New Hospital Cogeneration

- A Cogeneration Case Study
- University Medical Center at Princeton-Plainsboro, NJ

- Creating Sustainable Business in New Jersey- Focus on Hospitals
October 31, 2014

Presentation

- Who is NRG?
- Cogeneration Primer
  - What is it?
  - The Good, the Bad
  - Applications
  - Typical Prime Movers
- Why Cogenerate? A Global View
  - Turbulent Energy History
  - Competing Emerging Technologies
  - The Black Marble
- University Medical Center at Princeton
  - Hospital Background
  - Development History
  - Project Drivers
  - UMCPP Cogeneration System
  - First Full Year Results

Who is NRG?

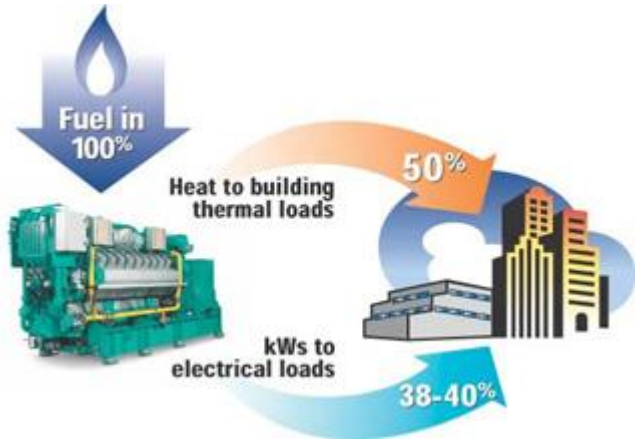
- Fortune 500, S&P 500 Company
  - NY Stock Exchange: NRG (Market Cap: $9.3 B)
  - NY Stock Exchange: NYLD (Market Cap: $841 M)
- Serves 2 Million Customers, 16 States
- Nearly 50,000 MW, Generating Capacity
  - Enough for nearly 50 million homes.
  - Coal, Gas, Oil, Solar, Nuclear: Everything But Hydro
- Leading Solar Developer / Operator
  - More than 2,000 MW Installed Capacity
  - Ivanpah (CA): 392 MW Solar Tower Project with 347,000 Mirrors, Steam Generating Power System

Who is NRG? Some NRG Companies

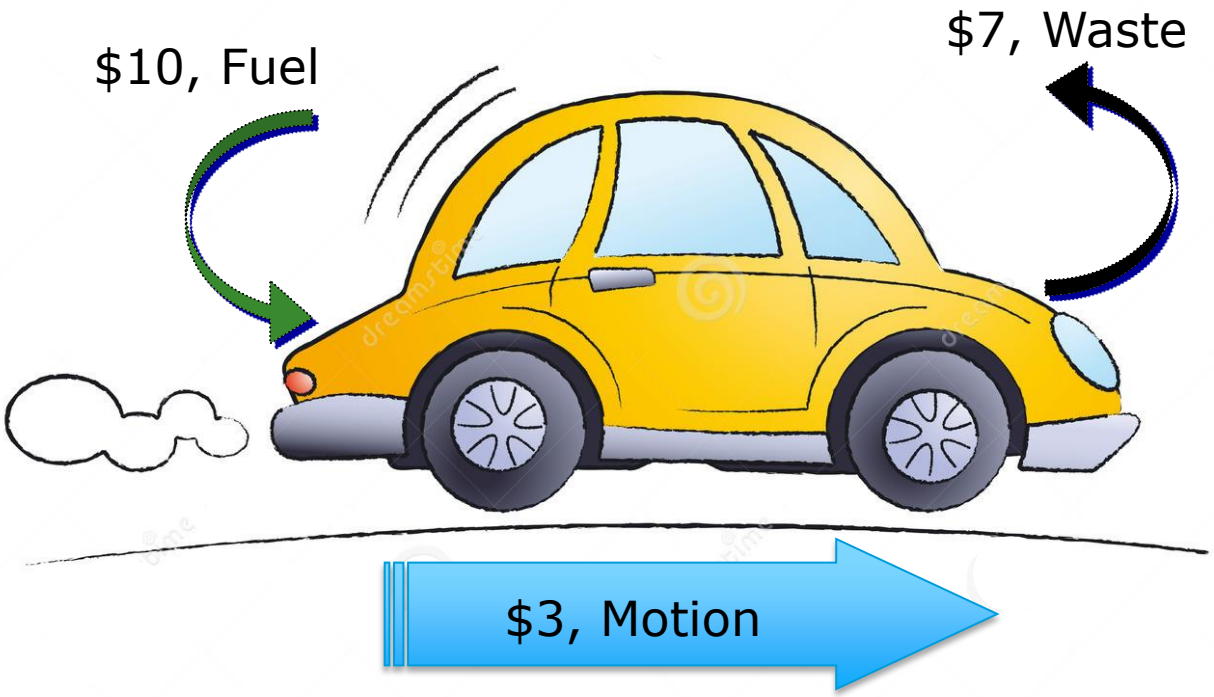
- Reliant: Electric service provider, Texas, Northeast
- NRG Energy Services: Operation and Maintenance Services for Energy Industry
- eVgo: Electric vehicle infrastructure development, operation.
- Green Mountain Energy Company: Energy provider from renewable Sources.
- Petra Nova: Carbon capture technology for coal power station.
- NRG Solar: Commercial solar system development, operation.
- dGen: Developer, owner, operator of district energy, cogeneration and back-up power stations.
- NRG Residential Solar: Provider of solar systems for the residential market.

Cogeneration Primer

- What Is It?
  - ***The Simultaneous Production of Two Forms of Energy***
- Usually Electricity and Thermal Energy, Often Cooling As Well.

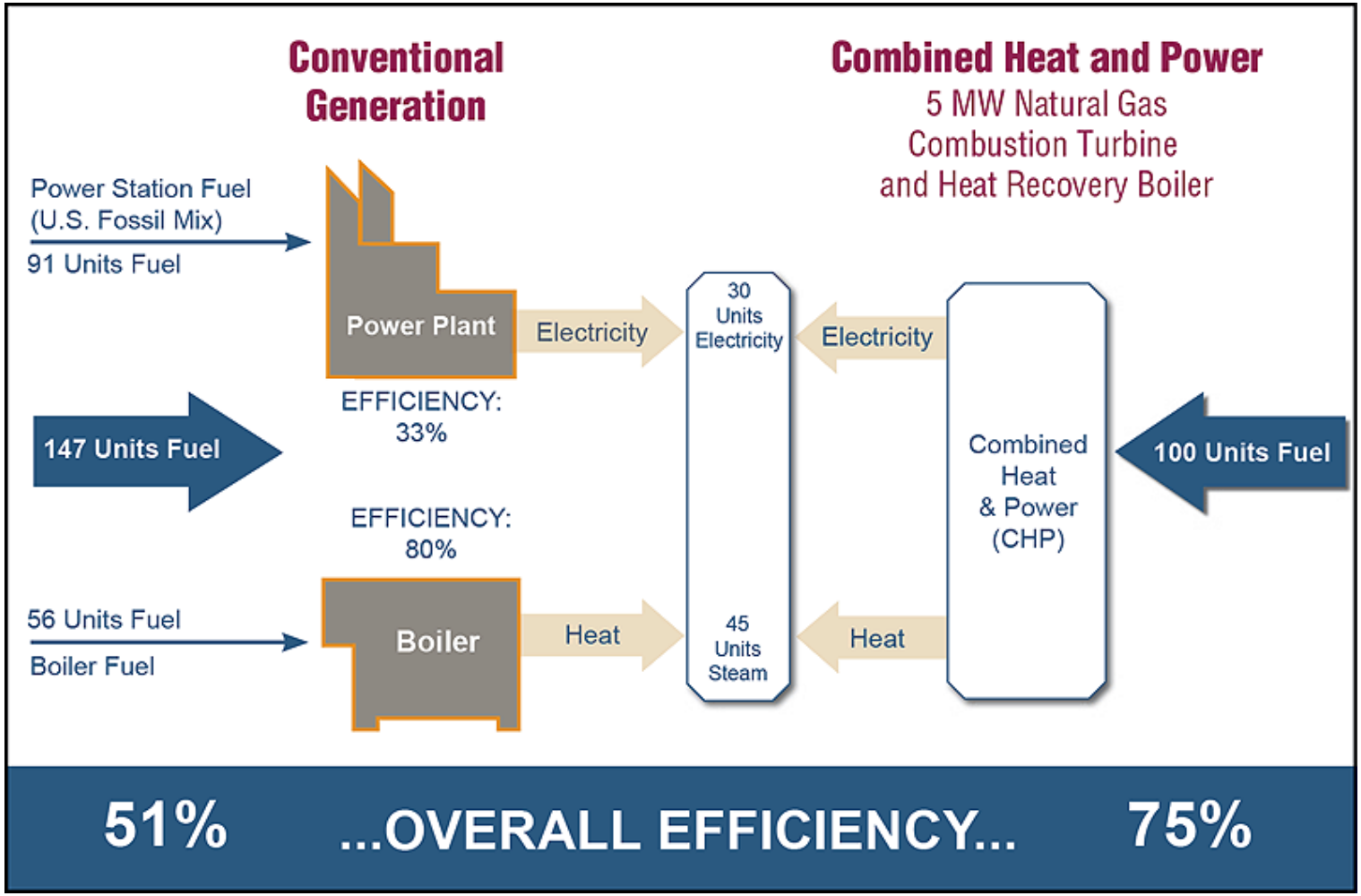


Cogeneration / CHP Primer



Life Without Cogeneration

The Cogeneration Comparison



Cogeneration

- The Good
  - About 50% more efficient
  - Mature, proven technology
  - Distributed generation improves reliability
  - Fuel Flexibility
- The Bad
  - Capital Intensive
  - Operationally complex
  - Needs space

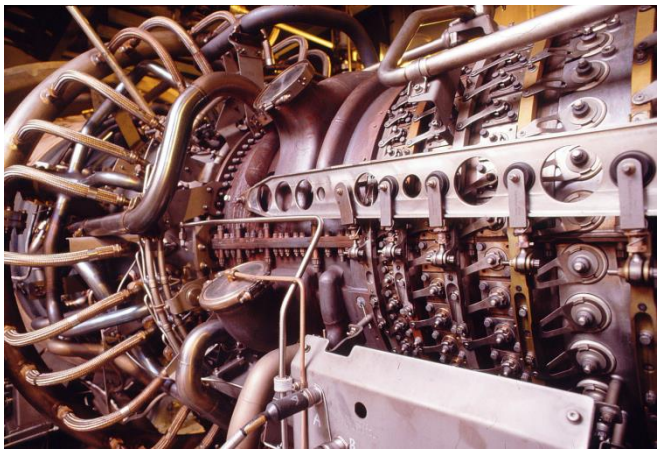
Cogeneration Applications

- Health Care Facilities
- College Campus
- Large Residential / Hotel
- Industry

Good "Thermal Balance", Flat Load Profile

Typical Prime Movers

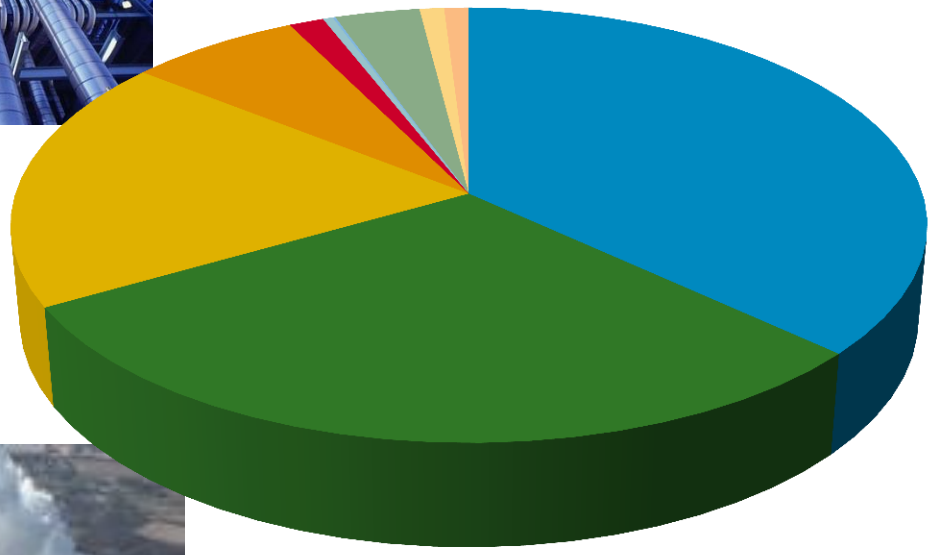
- Internal Combustion Engines
  - Proven Technology, Many Vendors
  - Most Common up to 6 MW
  - High Electric Efficiency, Reasonable First Cost
  - Maintenance Intensive
- Gas Turbines
  - Proven Technology, Fewer Vendors
  - Most Common, 3 MW +
  - Best For Big Thermal Loads
  - Less Downtime
  - More Costly Than IC Engines



Why Cogenerate?
A Turbulent Energy History

- 1880's: Edison's DC World
- 1940's: Nuclear Fission; Free Electricity!
- 1950's: Nuclear Fusion
- 1970's: Running Out of Oil
- 1990's: 350 Year Gas Bubble
- 1990's: Broken Bubble, Back to Coal
- 2000's: Hydrogen Economy
- 2000's: Methanol Future
- 2010's: Fracking

Why Cogenerate? (Finite Resources)

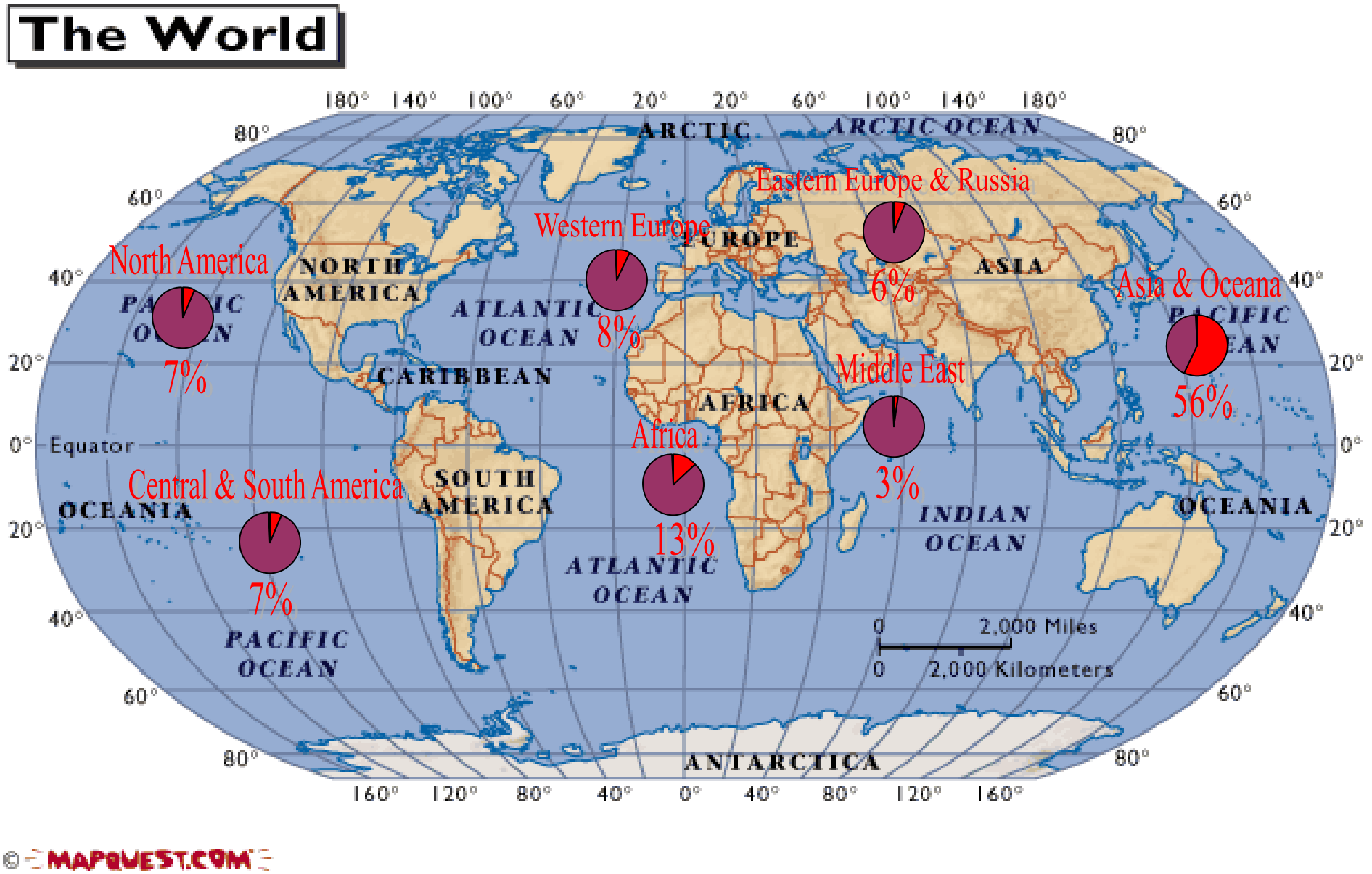


US Fuel to Electric Production*

**** US Energy Information Administration, 2012 Data***

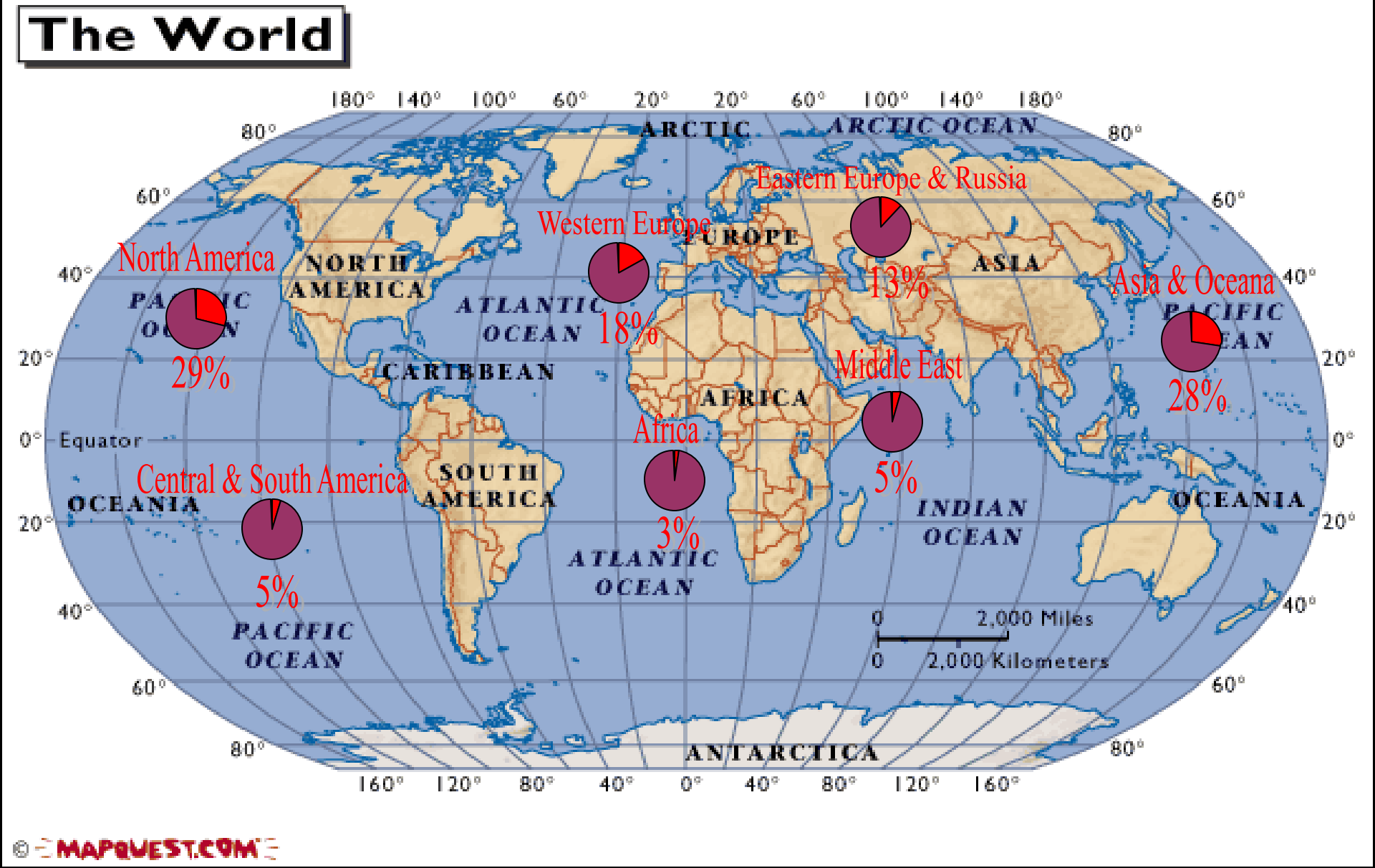
Why Cogenerate? A Global View

World Population

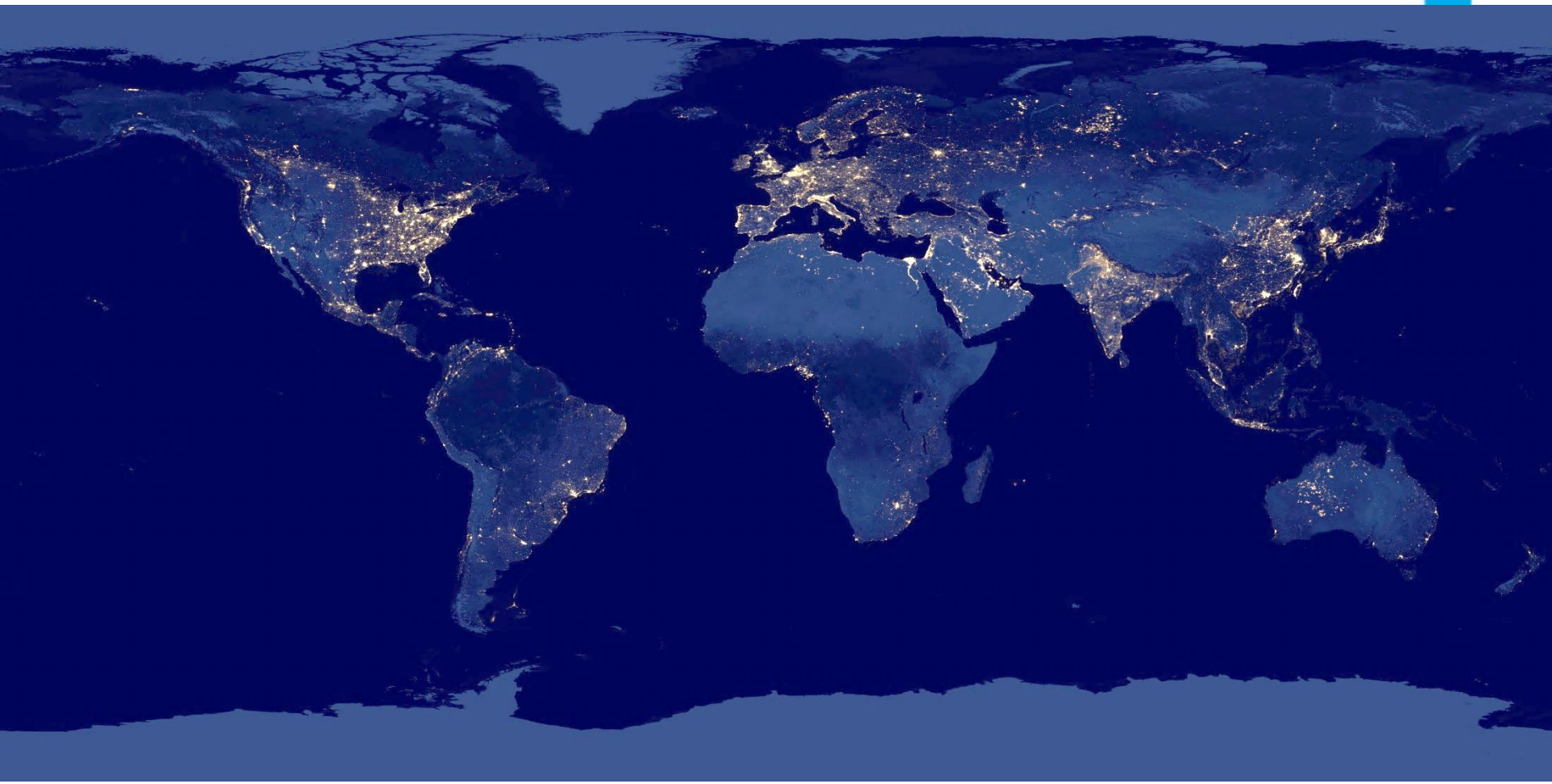


Why Cogenerate? A Global View

World Energy Consumption



The Black Marble



University Medical Center at Princeton Plainsboro

- 630,000 Square Feet, 238 Bed Acute Care facility.
- 160 Acre Campus
- Replaces Princeton Hospital, Downtown
- Functional Since 2012
- $441 M Project

Development History

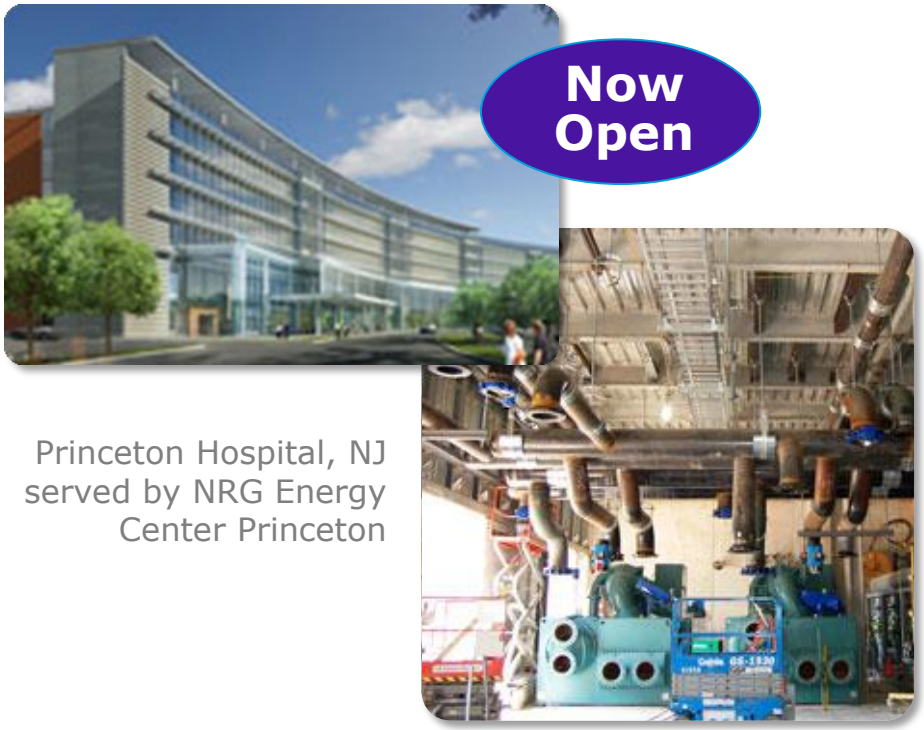
- Hospital Migration, Downtown to Suburbs, 2009 Initiation
- Designing Toward Self-Generation, Late Switch to Cogeneration
- Swayed by NJ State Presentation on CHP
- NRG Adopted Syska Design, Added CHP
- Syska Hennessey Architect, Turner Construction Management

Project Drivers

- Cost Control (Operating Cost)
- Reliability, Grid Independence
- LEED Initiative, Environmental Statement
- Cost Control (Capital Reduction)

Tailored Solution Provides Reliability with Multiple Levels of Protection

NRG Thermal's solutions to cut energy bill dramatically, reduce emissions and increase reliability



Princeton Hospital, NJ served by NRG Energy Center Princeton

CHP – Powered by a 4.6 MW combined heat and power (CHP) plant supplying 100% of heating and cooling needs

Thermal Energy – The recovered thermal energy is used to heat and cool the medical center and the steam is also used for sterilization

Solar –15 panels over the parking lot produce energy equivalent to what 30 average sized single family homes would use

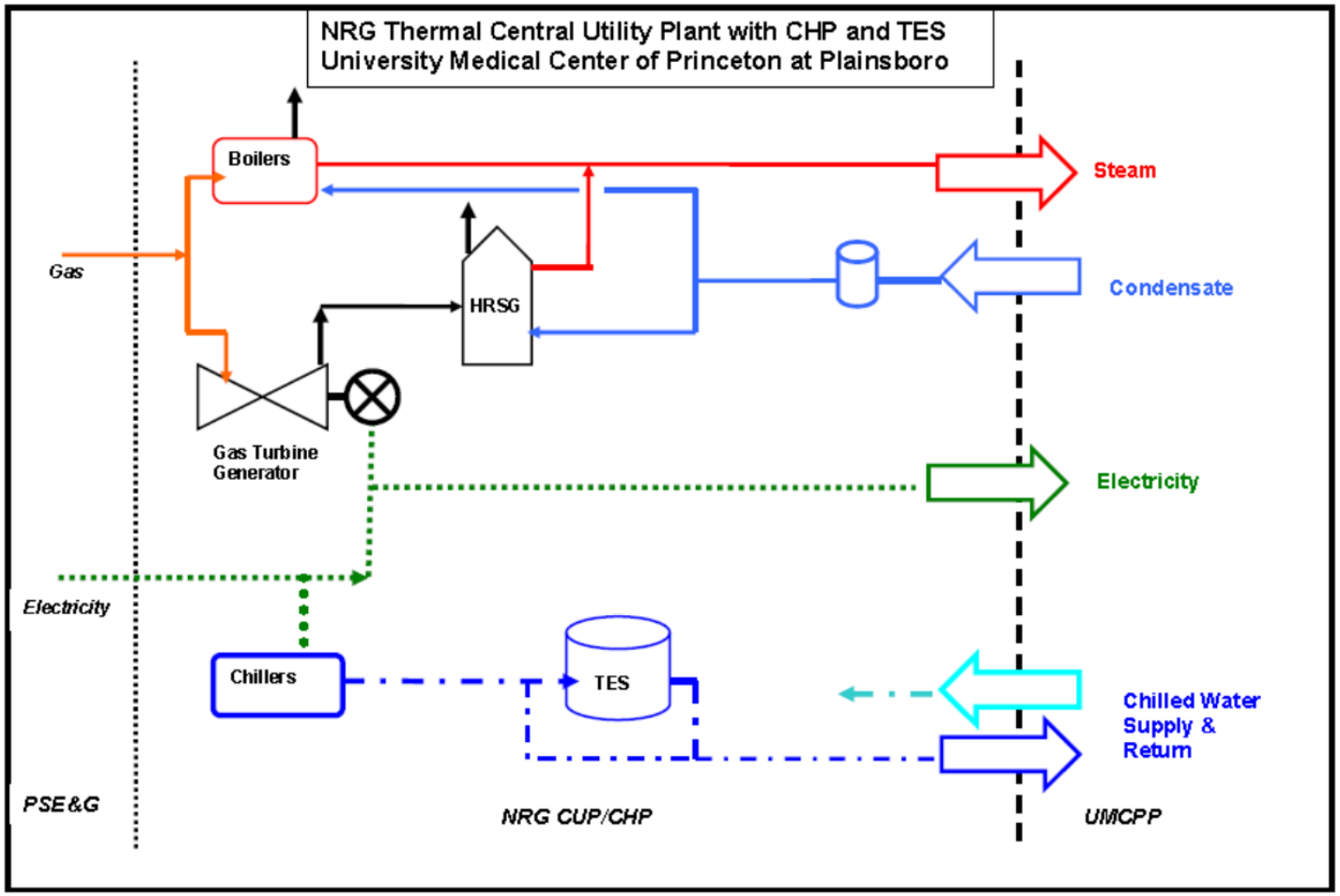
Grid power – And the ability to draw power from the PJM power grid is available if needed

NRG Thermal was responsible for the design, construction and start-up; and continues to provide on-going operations services

UMCPP Major Equipment Summary

- One, 4.6 MW Solar Mercury Turbine, Gas Fired.
- One, 35 mlb/hr HRSG, 150 psig, Gas Fired.
- Three, 700 HP (20 mmBtu) Fire-Tube Boilers, Dual Fuel.
- Three, 1,000 ton Electric Centrifugal Chillers.
- One, 700 ton Single-Stage Absorption Chiller.
- One, 1M Gallon Stratified Thermal Storage Tank
- Three, 2 MW Emergency Generators

UMCPP System Configuration



Plant Exterior

Plant Exterior

Heating, Cooling Equipment

First Full Year Economic Performance

- **Three Major Cost Categories:**
  - Commodity (Electricity, Fuel, Steam Chilled Water)
  - Operation, Maintenance
  - Capital Recovery

  ANNUAL WEIGHTED AVG

- **Annual Savings**

  - 50%

  +25%

  - 5%

  - 30%

Thank You!

The power to change life.℠

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