September 21, 2016

CHP for California Hospitals

Presentation to CSHE South Bay Counties Chapter

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Why is energy important for healthcare facilities?

#2

Hospitals are the second-largest energy-consuming organizations in America.[1]

2X

Healthcare facilities consume annually ~ 2x the energy of an average commercial building.[2]

≥15%

An average hospital spends at least 15% of its profit on energy costs.[3]

40%

Energy costs climbed about 40% since 1995 and will climb about 40% in the next 25 years.[4]

Every dollar a hospital saves on energy is the equivalent to increasing revenues by $20.[5]

+10%

Lowering energy costs by 25% can increase a hospital's profit by 10%.[6]

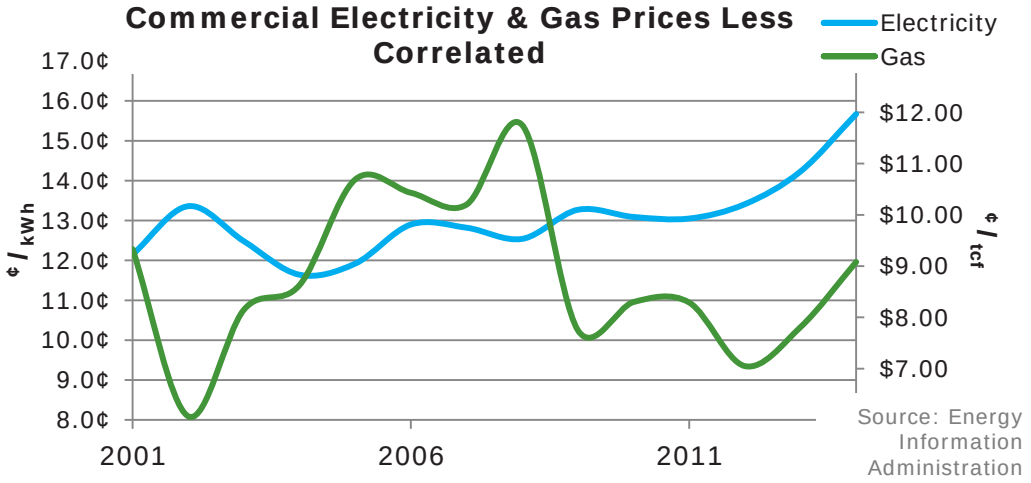
1-5 yrs

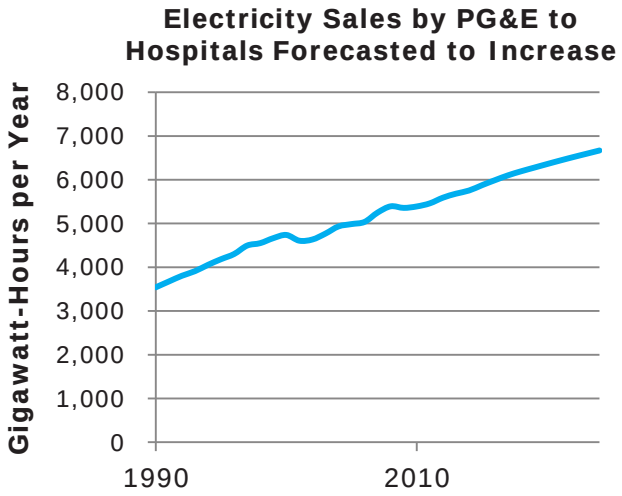
Most energy-efficiency solutions yield a payback in one to five years.[7]

See end of presentation for numbered sources.

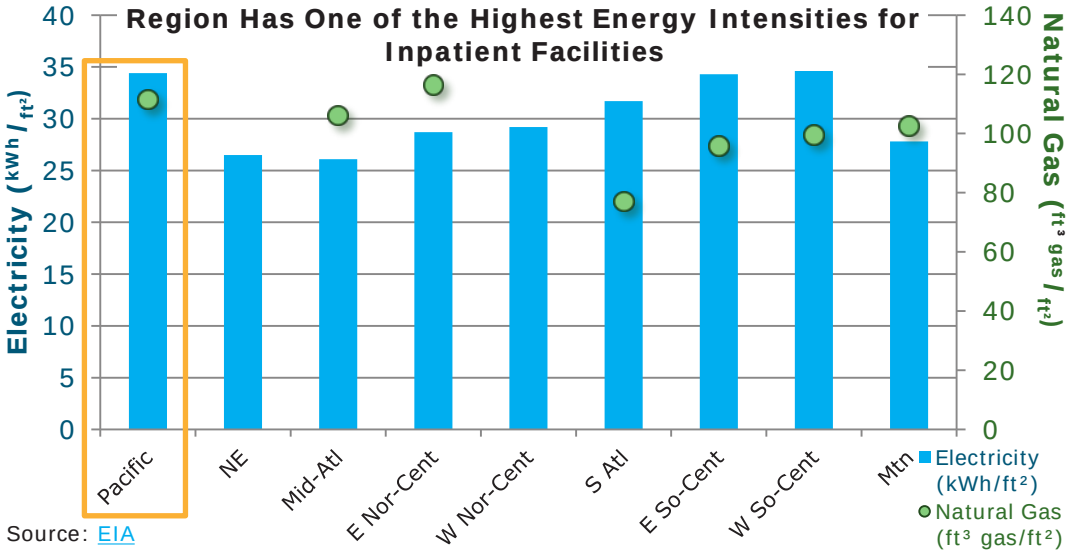
California Energy Economics

- In an era of falling natural gas prices, California's electricity prices have not followed them.
- Significant retirements of large power plants in the coming decade.





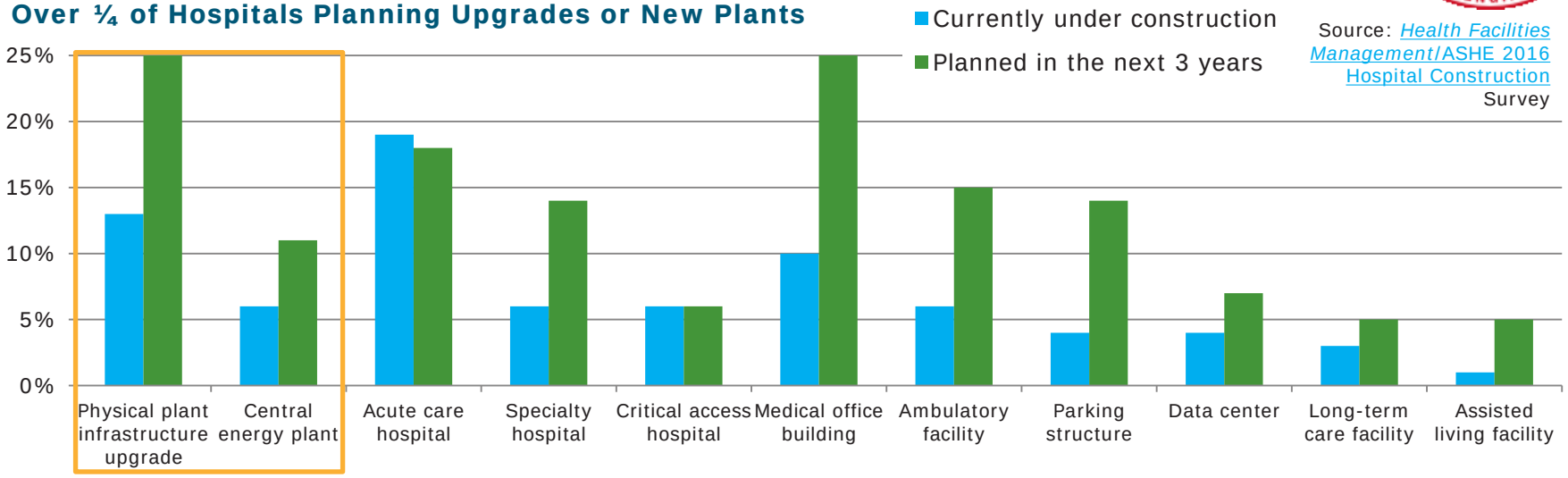
Source: California Energy Consumption by End Use



Source: EIA

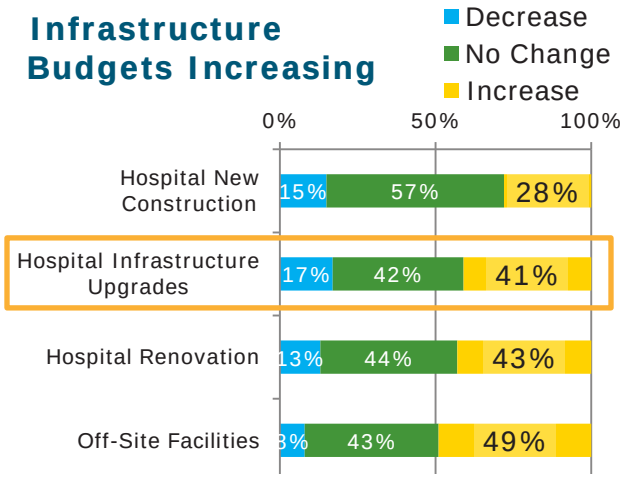
Hospitals Nationwide Focused on Physical & Central Plants

Over ¼ of Hospitals Planning Upgrades or New Plants



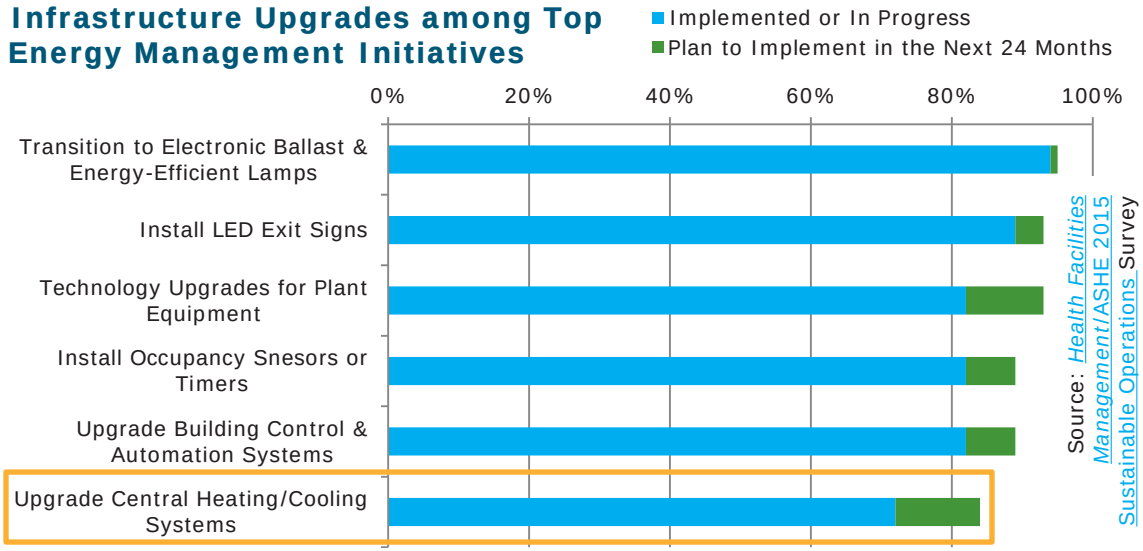
Source: *Health Facilities Management*/ASHE 2016 Hospital Construction Survey

Infrastructure Budgets Increasing



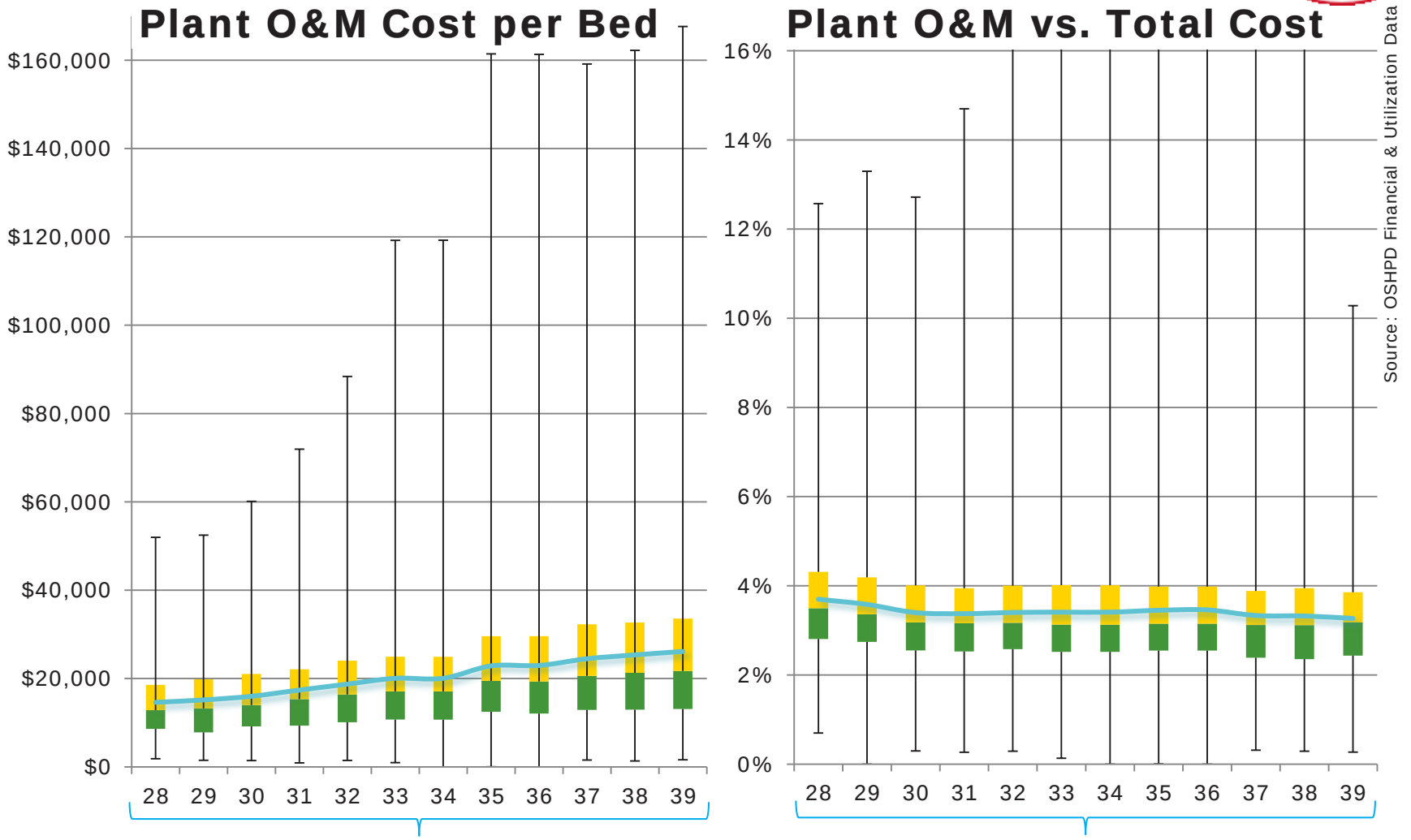
Source: *HFM*/ASHE 2016 Hospital Construction Survey

Infrastructure Upgrades among Top Energy Management Initiatives



Source: *Health Facilities Management*/ASHE 2015 Sustainable Operations Survey

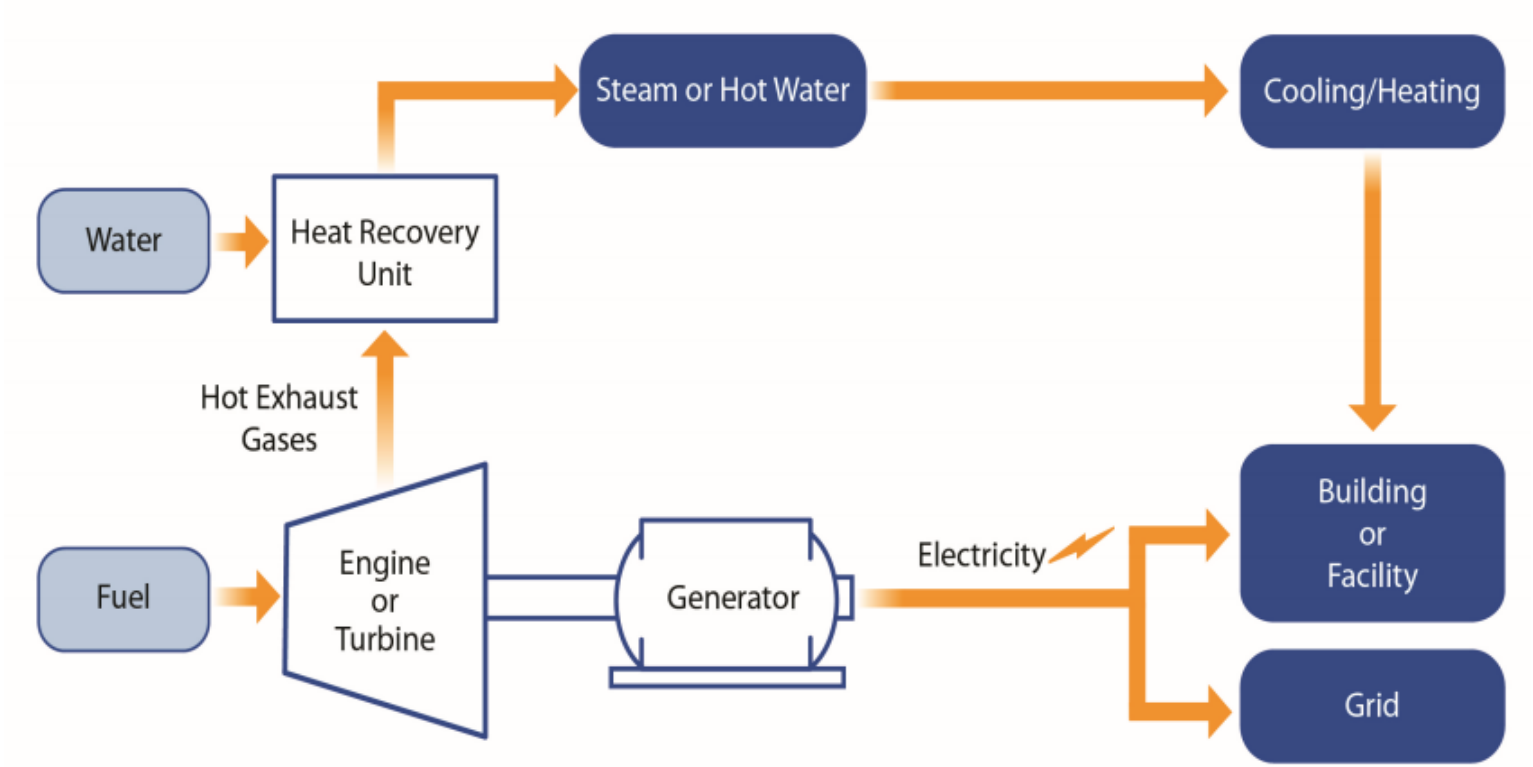
California Hospital Plant O&M Should Be $30k/Bed, or <4% of Total Costs



OSHPD Surveys (roughly 2002-2014)

What is CHP?

Combined Heat and Power – also known as ‘Cogeneration’



Utilizing heat normally lost during production of electricity, CHP systems create steam, and hot or chilled water to meet the specific requirements of the on-site host/customer.

CHP Technologies

Gas Turbine

- High reliability
- Low emissions
- High-grade heat available
- 500 kW to 250 MW

Reciprocating Engine

- High power efficiency
- Relatively low investment cost
- Operate on low-pressure gas
- 250kW to 6 MW

Steam Turbine

- High overall efficiency
- Any type of fuel
- Long working life and high reliability
- 50kW to 250 MW

Fuel cells

- Low emissions
- Low noise
- High efficiency over load range
- Modular design
- 300 kW to 2.8 MW

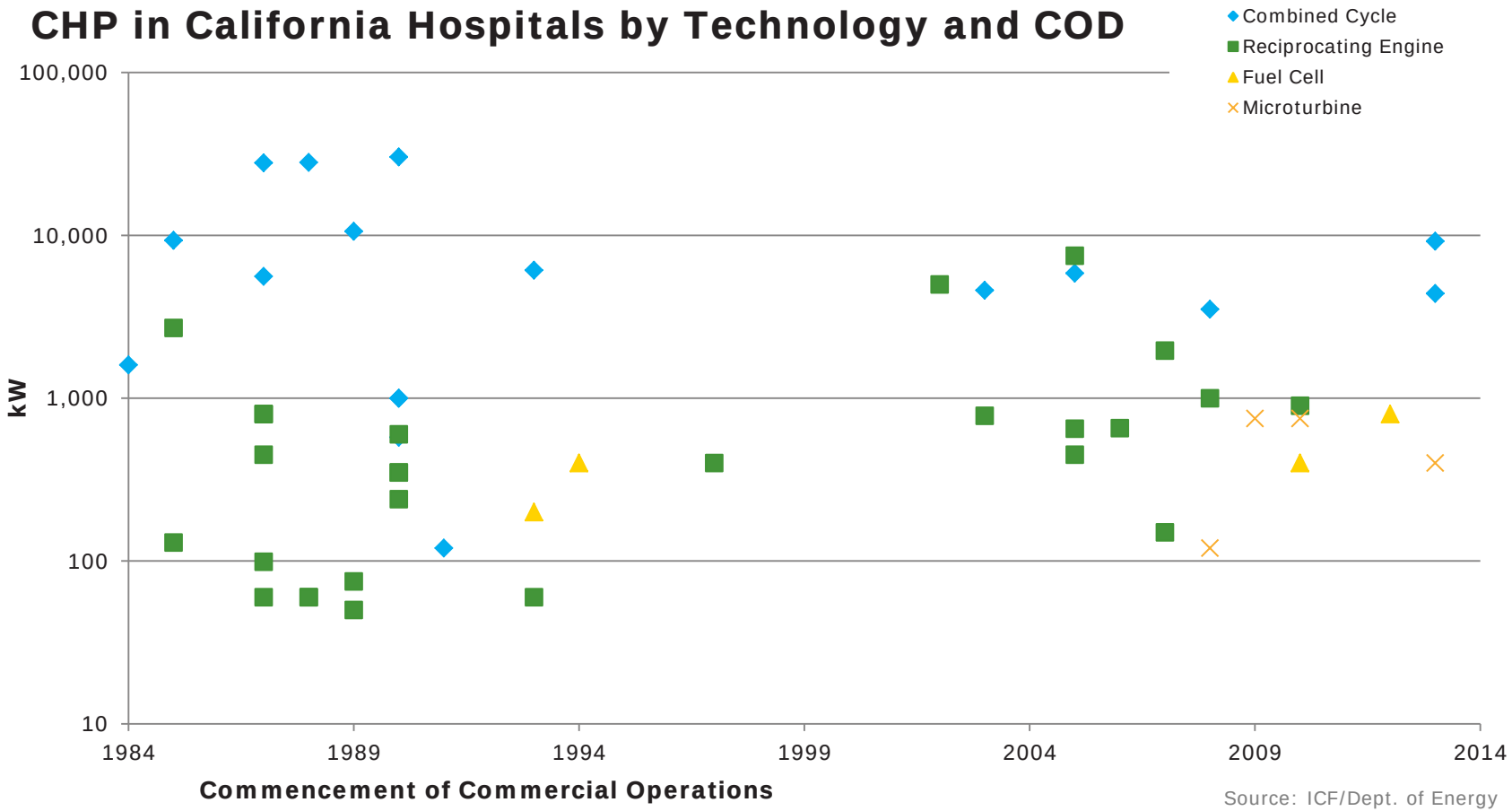
CHP Aligns with Hospitals' Strategic Goals

• Invest in core activities	→	• Avoid deferred maintenance
• Expand facilities	→	• Offset capital expenditures
• Lower costs to mitigate declining reimbursement rates	→	• On-site generation protects against rising grid electricity prices • Efficiency gains from the displacement of boilers by waste heat from power generation.
• Maintain resiliency	→	• Plant will be running 24/7/365, and can be designed to provide power even in the event of a grid outage.
• Promote sustainability	→	• Manage carbon footprint

CHP can address hospitals' critical needs and give them a leaner energy profile.

On-Site Power Generation Can Continue to Serve California Hospitals

CHP in California Hospitals by Technology and COD



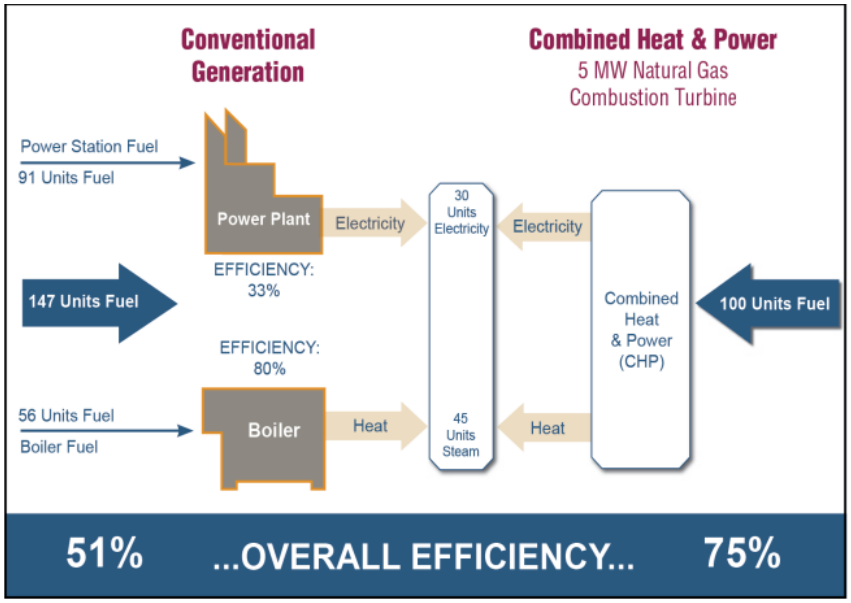
Source: ICF/Dept. of Energy

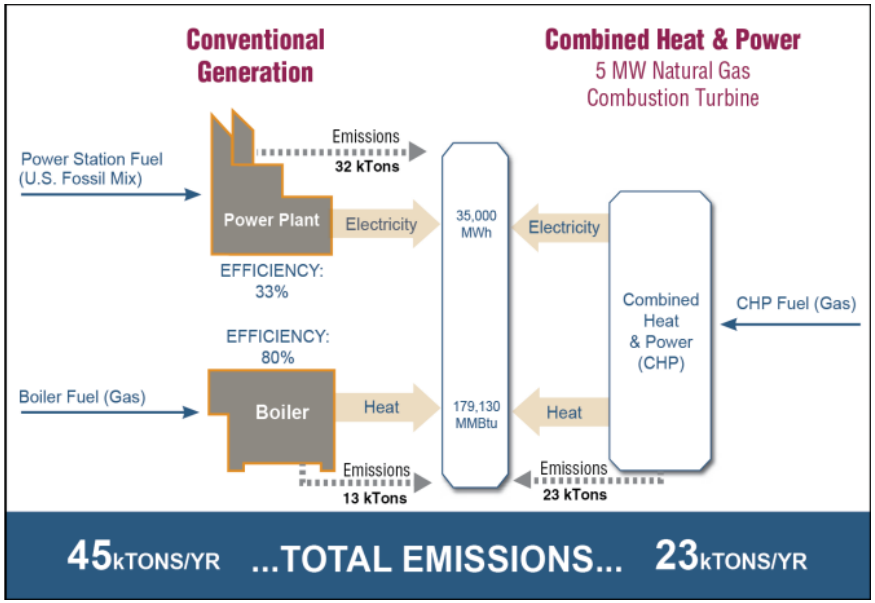
Gov. Brown plans to add 6,500 MW to state's existing 9,249 MW of CHP over the next 20 years.

Source: Clean Energy Jobs Plan

CHP Benefits

Less fuel consumption can save money…



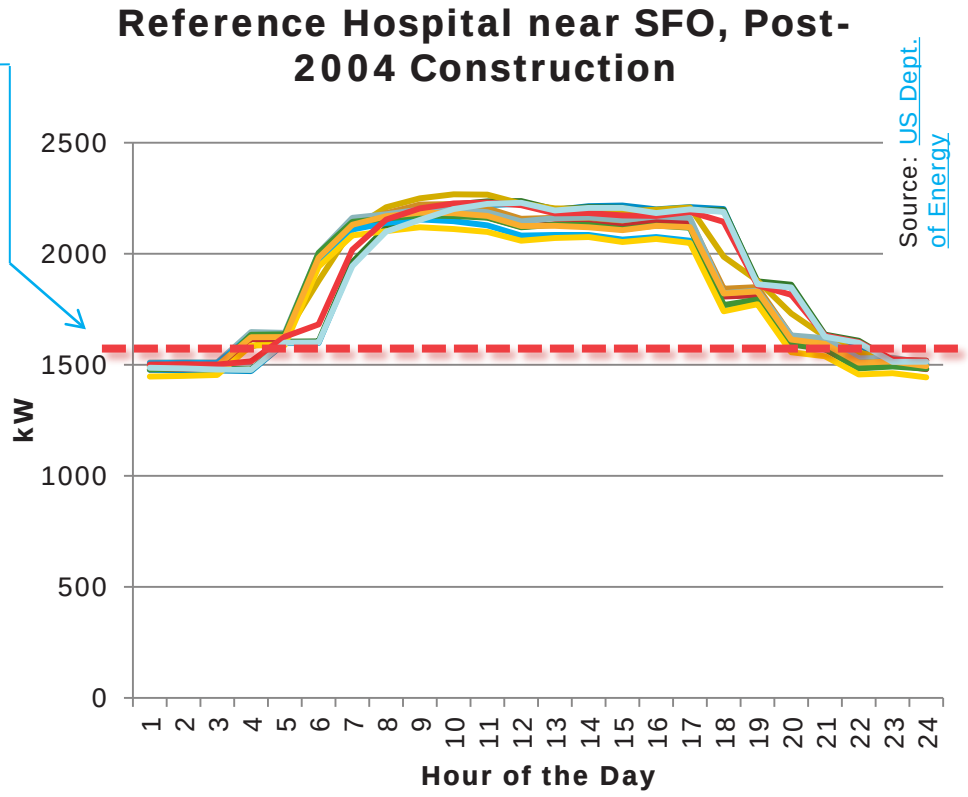


…and may mean fewer emissions.

Source: "How Combined Heat and Power Saves Money, Reduces Emissions and Improves Energy Security"

Why hospitals are good CHP candidates

- Flat Load Profiles
- Matching Thermal Load
- Long-Term Vision
- Values Reliability
- Public Stakeholders



Also, many hospitals are seeking opportunities to (re-)deploy capital to revenue-generating investments while cutting costs.

Qualifying CHP opportunities

Key Screening Questions	
A	What was the facility's average load (MW) over the past year?
B	What is your average all-in/retail price of electricity (in $/MWh) for the past 12 months?
C	What is the main thermal load of your facility? Please identify the best match from the following: • Hot water • Heating steam (25 pounds per square inch gauge) • 150 psig steam • 250 psig steam
D	How is your thermal consumption measured? Please select from the following: • Fuel consumption (MBtu/hour) • Net heat flow (MBtu/hour) • Steam mass flow (pph)
E	What was the facility's average thermal load in the past year (in the units noted above)?
F	What is the delivered/burner-tip cost of natural gas for the facility? Please specify the units (e.g. $/ccf, $/therm, $/MMBtu).

Economic Analysis

Using default settings/prices, 2 MW round-the-clock load profile:

Energy Use	No CHP	With CHP	Difference
Annual Electricity Use			
Annual Purchased Power, kWh	17,280,000	864,000	(16,416,000)
Annual CHP Power Generation, kWh	0	16,416,000	16,416,000
Total Annual Electricity Use, kWh	*17,280,000*	*17,280,000*	*0*
Annual Thermal Energy Use			
Non-CHP Thermal Use*, $^{MMBtu}/_{year}$	81,527	23,906	(57,620)
CHP Thermal Used, $^{MMBtu}/_{year}$	0	57,620	57,620
Total Thermal Energy Use, $^{MMBtu}/_{year}$	*81,527*	*81,527*	*0*
Annual Fuel Use			
Non-CHP Thermal Fuel Use*, $^{MMBtu}/_{year}$	101,908	29,883	(72,025)
CHP Fuel Use, $^{MMBtu}/_{year}$	0	155,821	155,821
Annual Total Fuel Use, MMBtu	*101,908*	*185,704*	*83,795*
Operating Costs			
Purchased Electricity	$2,020,032	$292,905	($1,727,127)
Purchased Fuel	$610,838	$1,113,108	$502,270
Incremental O&M	$0	$229,824	$229,824
Annual Operating Costs	*$2,630,870*	*$1,635,836*	*($995,033)*
Annual Operating Savings			***$995,033***

Type	Recip Engine
Capacity, kW	2,304
Electric Efficiency	35.9%
Thermal Output, $^{Btu}/_{kWh}$	3,510
Thermal Output, $^{MMBtu}/_{hour}$	8.1
System Fuel Cost (Natural Gas), $^{\$}/_{MMBtu}$	$5.99
Installed Cost, $^{\$}/_{kW}$	$1,750
O&M Cost, $^{\$}/_{kWh}$	$0.0140

Operating Cost to Generate	**$/kWh**
CHP Fuel Costs	$0.0569
Thermal Credit	($0.0263)
Incremental O&M	$0.0140
Operating Costs to Generate Power	*$0.0446*
Capital Charge	$0.0270
Total Costs to Generate Power	*$0.0716*
Current Average Electricity Price	$0.1169
Spark Spread, $^{\$}/_{kWh}	***$0.0453***

EPA Spark Spread Estimator

Factors for Consideration

Operational / Strategic

- Plans for expansion (and additional loads).
- Does the central plant demand too much of the facility engineers' time?

Budgetary

- Forecast of utility charges, including departing-load and standby charges.
- Plans for replacement: is the installed equipment at the end of its life?

Capital

- Opportunity costs for investment:
  - Energy infrastructure vs. revenue-generating equipment
  - CHP vs. other energy measures (e.g. solar or energy efficiency)
- Build-transfer vs. PPA: Hospital's financing capabilities.

Location / Permitting

- Site constraints (vs. CHP footprint)
- Would the CHP be under OSHPD jurisdiction?
- Bay Area Air Pollution Control District requires Best Available Control Technology.

NRG can advise you on CHP feasibility and the best approach.

CHP Incentives

- PON 13-401: Interest Rate 1% Loans
  Financing For Energy Efficiency & Energy Generation Projects

- 1% loan, maximum simple payback of 17 years
- 100% of costs, up to $3 MM per project
- Only Public Care Institutions/ Public Hospitals are eligible

- Self-Generation Incentive Program
  - Decreasing from $0.60/W to $0.40/W ($0.60/W max adder for biogas)
  - Biogas minimum:
    - 2016: 0%
    - 2017: 10%
    - 2018: 25%
    - 2019: 50%
    - 2020: 100%

Project Development Stages

Screening/ Qualification	Feasibility Analysis	Investment Analysis	Project Execution
• Red flags • Initial economics • Ranking vs. other energy measures.	• Detailed load profile • Full utility bill analysis • Scoping • Interconnection • Permitting/ environmental	• Detailed design/costing • Firm pricing for engineering, equipment and construction • Capital structuring/ raising	• Permitting • Engineering • Financing/ incentives • Procurement • Construction • Commissioning • Asset management

This process often takes 18-24 months.

NRG Covers a Wide Range of Conventional On-Site Power Generation

NRG's distributed generation assets have steam & chilled water capacity of 1346 net MWt, and electric generation capacity of 123 net MW.

District Heating and Cooling

Combined Heat & Power

Reliability Solutions

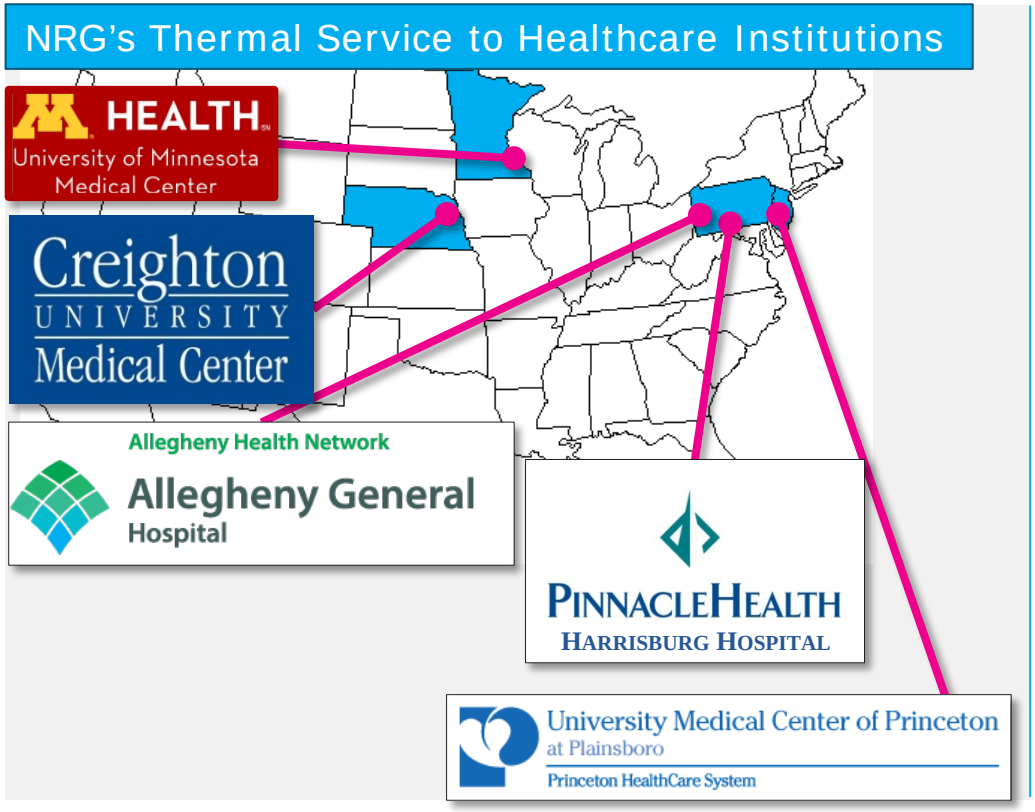
Microgrid

Our thermal plants consistently exceed 99.9% operating uptime without unplanned interruptions.

NRG's safety record is among the best in our industry, due in large part to our robust programs and our experienced personnel.

NRG can draw upon extensive asset management and operational experience to meet a hospital's high reliability requirements.

NRG can be your partner in CHP



- NRG is technology-agnostic – we will design the system that best meets your needs. We have extensive experience managing a wide range of engines and thermal systems.
- We take responsibility for the full lifetime of a customer-sited energy project.
- NRG's focus on reliability is demonstrated by our thermal plants' performance: consistently above 99.9% operating uptime without unplanned interruptions.
- NRG's safety record is among the best in our industry, due in large part to our robust programs and our experienced and well-trained personnel.

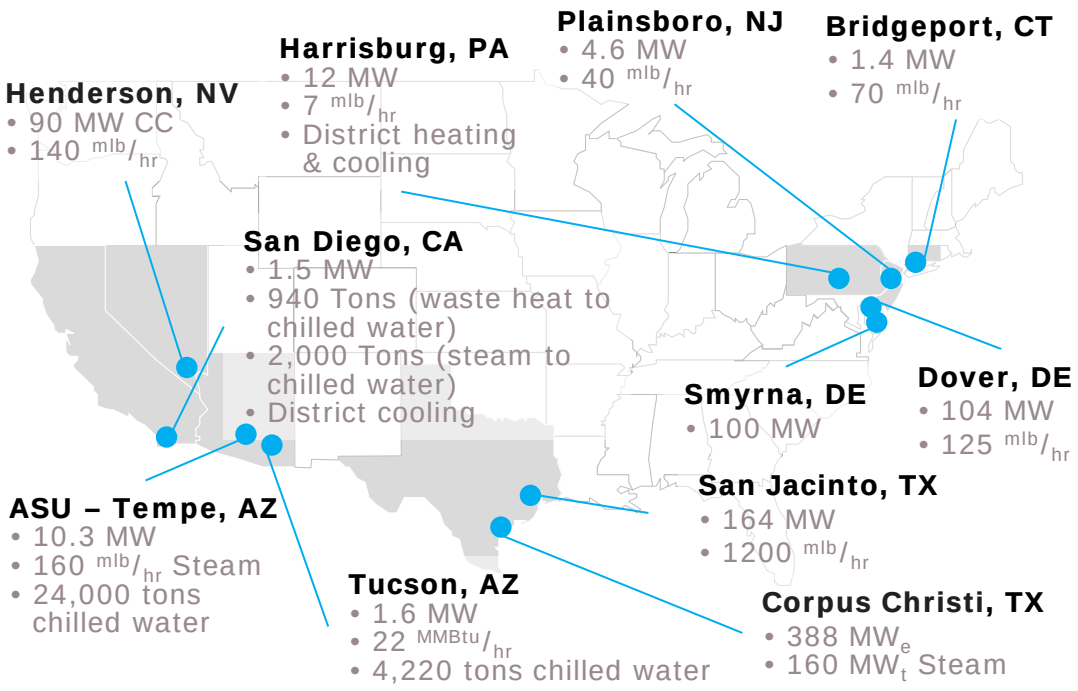
NRG draws upon extensive asset management and operational experience to meet our customers' highest reliability requirements.

CHP Provides Enhanced Reliability with Optimal Energy Efficiency

Utilizing heat normally lost during production of electricity, Combined Heat & Power systems create steam, and hot or chilled water to meet client requirements.

NRG Energy Center San Diego – using CHP technology to cool downtown building space.

NRG's CHP Portfolio



NRG serves a wide range of industries with reliable, competitive electricity and thermal products.

Strategic Benefits to a Hospital of an NRG Partnership

- The hospital can exit the power business and focus on its core patient care mission.
- Leverages the experience and expertise of a leading operator of CHP and district energy systems to maintain a high level of reliability and efficiency.
- Provides stability to the hospital's operations and capital budget.
- NRG can work with the hospital to develop optimal energy supply for supporting new campus infrastructure.
- NRG is technology-agnostic – we will design the system that best meets your needs. We have extensive experience managing a wide range of engines and thermal systems.

NRG can eliminate the need for up-front capital investment,
and minimize financial, legal, development and operational risks.

NRG's Extensive California Presence

9,543 MW* total generation

CAN SUPPORT NEARLY 18 million people

1,750 MW* renewables

AVOIDS 2.7 million pounds of CO_2

STEAM DISTRIBUTION PROVIDED

MORE THAN 37 million sq ft at San Francisco District Energy Center

KAISER PERMANENTE

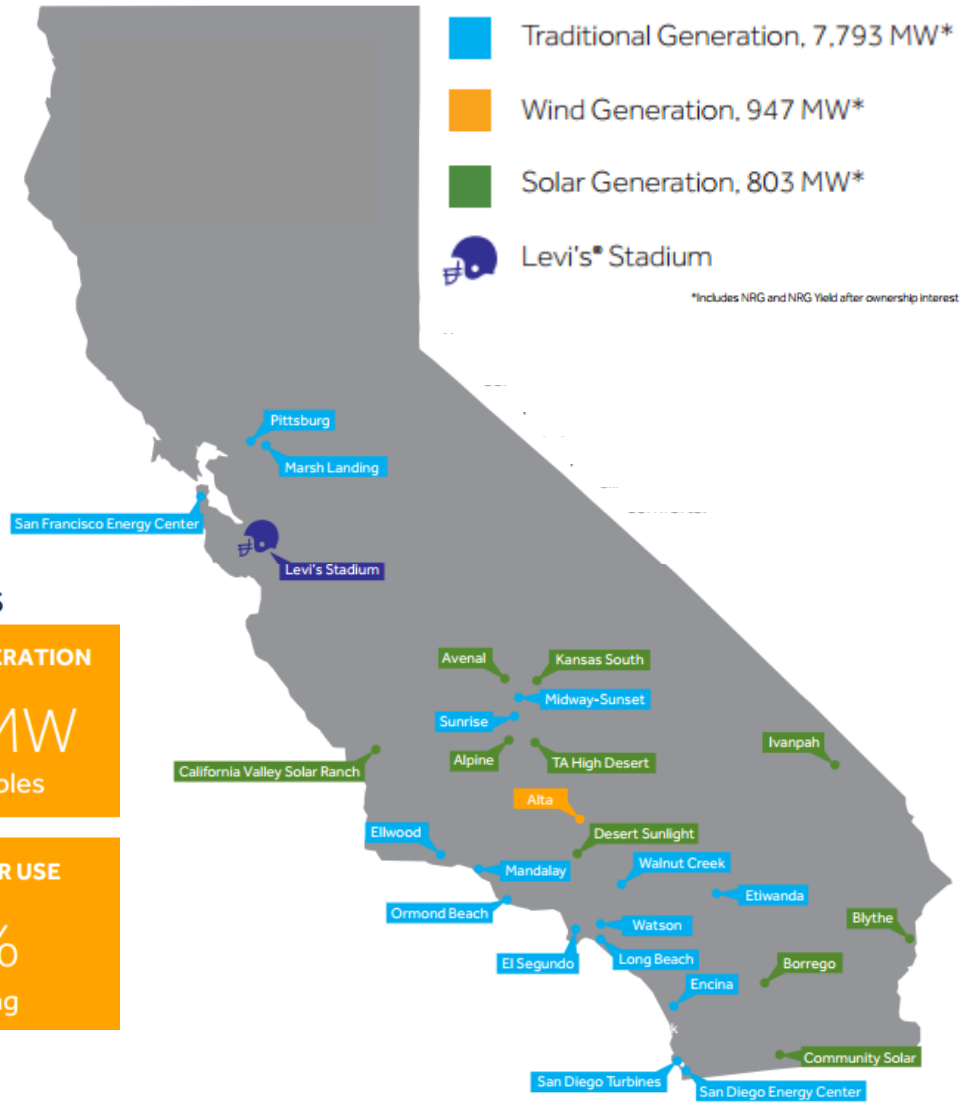
TOTAL EXPECTED SOLAR CAPACITY OF UP TO 68 MW

AT AS MANY 70 Kaiser Permanente sites

NATURAL GAS

NEW FAST-START GENERATION 1,888 MW to enable renewables

REDUCTION IN WATER USE 99.9% at Marsh Landing



NRG serves the 237-bed University Medical Center Princeton at Plainsboro

Enhanced **reliability** and 100% redundancy for power needs.

Optimizes feeder usage for energy cost savings during normal operation.

Efficiency of about 70 to 73% versus 30 to 35% from a traditional power plant.

Islands from the grid and serves critical loads during grid outages.

Building in absolute reliability from the start, with a highly cost-effective solution.

NRG's Microgrid Solution for the University Medical Center

CHP – 4.6MW natural gas plant supplies 100% of heating & cooling needs and most of the electrical needs

Enterprise Energy Management –Advanced software system optimizes operations for energy use and cost efficiency

Backup generation – With the grid down, the 3 back-up generators can support the hospital's essential power needs

Chillers – Three 1,000-ton electric chillers and one 700-ton absorption chiller provide chilled water

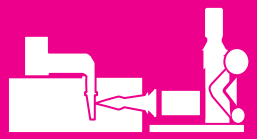
Grid – Can draw power from or export to the PJM power grid

Thermal Storage – 1.2 M gallon chilled water storage for cooling the hospital

Solar – 200kW Solar Array provides electricity, and reduces carbon emissions

EVgo – Two 30 amp electric vehicle charging stations

Benefits to the University Medical Center

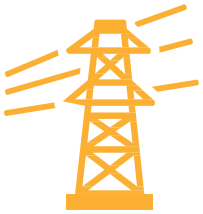


CHP has cut the new building's energy costs by 25% and reduced its carbon footprint by 50%

And CHP produces electricity, steam for heating and sterilization, and chilled water for air conditioning

Entitled the hospital & NRG to millions of dollars in grants and loans from the local utility, the New Jersey Development Authority and the federal government

Million-gallon Thermal Energy Storage system supplies chilled water at a fraction of what it would otherwise cost at times of peak usage



The plant also saves money by selling energy to the grid

Managed by a full-time staff of nine NRG employees. Princeton hospital staff can focus on a different form of efficiency – the kind that saves lives

Thank you!

Alan Cordova

NRG Thermal

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(415) 627-1688

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