Co-generation in Healthcare

Villa Columbo Vaughan ON, Long Term Care

CHP in Healthcare Facilities
IEEE Reliability Regions

CHP in Healthcare Facilities
IEEE – Day-to-Day Operations – Event Duration

CHP in Healthcare Facilities
IEEE – “other effects”

CHP in Healthcare Facilities
IEEE – Frequency & Duration (excludes major events)

Trends for Utilities providing data

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Duration – How are we on a global scale?

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IEEE – System Average Interruption Duration Index

CHP in Healthcare Facilities
Reliability & Frequency

So everything’s good ..... 
Right?
IEEE – Total Duration, including major events

CHP in Healthcare Facilities
IEEE – Day-to-Day Operations – Event Duration

CHP in Healthcare Facilities
Additional Generation in Healthcare – why?

ONE REASON

DECREASING ELECTRICITY GRID RELIABILITY AND NATURAL DISASTERS

ie. utility just not there

2003 Blackout, ON PQ

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Natural Disasters

2012 Hurricane Maritimes

'98 Ice Storm PQ

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Natural Disasters - what's missing?

Seismic Events - not typical in Canada

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Additional Facility Power During Utility Outages

- CSA Z317.2-10 defines mechanical operations “post disaster”
- Next version released will have even more requirements
- CSA standards are NOT retro-active, however, older facilities cannot carry on operations to the degree specified in new standards so voluntary upgrades are desirable to keep facility current....need more on-site power.
- Old standards (especially CSA Z32.2) were written around buildings with operable windows (ie. ventilation only during outage). New codes allow operable windows but codes limit opening to a few inches. With sealed buildings and limited natural ventilation, air conditioning is required during sustained power outages.
- Sustained outage is driving increased requirements to ensure continued operations beyond type 1 departments.
- IT cooling (part of 24/7 cooling systems) is becoming king and is distributed throughout the facility.

CHP in Healthcare Facilities
Additional Facility Power During Utility Outages

- Renovations drive electrical changes. Air handlers that were on “normal” power now require emergency power because type I departments are now supplied by the unit. The affiliated air conditioning load (which is twice the ventilation electrical load if electrical centrifugal chillers) must additionally be satisfied.
- Latest CSA Z32.2 standard requires redundant electrical essential generators. Codes are not retroactive, however, the intent requires voluntary upgrade consideration.
CHANGES TO CSA 282-09 (EM BLDG SUPPLY)

- Generation design and operating requirements for HCF’s transferred from Z32.2 to C282
- Option to have HCF’s emergency generators fed by off-site fuel source
- Increase in minimum fuel storage requirement for Class-A (24h to 72h)
- Specific reference to bi-fuel option
- Requirement for more connected chiller capacity (CSA Z32-09): Class-A: OR, CCU and ICU (Conditional Loads)
7.3.1 Fuel Supply
7.3.1.1 “A quantity of fuel sufficient for operating the engine under maximum site design load for at least 2h shall be maintained on-site at all times”
7.3.1.2 “…… where a generator set is required for emergency power supply to essential electrical systems in conformance with CSA Z32, a fuel supply shall be maintained on site at all times that is sufficient for operating the engine under full load for at least 24h (Class B & C), and 72h (Class A)”
7.3.2 “Notwithstanding Clause 7.3.1, when it can be demonstrated to the AHJ that reliability of the off-site utility fuel supply and the associated piping meets the requirements of Clause 7.3.1 for a continuous fuel supply, on-site storage might not be required”
EXCERPTS FROM CSA 282-09

- If off-site fuel is accepted, then the equivalent times are deemed as being accepted by the AHJ
- Gas service reliability 2012: 99.9998\% - Ref. Enbridge Gas Distribution, Engineering Dep’t
- In all the previous Canadian disasters noted, natural gas remained available.

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DEFINITIONS CSA Z32

Vital Branches:
- “that portion of an essential electrical system in which circuits require power restoration within 10s” (e.g. lighting, fire alarms, fire detection, PA systems)
- ~15% of total hospital load (HHA estimate)

Delayed Vital Loads:
- “that portion of an essential electrical system in which the circuits require power restoration within 2min” (e.g. fire pump, surgical ventilation, blood bank refrigerators, X-ray, elevators, 24/7 cooling, critical cooling CSA Z317.2)
- ~25% of total hospital load (HHA estimate)

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Conditional Loads:

- “that portion of an essential electrical system in which the essential loads may be transferred to the emergency source at a time dictated by the prevailing need” – manual or automated connection (mainly mechanical systems but required to keep facility operational)
- ~20% of total hospital load
- Note: CSA Z32 & CSA Z317.2 all not fully aligned. Z317.2 has more departments and more air conditioning.
New facility procurement & specifications

**Specifications:**
- Recent procurement for new hospitals utilizes P3 model (BC, Ontario, Quebec...). Level of back-up power in P3 specs often exceeds “essential” power requirements of CSA Z32.2, CSA Z317.2 and CSA 289 (HHA currently estimate “essential” at 60% facility load).
- GOS (Ontario 'recommendation') looks for 100% back-up with redundant generator available.

CHP in Healthcare Facilities
CHP Technologies – turbine/HRSG

CHP in Healthcare Facilities
CHP Technologies – Recip/Jacket Water/HRSG

7-12% loss

STEAM

Heat exchanger

HOT WATER

5% radiation loses

100% Primary Fuel

Engine

40~50% MWth

38-44% MWe

Generator

ELECTRICITY

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Technology Selection

**Turbine**
- Good selection if heating distribution/thermal utilization is steam
- Electrical efficiency is fairly low
  - Could use combined cycle…but then higher steam pressures

**Reciprocating Engines with jacket water & exh. reclaim**
- Great electrical output
- Thermal utilization needs to utilize hot water
- Can produce steam if necessary
What are some cogen limitations?

**Turbine Generators with HRSG**
- Long purge and starting times, could be minutes
- Very low inertia constant, poor step load performance

**Reciprocating Engines with jacket water & exh. reclaim**
- Smaller machines could start within 15 seconds
- Gaseous fuel has poor step load performance (say 30~40%)
What does CSA 282 say about these parameters?

**Starting time for healthcare**
- 10 seconds
- 15 seconds is acceptable for other occupancies

**Step Load Test**
- 100% step load for the “maximum site design load”
- Doesn’t seem to recognize Canadian Electrical Code (requires multiple transfer switches for fire pumps, life safety loads and other loads) nor the standard itself which allows elevators after 1 minute, etc.
Possible Alternative Electrical Strategy

- Integrate combined heat and power (CHP) into hospital’s existing diesel emergency generator fleet:
  - Leave the diesels to pick up vital and perhaps delayed vital loads
  - Have CHP pick up the conditional loads plus all/portion of remaining loads whose start-times are less rigorous
  - Consider designing the CHP system to pick up the diesel’s loads at an appropriate time.
- Nothing in Codes and Standard prohibits this design for a new facility and a great option for retrofit.
Possible Alternative Thermal Strategy

- CSA Z317.2 requires multiple boilers for heating. CHP unit can be one of the 'boilers'...but this currently would have to be a dual fuel CHP unit if code has to be met. Not a problem for turbine technology.
- CSA Z317.2 already allows “essential” cooling to come from natural gas supplied sources (on-site CHP generation to electrical driven centrifugal, absorption chillers, or gas engine driven centrifugal)
Possible Alternative Strategy

- Dual fuel turbine/HRSG satisfies Z317.2 & gas recip satisfies “essential” for long term care facility.

CHP in Healthcare Facilities
Possible Alternative Strategy

- **Benefits:**
  - Natural gas service is continuous (even during power outages) and highly reliable
  - Diversifies hospital's diesel fuel supply
  - Lowers amount of stored fuel required, transfer to gas fueled generation when available
  - Will prolong on-site diesel fuel supply, and update facility to compliance or intent with current Codes and Standards
  - In a disaster this could mean no patient and employee relocations, evacuations, operation cancellations, hospital clean-ups, etc.

CHP in Healthcare Facilities
Financial Advantages

Take advantage of favorable spark-spread that’s come about by increased supply of domestic natural gas:

- Economics of CHP have changed dramatically in past 5 years

![Spark Spread Graph](image)
Ontario - HOEP remains low but Global Adjustment charge is really trending upwards. CHP can now be financially justified on its own (ie. there's an attractive payback).

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Financial Advantages - Even Better!

Ontario & British Columbia now have “standing offer programs” for CHP. Although the electrical demand has remained low relative to pre-recession highs, several provinces recognize the carbon advantages of on-site CHP. Typically need to hit an annual efficiency.

Ontario has recently awarded some contracts under CHPSOP (ie. Villa Columbo long term care).

BC this spring established the rules of their program (HHA currently have 6 greenhouses in application to this program).

Ontario recently allowed CHP as energy 'savings' (savings from the Ontario grid supply) and will currently fund 40% of capital for behind-the-meter CHP.
The future

With fracking technology the North American gas reserves have increased dramatically.

Pricing for natural gas has decreased. Stable pricing is anticipated.

Electricity pricing will continue to rise. Natural gas is expected to be a larger part of the utility supply because of stable fuel prices and increasing spark spread.

LNG is gaining traction and natural gas generation technology is being more widely applied in remote areas (territories, northern Ontario, etc.). Capital cost/kW is decreasing, available capacities increasing.

Surplus of propane. Caterpillar are expanding their large engine fleet where propane was previously “residential”.

CHP in Healthcare Facilities
Powering into the future ....

- May lower your carbon footprint...clean
- Increasing your self sufficiency
- Increasing your facilities reliability
- Increasing your back-up capacity and therefore operational ability during utility outages
- Modernizing your facility up to align with current operational intents
- Decreasing your operating costs
- Assisting provincial need by avoiding replacement utility generation
- Decreasing provincial electricity peak production

- May avoid costs of boiler replacements or diesel generator replacements

...... absolutely!

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