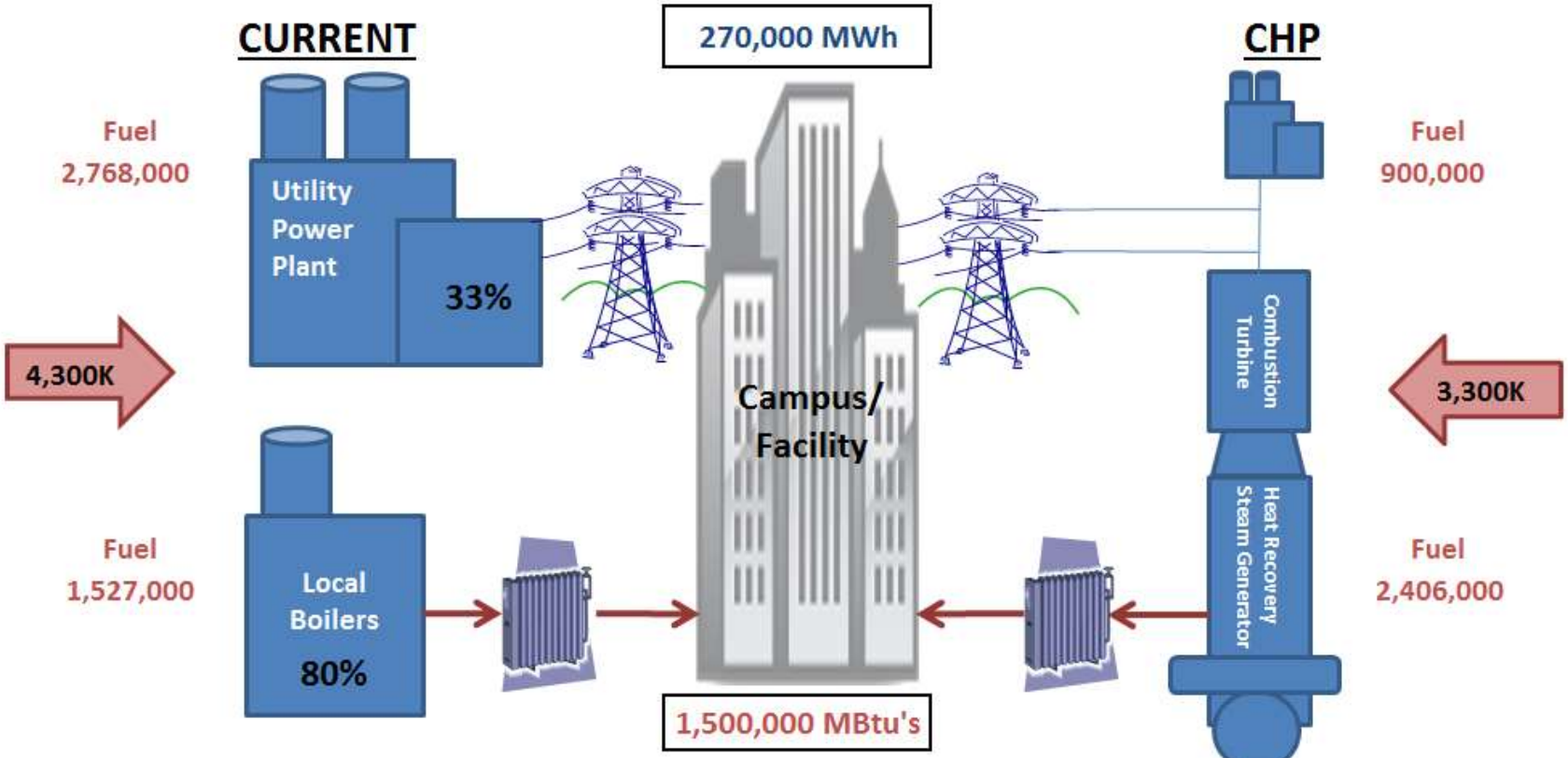


TYPICAL TECHNOLOGIES

HEAT RECOVERY POTENTIAL (RULES OF THUMB)

- Reciprocating engines
  - Approximately 1.2 lbs/hr of 100 psig saturated steam per kW
  - Approximately 2.5-3.0 MMBtu of hot water per MW (jacket water and exhaust in series)
- Gas turbines
  - Unfired approximately 4.0-6.0 lbs/hr of 100 psig saturated steam per kW
  - Fired to 1600F approximately 2 x unfired capacity

CHP EFFICIENCY



56%	Overall Efficiency	73%
69,000	Carbon Footprint (MTCE)	49,000

WHERE CHP?

- University campuses
- Hospitals
- Military bases
- Manufacturing facilities
- Research facilities
- Data centers

Type	MW	Heat/Power Ratio
Universities	5-30	High
Hospitals	4-10	Low-Medium
Industrial/Manufacturing	5-60+	Medium-High
Government/Military	5-60	Low-Medium
Mixed Use Developments	3-10	Low

UTILITY INVOLVEMENT

UTILITY-OWNED CHP

UTILITIES **INVEST** IN CHP BECAUSE THEY…

- Can enter into long-term contracts with mature costumers and continue or add a predictable revenue stream.
- Low barriers to entry (interconnect, expertise, etc,)
- Can add affordable capacity and potentially forgo the costs associated with upgrading their existing power plants to meet environmental regulations
- Strategic distribution/transmission advantages
- Have access to capital

UTILITY-OWNED CHP

PRIVATE COMPANIES **AVOID** CHP BECAUSE THEY…

- Find capital costs of CHP prohibitive
- Are cautious about entering into the electricity production business, which falls outside of their expertise
- Do not have necessary skills to operate/maintain
- May not be able to take full advantage of all the byproducts/benefits of CHP

UTILITY OWNED CHP

ADVANTAGES TO UTILITY COMPANIES

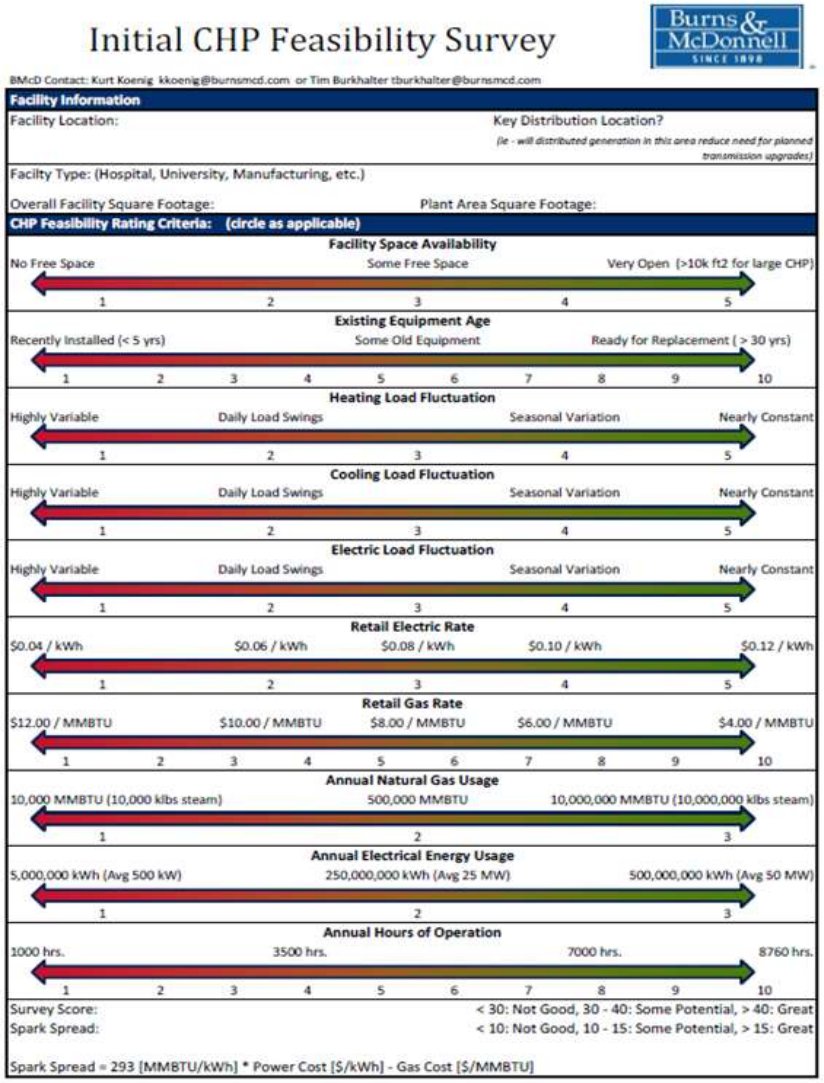
- Protect load
- Maintain client relationship
- Good will through environmental stewardship
- Gas sales
- Low cost capacity
- Distribution relief

ADVANTAGES TO CUSTOMERS

- Cost savings
- Meets environmental goals
- Energy backup
- Improved reliability
- Resiliency
- Real estate
- Core business

Good Partnership Candidates

- Greenfield Facilities
- Open Markets (PJM, ERCOT, etc)
- Old/Inefficient Equipment
- Predictable consistent thermal loads
- Key distribution location
- Overall Size
- Spark Spread



Initial CHP Feasibility Survey

Burns & McDonnell SINCE 1898

BMcD Contact: Kurt Koenig kkoenig@burnsmcd.com or Tim Burkhalter tburkhalter@burnsmcd.com

Facility Information

Facility Location: | Key Distribution Location? (ie - will distributed generation in this area reduce need for planned transmission upgrades)

Facilty Type: (Hospital, University, Manufacturing, etc.)

Overall Facility Square Footage: | Plant Area Square Footage:

CHP Feasibility Rating Criteria: (circle as applicable)

Facility Space Availability

No Free Space — Some Free Space — Very Open (>10k ft2 for large CHP)

1 2 3 4 5

Existing Equipment Age

Recently Installed (< 5 yrs) — Some Old Equipment — Ready for Replacement (> 30 yrs)

1 2 3 4 5 6 7 8 9 10

Heating Load Fluctuation

Highly Variable — Daily Load Swings — Seasonal Variation — Nearly Constant

1 2 3 4 5

Cooling Load Fluctuation

Highly Variable — Daily Load Swings — Seasonal Variation — Nearly Constant

1 2 3 4 5

Electric Load Fluctuation

Highly Variable — Daily Load Swings — Seasonal Variation — Nearly Constant

1 2 3 4 5

Retail Electric Rate

$0.04 / kWh — $0.06 / kWh — $0.08 / kWh — $0.10 / kWh — $0.12 / kWh

1 2 3 4 5

Retail Gas Rate

$12.00 / MMBTU — $10.00 / MMBTU — $8.00 / MMBTU — $6.00 / MMBTU — $4.00 / MMBTU

1 2 3 4 5 6 7 8 9 10

Annual Natural Gas Usage

10,000 MMBTU (10,000 klbs steam) — 500,000 MMBTU — 10,000,000 MMBTU (10,000,000 klbs steam)

1 2 3

Annual Electrical Energy Usage

5,000,000 kWh (Avg 500 kW) — 250,000,000 kWh (Avg 25 MW) — 500,000,000 kWh (Avg 50 MW)

1 2 3

Annual Hours of Operation

1000 hrs. — 3500 hrs. — 7000 hrs. — 8760 hrs.

1 2 3 4 5 6 7 8 9 10

Survey Score: < 30: Not Good, 30 - 40: Some Potential, > 40: Great

Spark Spread: < 10: Not Good, 10 - 15: Some Potential, > 15: Great

Spark Spread = 293 [MMBTU/kWh] * Power Cost [$/kWh] - Gas Cost [$/MMBTU]

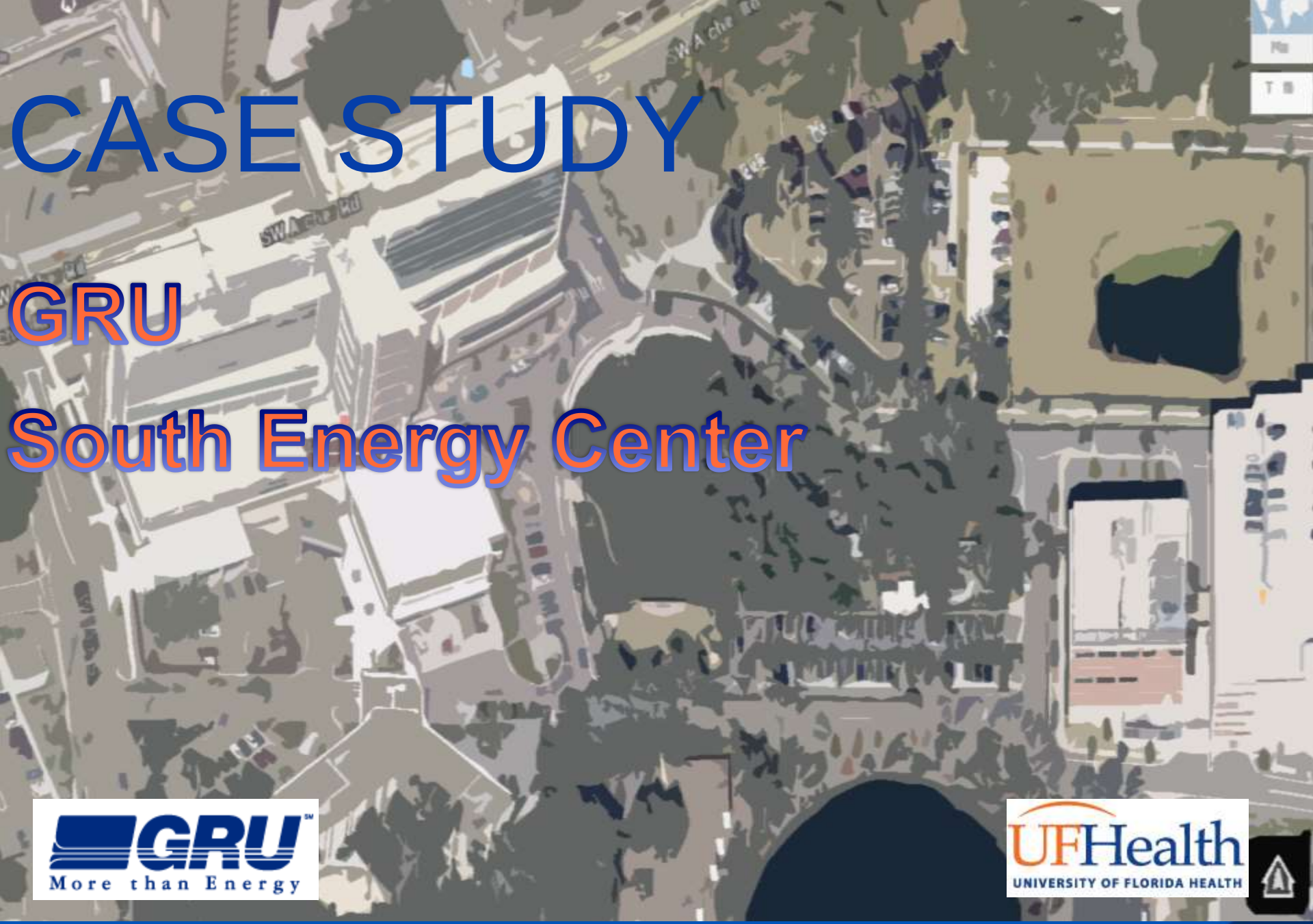
KEY CHALLENGES

- Regulatory Hurdles
  - Municipal Utility, Regulated Utility, IPP, IOE, etc.
  - Rate Based, PPA, Capital Commitment, etc
- O&M Strategy
  - Operational Staff
  - Maintenance Staff
- The Deal
  - Point of demarcation
  - Performance and Uptime Guarantees
  - Rate Structure
  - Fixed vs variable costs
  - Contribution to Capital
  - Duration

CASE STUDY

GRU

South Energy Center



GRU More than Energy

UFHealth UNIVERSITY OF FLORIDA HEALTH

APPLICATION OVERVIEW

- New medical campus focused on treatment of cancer
- Multiphase construction
- Energy services outsourced as design / build / own / operate / maintain

GRU More than Energy

OVERVIEW

SHANDS CANCER HOSPITAL

- University of Florida
- Phase 1
  - 500,000 SF
  - 200 bed
  - Level 1 trauma
- 35 Year Plan
  - 3,000,000 SF
  - 1200 bed
  - 15 MW
  - 16,000 tons

GRU More than Energy

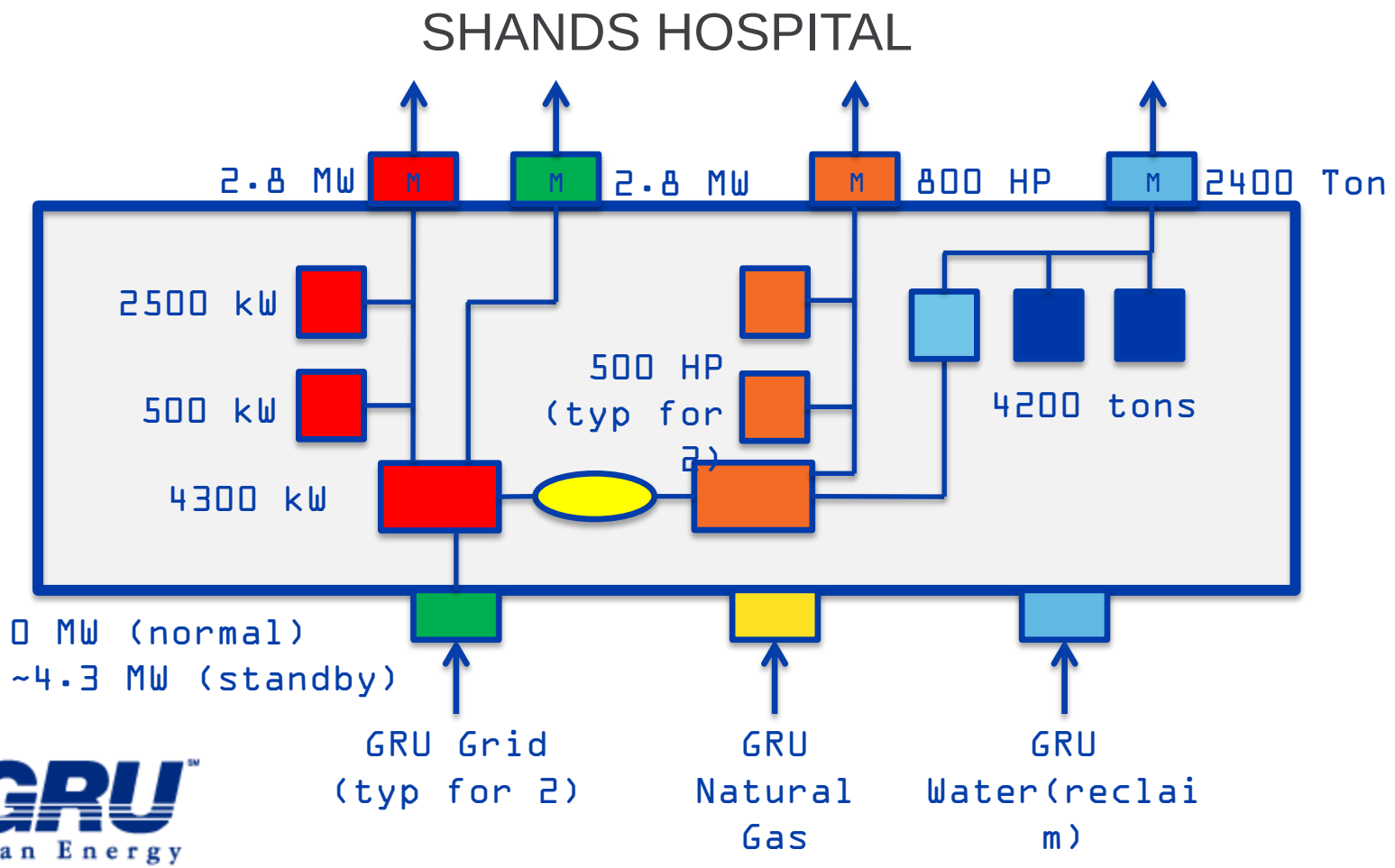
TECHNICAL OVERVIEW

GRU SOUTH ENERGY CENTER

- 4.3 MW recuperated combustion turbine
- 40 klbs/hr heat recovery steam generator
- Back-up boiler
- 4,200 Tons of cooling
- 2.25 MW emergency diesel
- 500 kW black start diesel

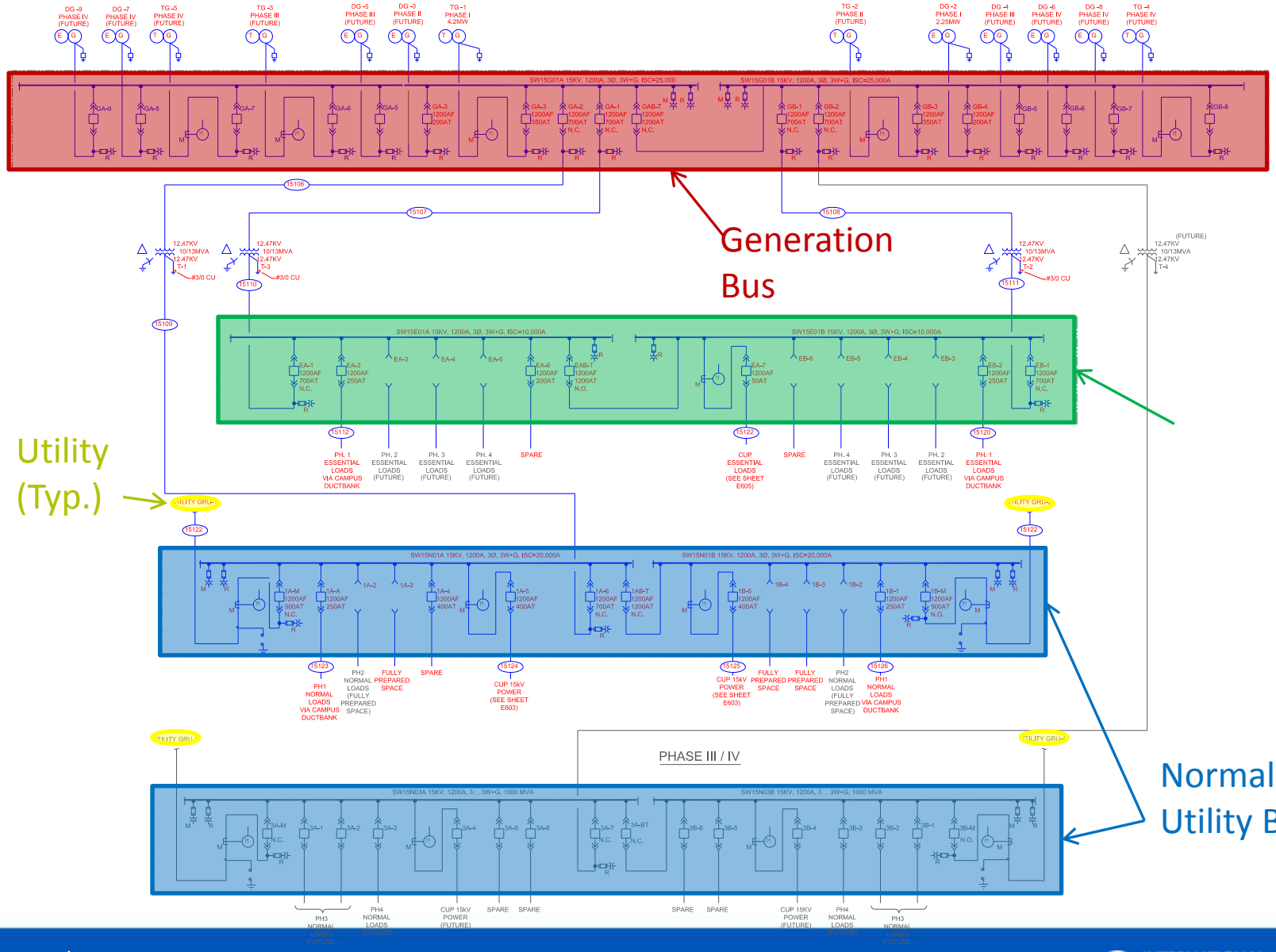
GRU More than Energy

SOUTH ENERGY CENTER



GRU
More than Energy

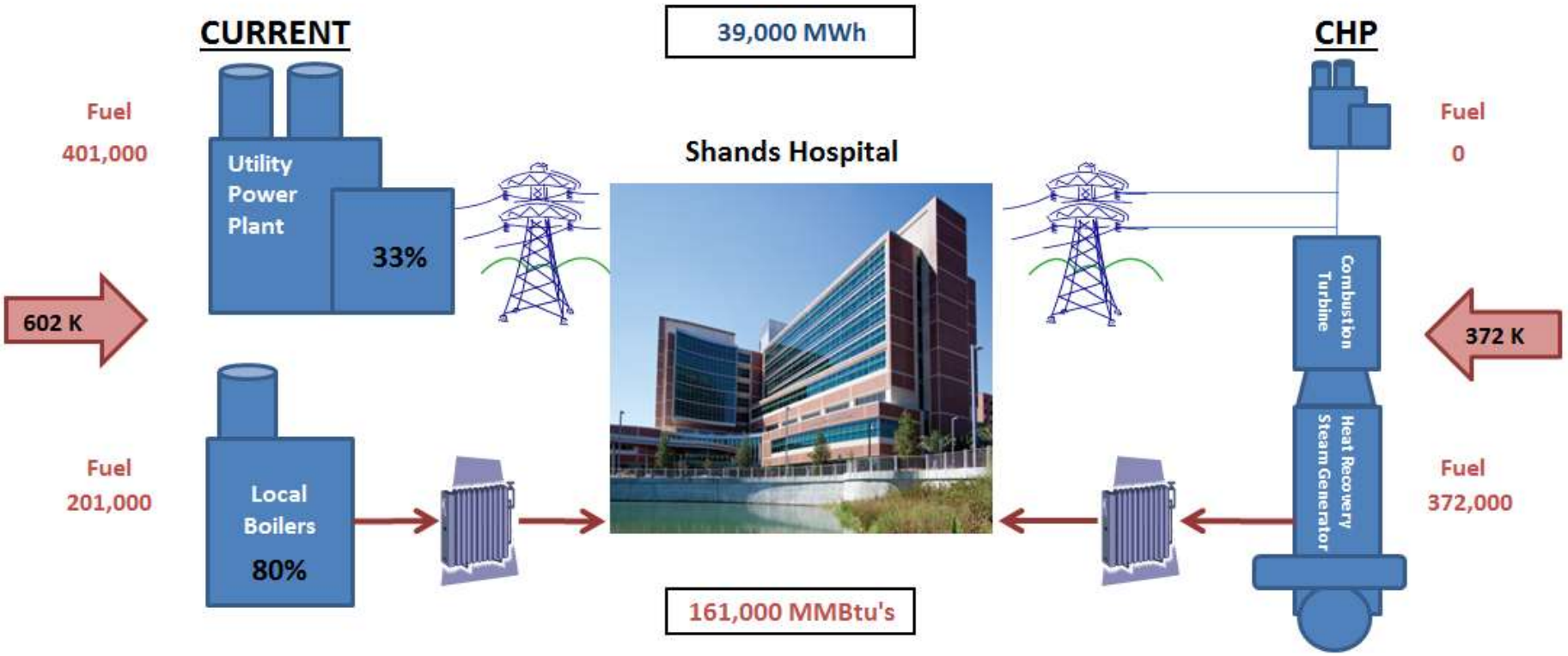
MICROGRID



GRU ENERGY CENTER BENEFITS

- Partnership between hospital and municipal utility
- Combined heat & power for efficient generation of utilities
- Multiple levels of redundancy
- Fully load diesel generators during testing
- CHP yields 80% efficient operation
- Hospital achieved LEED Gold certification thanks to Energy Center
- Concentrate on core business

SEC EFFICIENCY



49%	Overall Efficiency	79%
9,600	Carbon Footprint (MTCE)	6,000

OVERCOMING CHALLENGES

- Regulatory Hurdles
- O&M Structure
- The Deal

GRU More than Energy

WHATS NEXT AT THE SEC?

QUESTIONS & ANSWERS

BURNSMCD.COM/ONSITE

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