Hospitals need reliable power—application for microturbines?

Presented to
Microturbine Applications Workshop

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Combined Heating and Power Group
Oak Ridge National Laboratory

Blackout: power problems taxed electric grid means trouble spreads quickly

Importance of distributed generation and CHP is obvious

Blackout: Lessons Learned

- Hospitals designed to minimum stands
  - Hill Burton Act: modernize hospitals in disrepair due to depression & WWII
- Infection Control – negative & positive
- Cooling/dehumidification/ventilation
- Hospitals need integrated energy supply systems:
  - NFPA Codes can support on-site energy supply (see handout)

Blackout did not affect South Oaks Hospital, Amityville, NY

- Staff didn't know there was a blackout until the police called. Hospital offered community services to police and fire stations.
- System details:
  - Installed in 1990 for cost savings
  - 2 dual-fuel engines, 1,300 kW provide all electricity
  - 24/7 operation produces steam (15 lb from jacket water, and 100 lb from engine exhaust)
  - Steam used for building heat, hot water, laundry, kitchen, heating and absorption cooling
- "Good maintenance is key to performance," says Robert Chester, Director of Engineering, "Engines are maintained every 1,000 hours."

Advocate South Suburban Hospital —reliability beyond emergency backup

- Snowstorm in Hazel Crest, Illinois left residents without electricity while hospital operated at full capacity.
- System Details:
  - Installed in 1997, $1.7M
  - Savings of $200,000/yr
  - 1,050 kW engine generator
  - Recovered heat used for building heat and hot water
  - Direct-fired absorption chiller

"Some equipment, such as MRI units, are unable to operate while on backup generators. With the on-site power generation, we have three levels of security for our patients," says Lamar Davis, Director of Facilities Management.

Children's Hospital—utility rate structure guides system operations

- Installed in Philadelphia, Pennsylvania during 1996, expanded in 1998
- Estimated savings of $240,000/yr or 5% of electric bill
- 4-760 kW natural gas generators provide cogeneration and shave peak electricity demand

"Our electric power contract is based on our load factor, so we save money throughout the year. We get . . . discounts, and we produce kilowatt hours which we don't have to purchase from the power grid," reports Kevin McCarthy, assistant director of facilities operation.

CHP in Hospitals Today: >200 existing sites, with 470 MW, just 4% market penetration

Overcoming Barriers to CHP

- Case studies demonstrate economic potential of CHP
- CHP Application Centers increasing CHP visibility at state level especially in Midwest

Case Studies Available

Advocate South Suburban Hospital

Beloit Memorial Hospital

Children's Hospital

Hospital in Washington State

Lake Forest Hospital

Little Company of Mary Hospital

Northwest Community Hospital

Presbyterian Homes

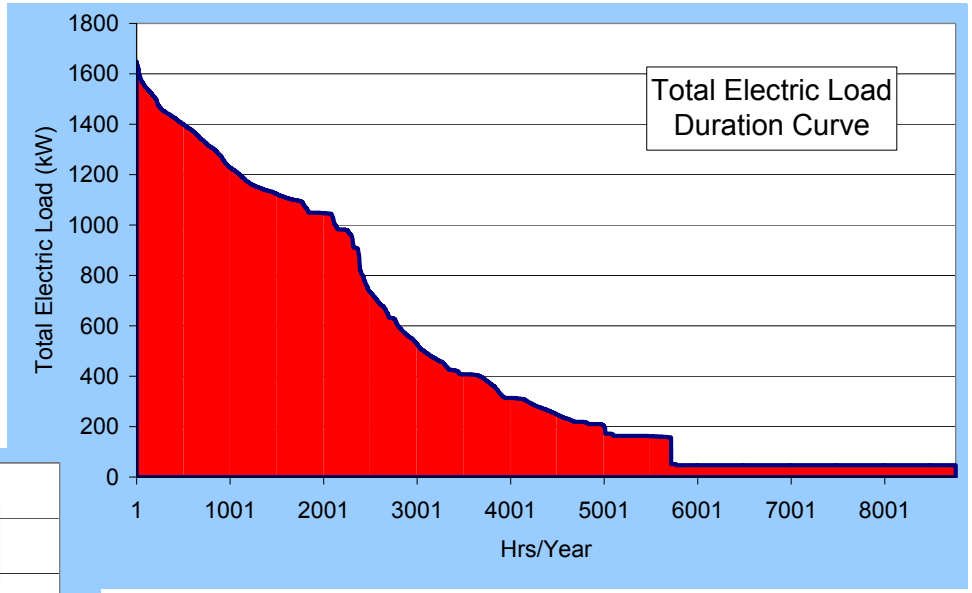
Resurrection Hospital

St Francis Hospital

University of California - Davis Medical Center

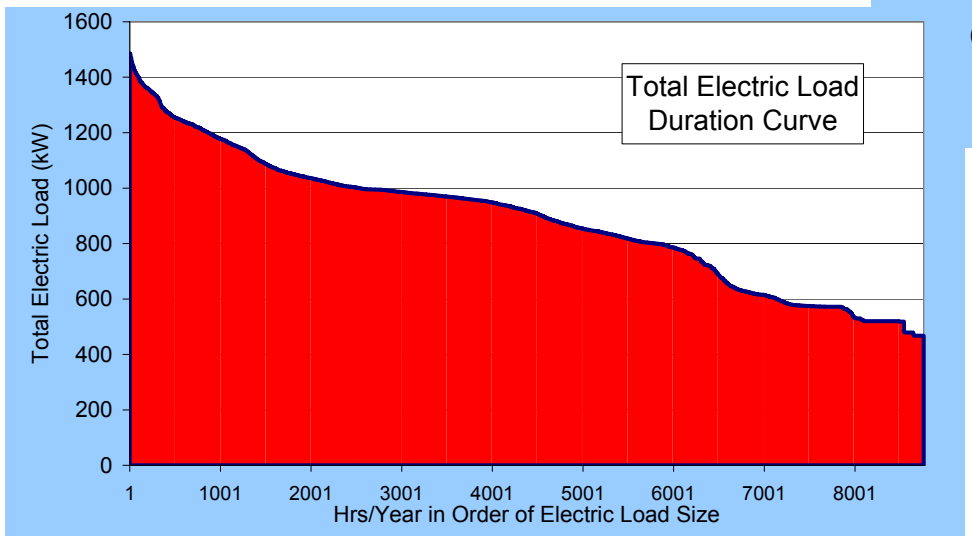
www.bchp.org/hospitals/

Hospital Energy Consumption is More Constant than Other Commercial Loads

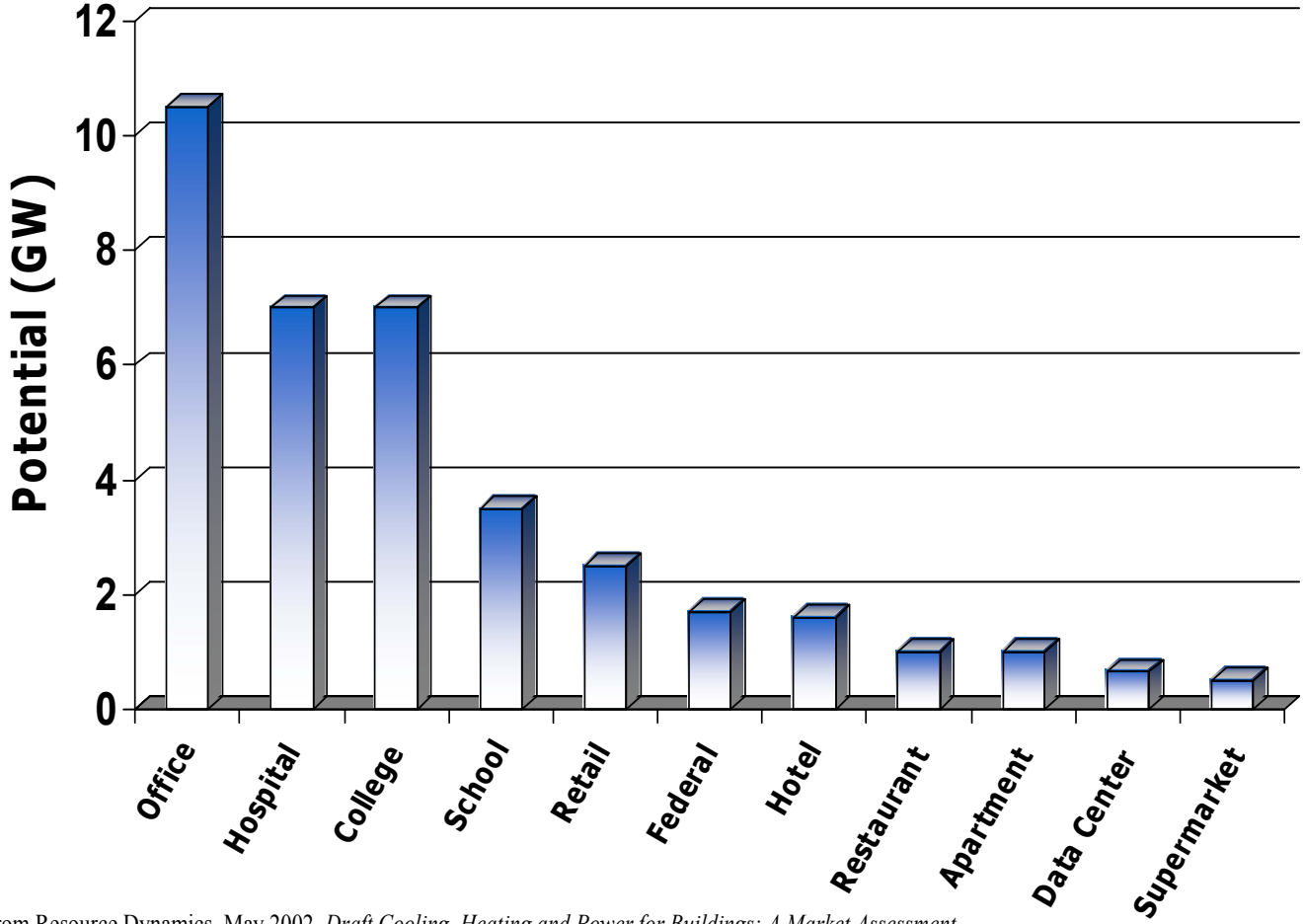


Office Bldg 300,000 SF

Hospital 300,000 SF

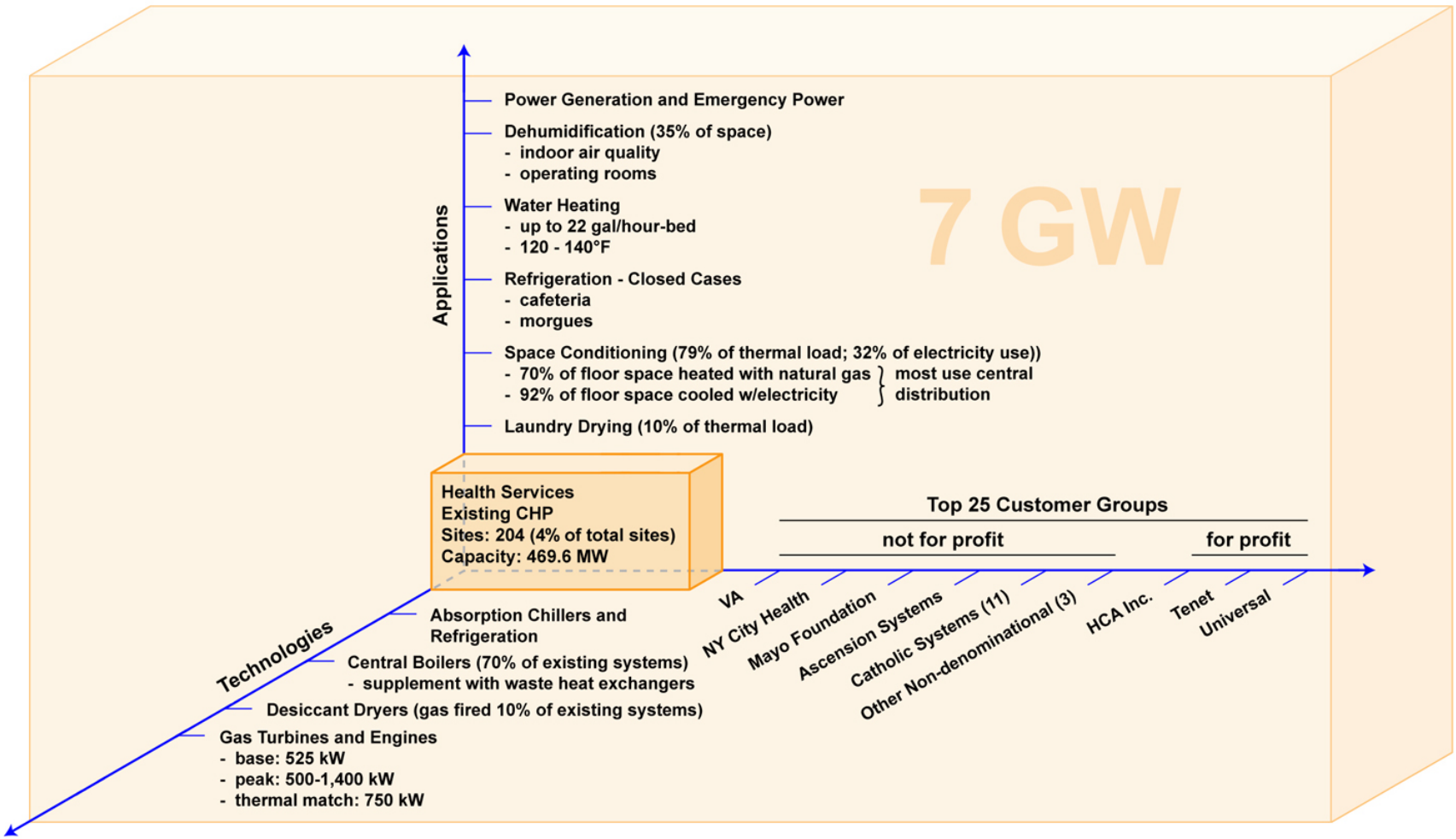


Hospitals: key CHP market segment



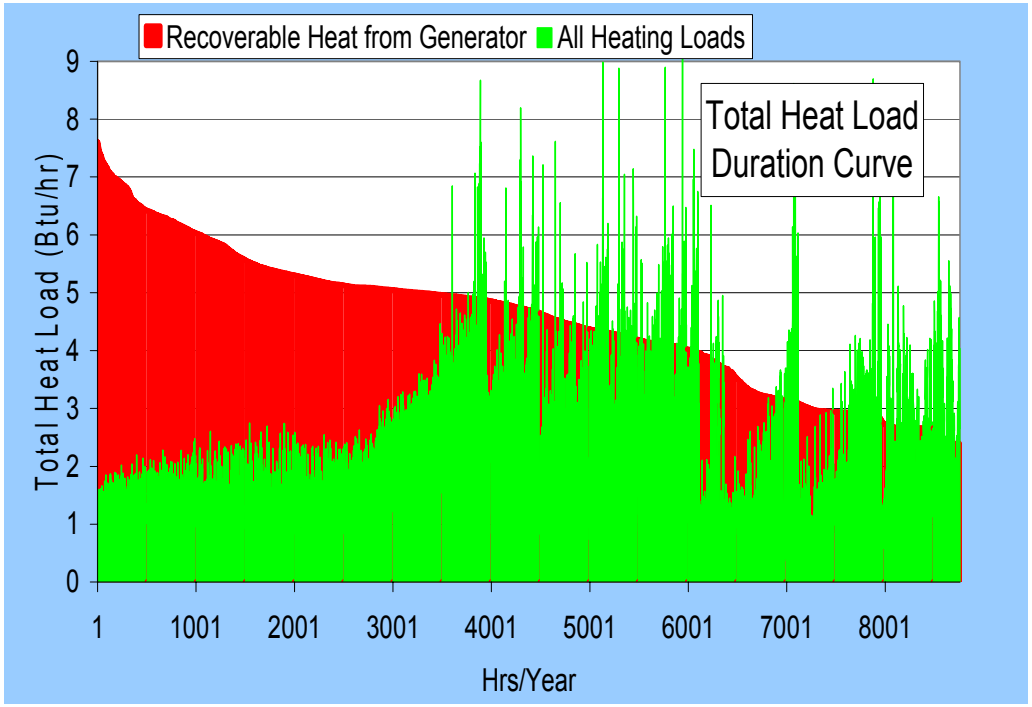
Data from Resource Dynamics, May 2002, *Draft Cooling, Heating and Power for Buildings: A Market Assessment*

Market Analysis: 7GW of CHP potential, CHP technology matches needs of for-profit/non-profit facilities



Data Source: Energy and Environmental Analysis, Inc.

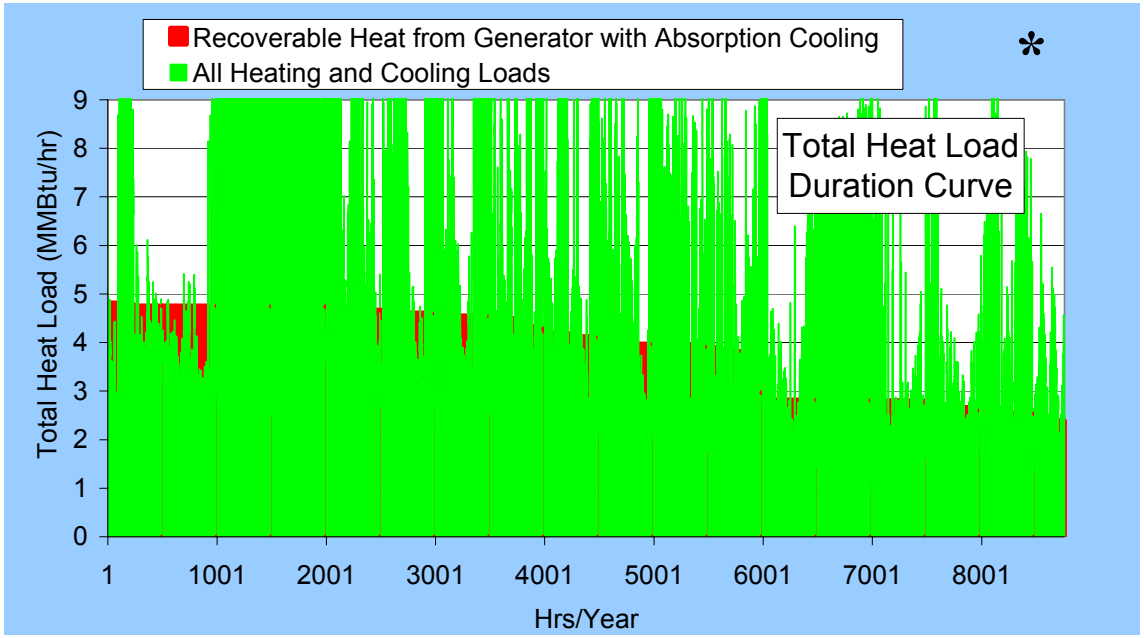
Hospital CHP: *Improve Power Quality and Reliability*



- Reduce momentary outages
- Provide backup electricity
- Provide backup cooling
- 42% of waste heat for space & water heating

Reference: William Ryan, Ph.D., UIC

Base-load Hospital CHP:
Optimize Energy Supply



- Mix electric and absorption chillers to reduce boiler use
- Match heat rejected by generator with a thermal load
- 85% of the Waste Heat Can Be Used for Heating/Cooling
- Peak loads 500-1,400 kW**
- Base load 750kW**

Reference:

* William Ryan, Ph.D., UIC

** Energy and Environmental Analysis

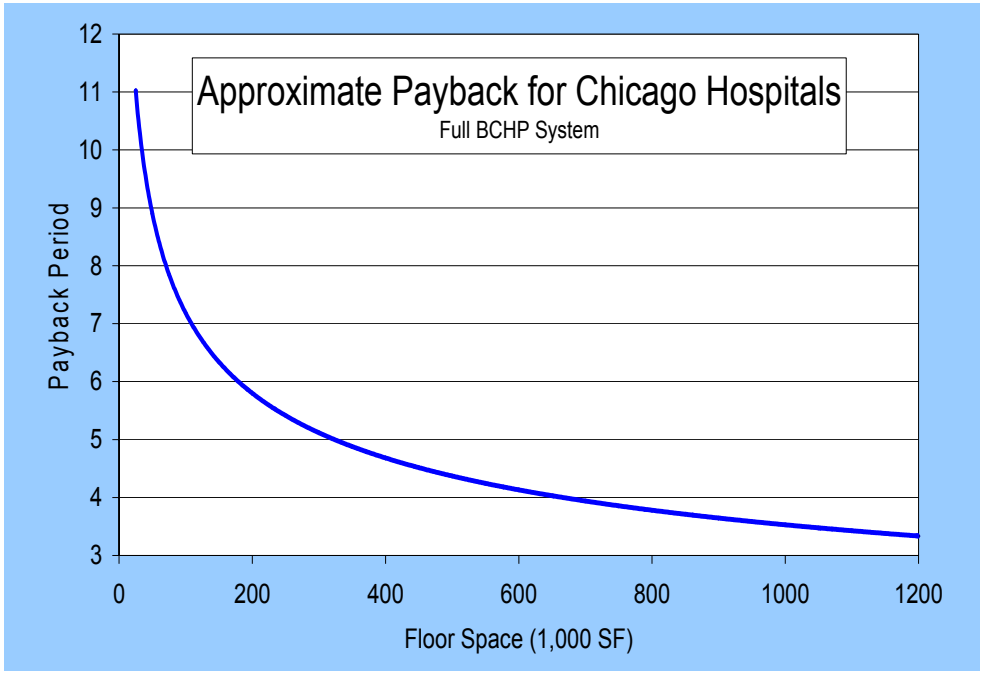
Develop Business Case for Chief Executives

Reduce energy costs:

- Cost savings because of improved energy efficiency and reduced momentary outages
- Keep revenue-generating diagnostic equipment operational
- Offer energy flexibility and reduce exposure to energy price volatility

Community Leadership:

- Improve environmental quality because of higher efficiency energy use



Reference: William Ryan, Ph.D., UIC

Active DE/CHP-ASHE Partnership

- Interview and build on experiences of 204 hospitals with CHP
- Analyze data from 150-300 EPA Energy Star Hospital Surveys for potential CHP applications.
- Evaluate AHA construction data base to identify hospitals that are expanding. Encourage capital improvement could include DE/CHP.

American Society of Hospital Engineers

U.S. Department of Energy
Energy Efficiency and Renewable Energy

DER
DISTRIBUTED ENERGY RESOURCES

UT-BATTELLE
OAK RIDGE NATIONAL LABORATORY

Hospitals Interested in CHP Installations, but Barriers Exist

Market Drivers

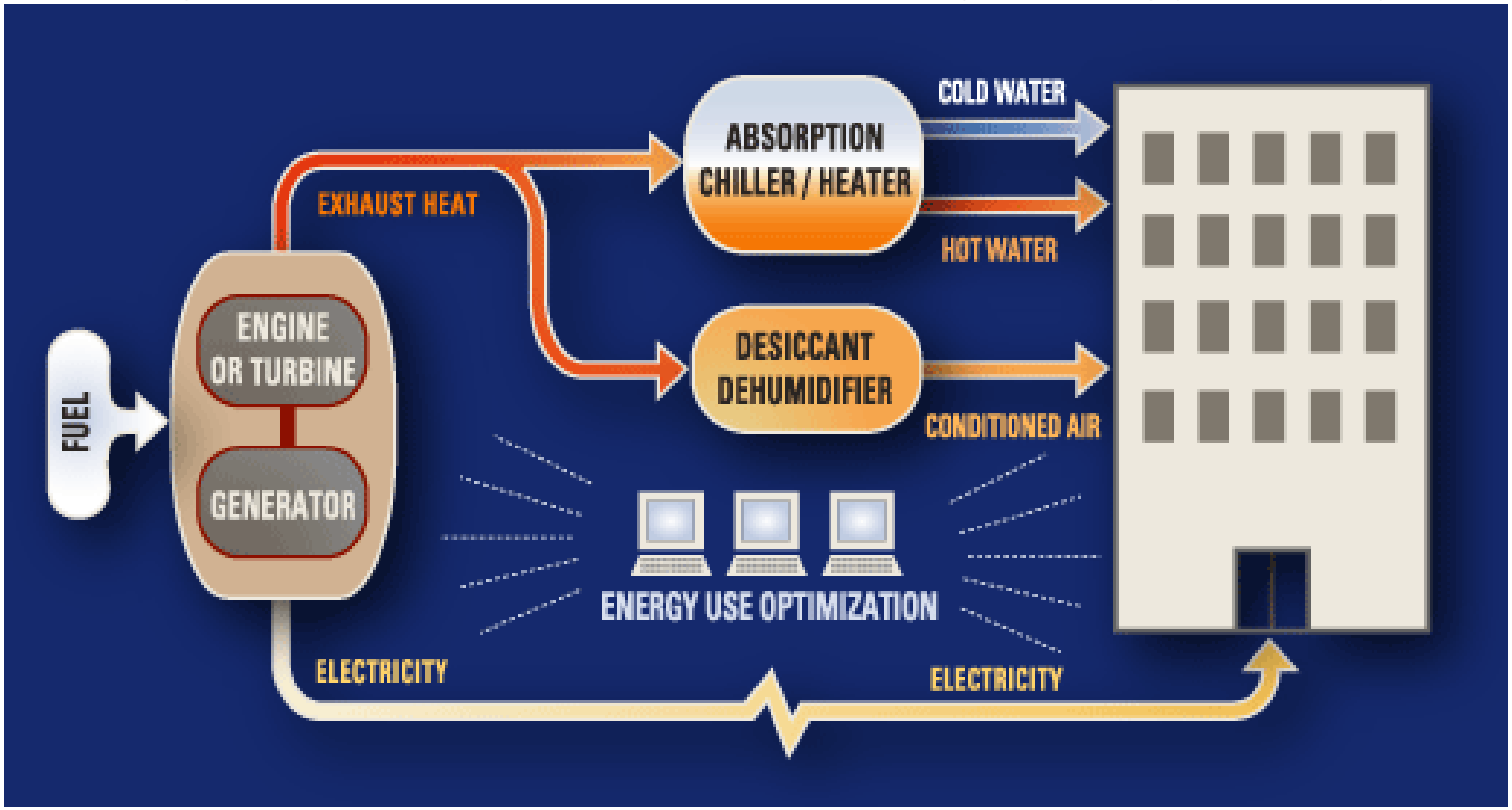
- Expansion required
  - Under built in 1990's
  - Aging demographics
- New role in community
- 6,000 U.S. hospitals
  - ~0.38 quad/yr of potential savings
- Deregulation introduces uncertainty in long-term project economics

Market Needs

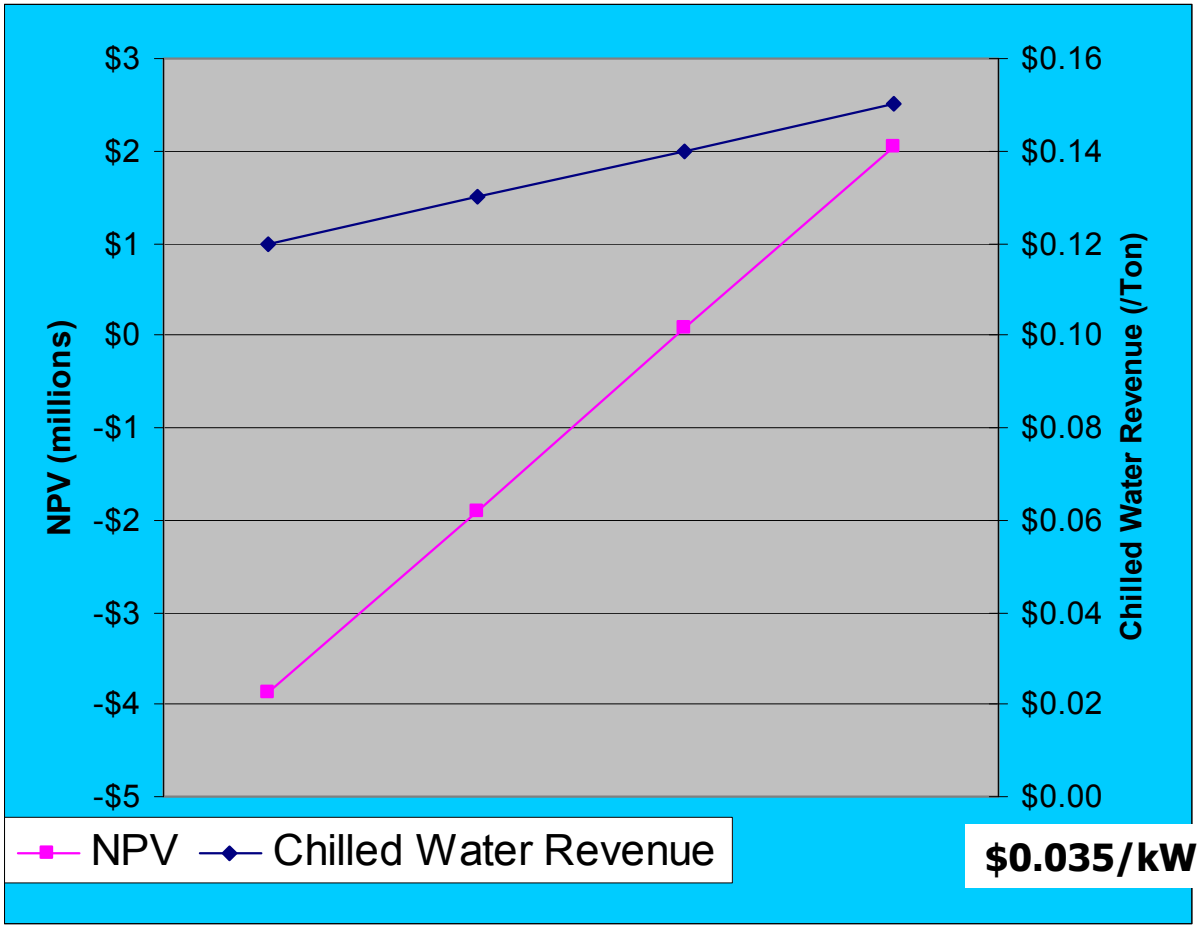
- Knowledge about:
  - CHP benefits especially at executive level
  - Technology advances
- Decisions influenced by:
  - CFO
  - VP of Operations
  - Facility managers
  - Consulting engineers
- Incentives

CHP Tomorrow: Integrated Energy Systems Remove Barriers, Improve Products

- Up to 30% lower capital cost
- 1/3 less time and lower cost for installation
- Standardized interfaces
- Integration helps optimize facility energy supply



Chilled Water Rate Drives Project Economics



32% of hospital electricity use is for air conditioning

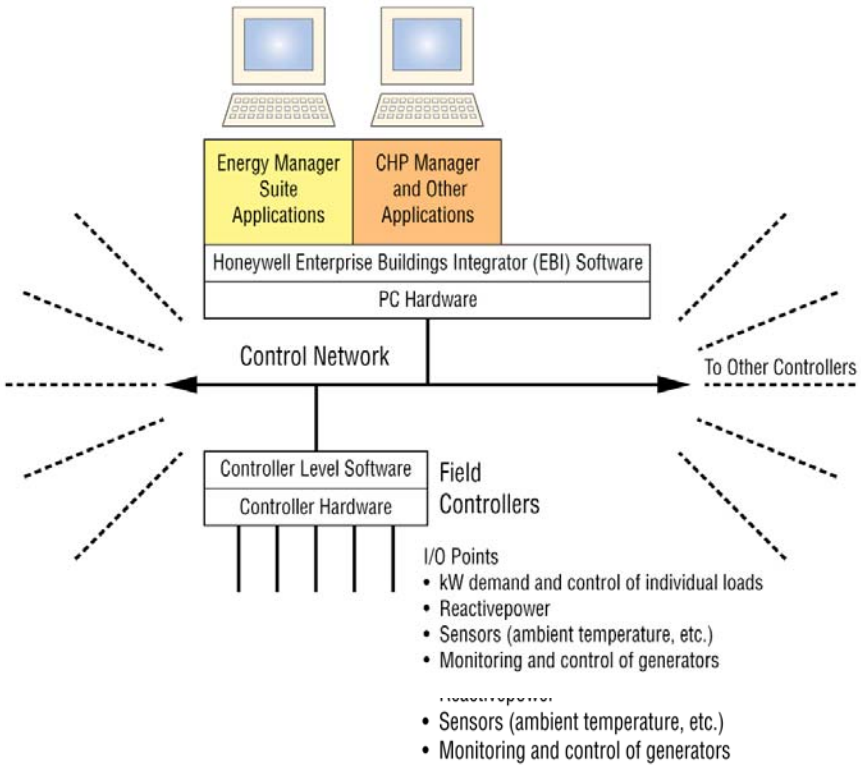
79% of hospital thermal energy is for HVAC

Source: Clark Energy

Reference: Burns & McDonnell

Integrated Energy Systems Advance Systems Controls

- Optimize system performance on:
  - Cost savings,
  - Energy reliability for critical uses
  - Compliance with emissions permit,
- Multiple operating scenarios



Hospitals—good application for micro-turbines?

- Existing reciprocating engine systems have been successful
- Hospital systems thermal and electric loads match microturbine application
- Partnerships foster interest in hospital market sector

Background information—not presented during session

NFPA and Using CHP to Supplement Emergency Power

Dan Chisholm, Principal

Motor and Generator Institute

NFPA 99, 4.4.1.1
On-Site Generator Set

4.4.1.1.1* Design Considerations. Dual sources of normal power shall be considered but shall not constitute an alternate source of power as described in this chapter.

*A.4.4.1.1.1 ….Facilities whose normal source of power is supplied by two or more separate central-station-fed services (dual sources of normal power) experience greater reliability than those with only a single feed…

NFPA 99, 4.4.1.1.4

Essential electrical systems shall have a minimum of two independent sources of power: a normal source generally supplying the entire electrical system and one or more alternative sources for use when the normal source is interrupted.

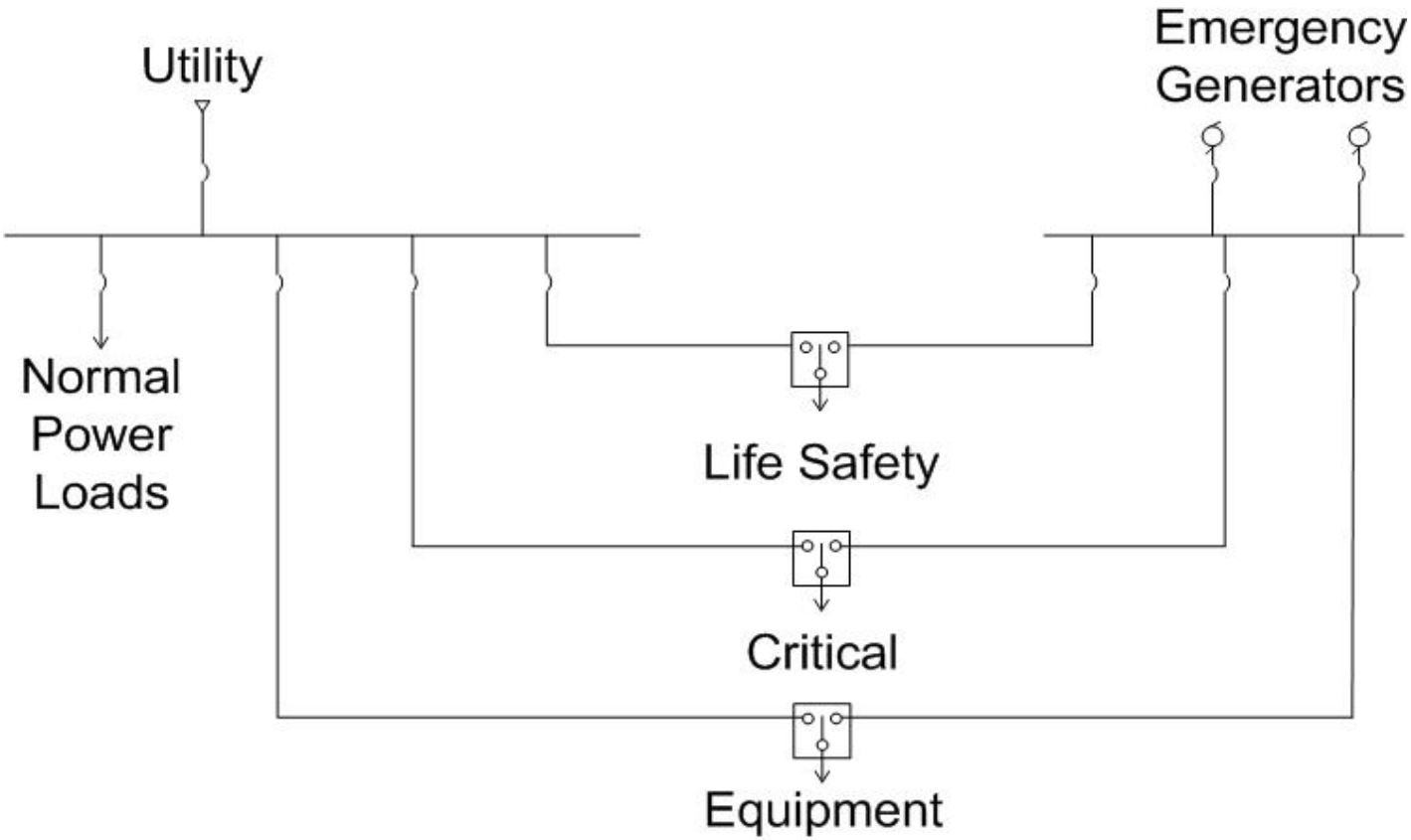
NFPA 99, 4.4.1.1.6

Where the normal source consists of generating units on the premises, the alternate source shall be either another generating set or an external utility service

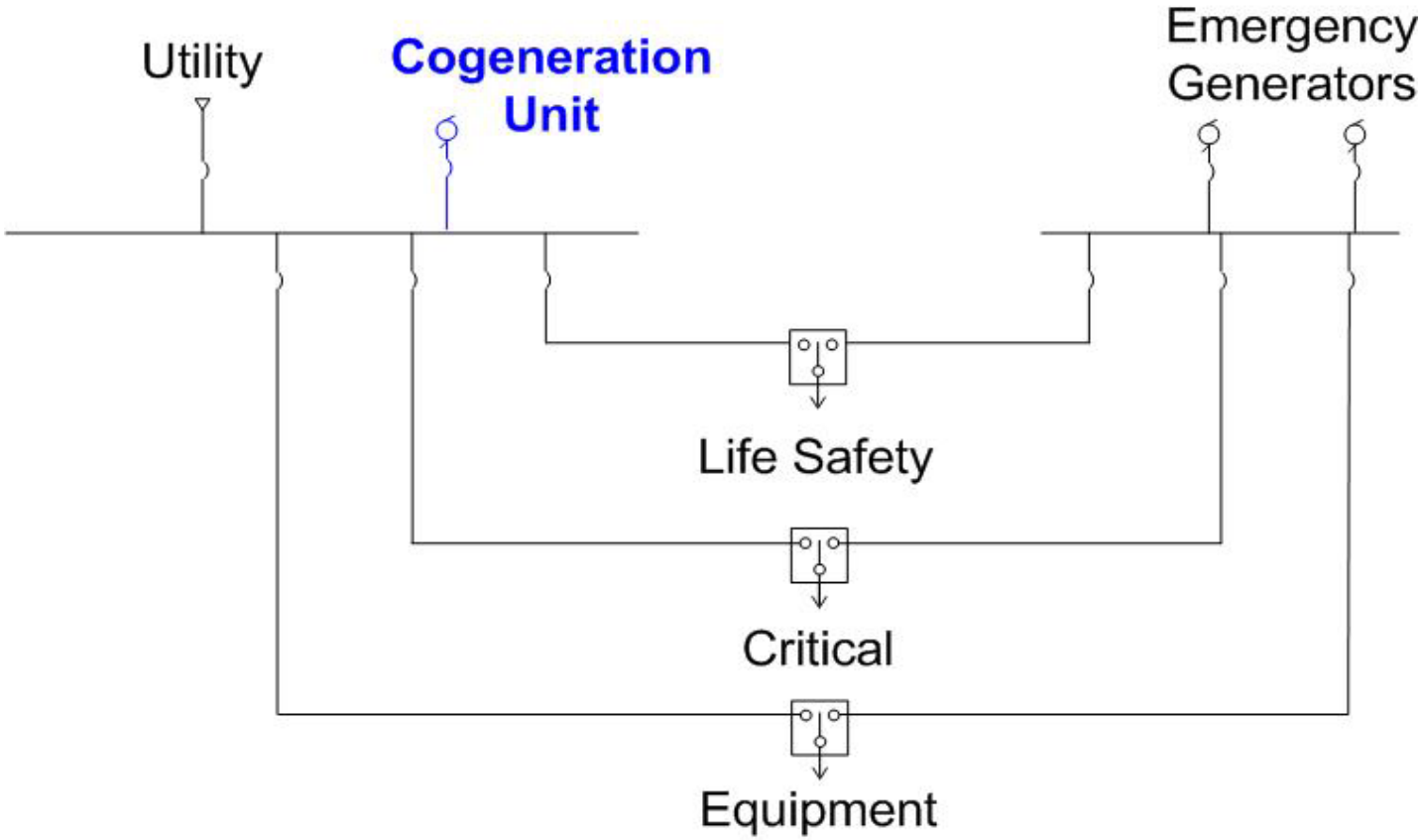
NFPA 99, 4.4.1.1.8.3

Optional loads *shall be permitted* to be served by the essential electrical system generating equipment. Optional loads *shall be served by their own transfer means* such that these loads shall not be transferred onto the generating equipment if the transfer will overload the generating equipment and *shall be shed* upon a generating equipment overload. Use of the generating equipment to serve optional loads shall not constitute “other purposes” as described in 4.4.1.1.8.1 and therefore *shall not require multiple generator sets.*

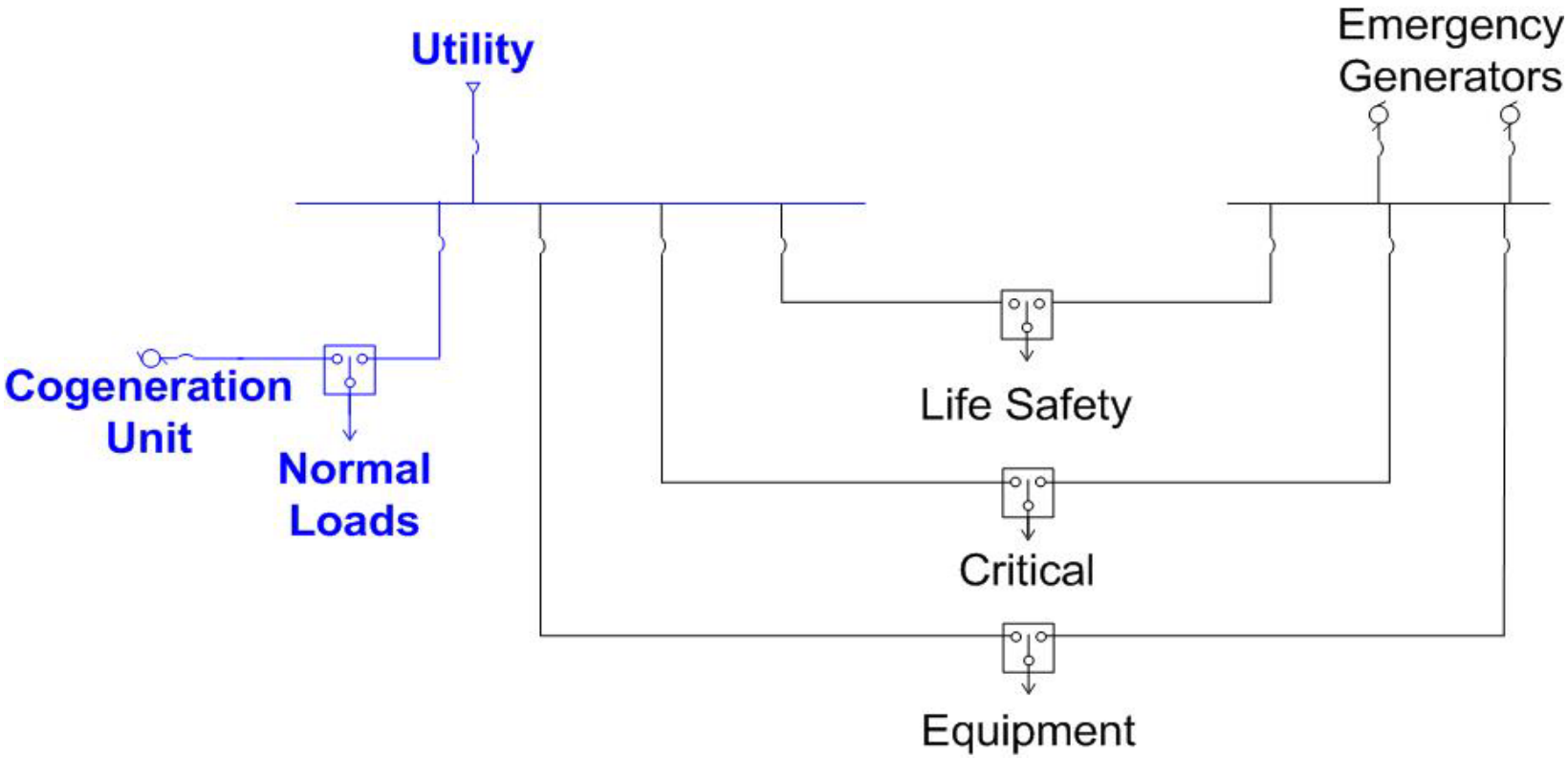
Healthcare Electrical Distribution System



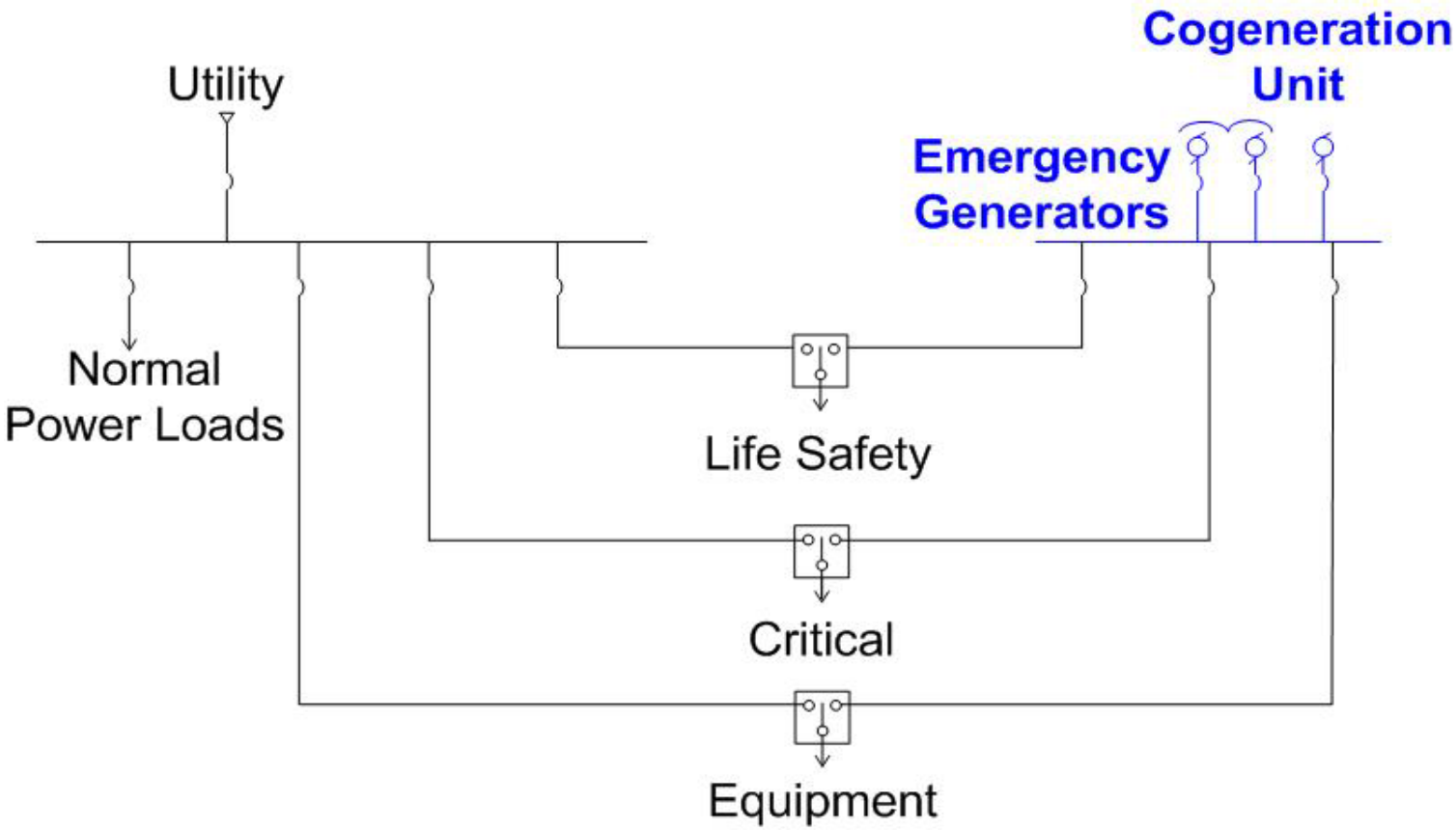
Option #1 Parallel to Utility

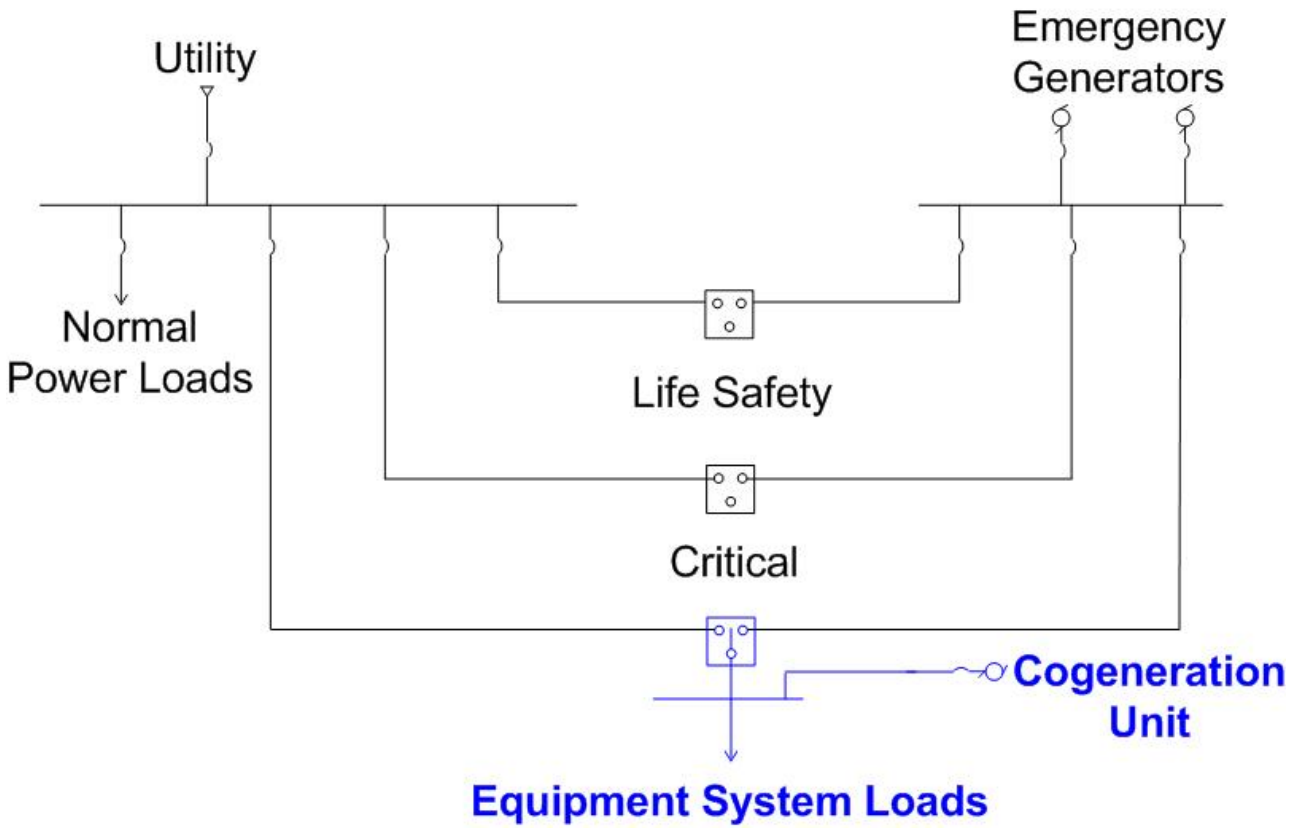


Option #2 Segregate Normal Loads Via Transfer Switch



Option #3 Parallel to Emergency Generators



States Differ

Option #4 Parallel to Utility <u>and</u> Emergency Generators