



COMBINED HEAT AND POWER: Revisiting the Business Case and Reliability Benefits for Ontario's Hospitals

May 26, 2014



HEALTHCARE
ENERGY
LEADERS
ONTARIO

Generating Savings for Care





Presentation Outline

- **CHP Basics**
- **The Business Case for CHP**
- **Reliability Benefits**
- **Implementation Guidelines**
- **Conclusions**
- **Questions**



Key Market Drivers for CHP

- **Energy Price Outlook**
 - The price differential between electricity and natural gas is predicted to remain favourable for CHP for the foreseeable future
- **Emerging Reliability Concerns**
 - Hospitals want to ensure the supply of electrical power for their critical systems and to maintain normal operations during blackouts, grid failure
- **Financial Incentives**
 - OPA incentives up to 40% of implementation costs



What is Combined Heat and Power?

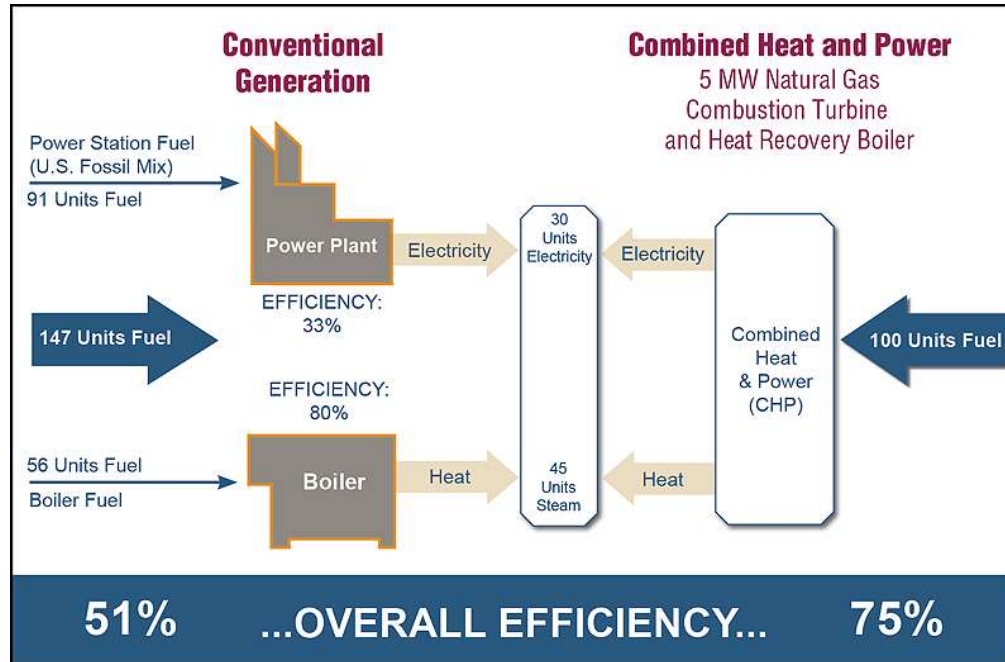
CHP is an integrated energy system that:

- **Generates electrical power**
- **Recovers waste heat for:**
 - Space heating
 - Water heating
 - Space cooling (absorption chillers)
 - Process heating
- **Can utilize a variety of technologies and fuels**
- **Is commonly known as cogeneration**





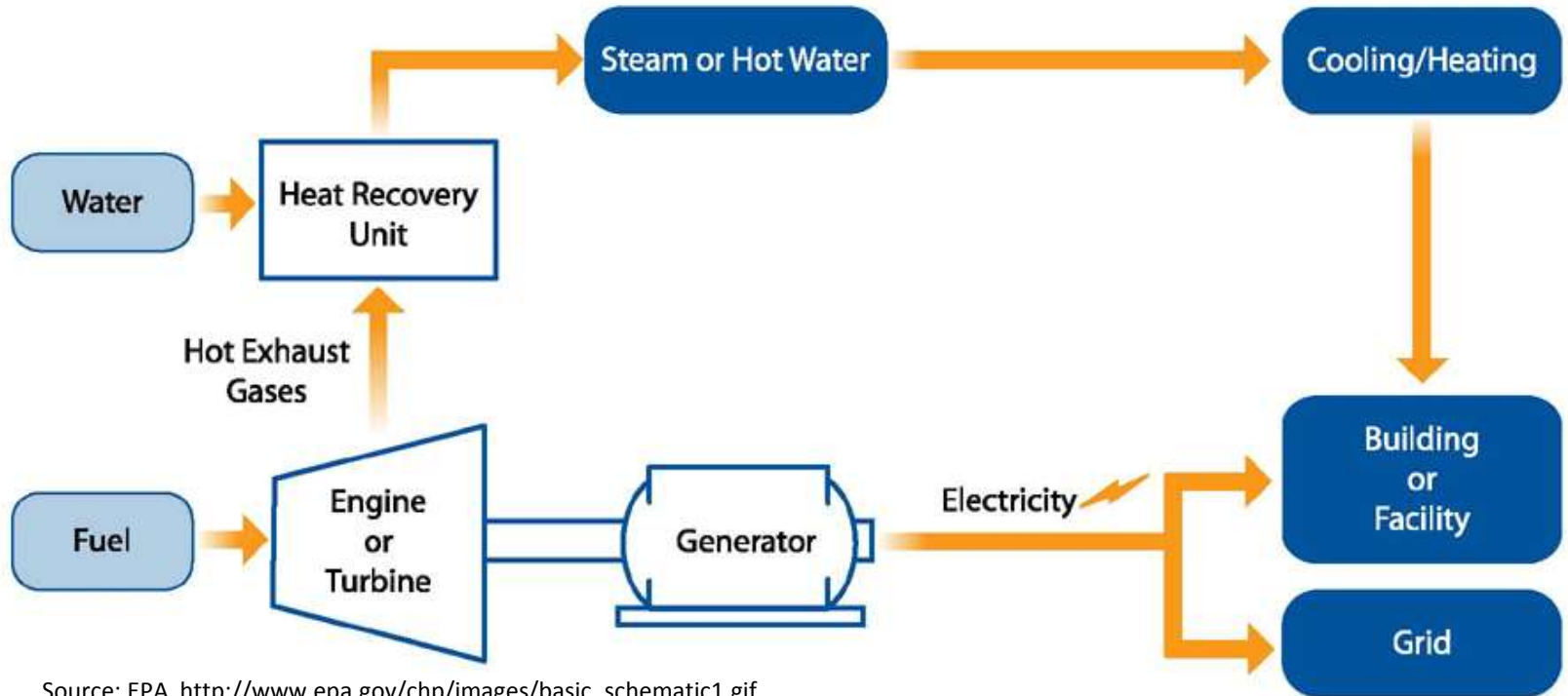
CHP is Thermodynamically Efficient



CHP can provide significant energy efficiency advantages over conventional heat and power generation



CHP Schematic





CHP Applications



Industrial



Institutional



Residential








Utility Scale



Commercial



CHP Technologies

 Analysis Assumptions				
CHP Technology	Reciprocating Engine	Micro Turbine	Gas Turbine	Fuel Cell
Typical Size Range	75 kW - 10 MW	30 kW - 200 kW	.5 MW - 40 MW	1kW - 400 kW
Average Installed cost (\$/kW)	\$ 1,130 - \$ 2,210	\$ 2,440 - \$ 2,970	\$ 972 - \$ 3,324	\$ 6,310 - \$ 9,100
Total Average CHP System Efficiency	74 - 79.0%	63.8 - 71.2%	66.3 - 72.1%	65.0 - 81.0%
Gas Input (MMBTU/Hr)	1.2 - 43.79	0.422 - 3.165	18.5 - 368.8	0.1 - 1.9
O&M Cost (\$/kWh)	\$ 0.009 - \$ 0.022	\$ 0.012 - \$ 0.025	\$ 0.0042 - \$ 0.011	\$ 0.033 - \$ 0.038
Notes:	Less than a 75kW Engine is considered Micro-CHP	Can package multiple Micro turbines to reach 2 MW	Size starts at 1000KW	PEM: 1KW to 200 KW, PAFC: 250KW-400KW



A Typical Hospital CHP System



- **Natural gas fired reciprocating internal combustion engines have broad applicability in the sector**
- **Units typically range from 75 kW to 10 MW**
- **Typically sized to meet base thermal load requirements**



Norfolk General Hospital

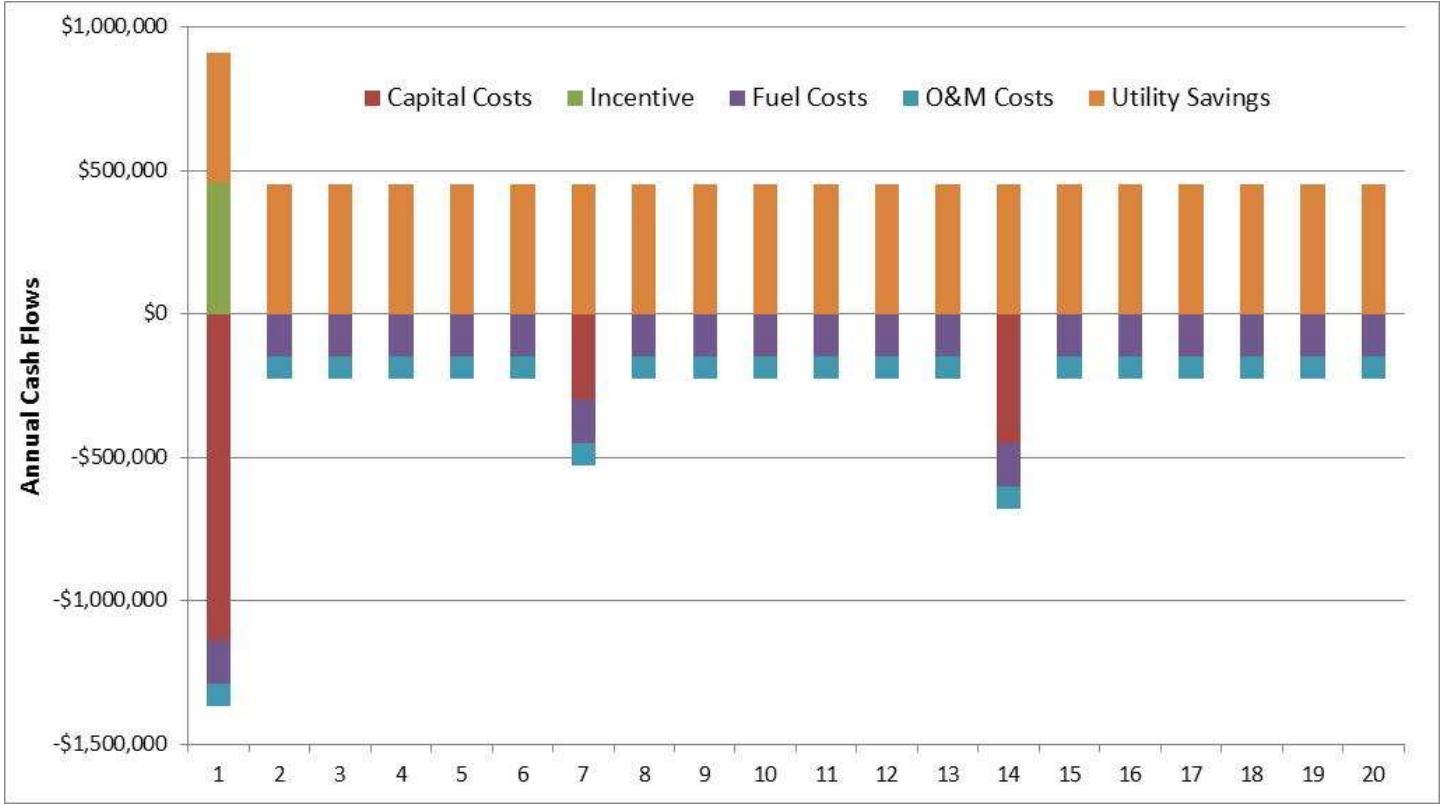


- Full service hospital and long term care facility in Simcoe, Ontario
- 242,000 ft²
- Annual electricity consumption of 4,600 MWh
- Annual gas consumption of 1 million m³



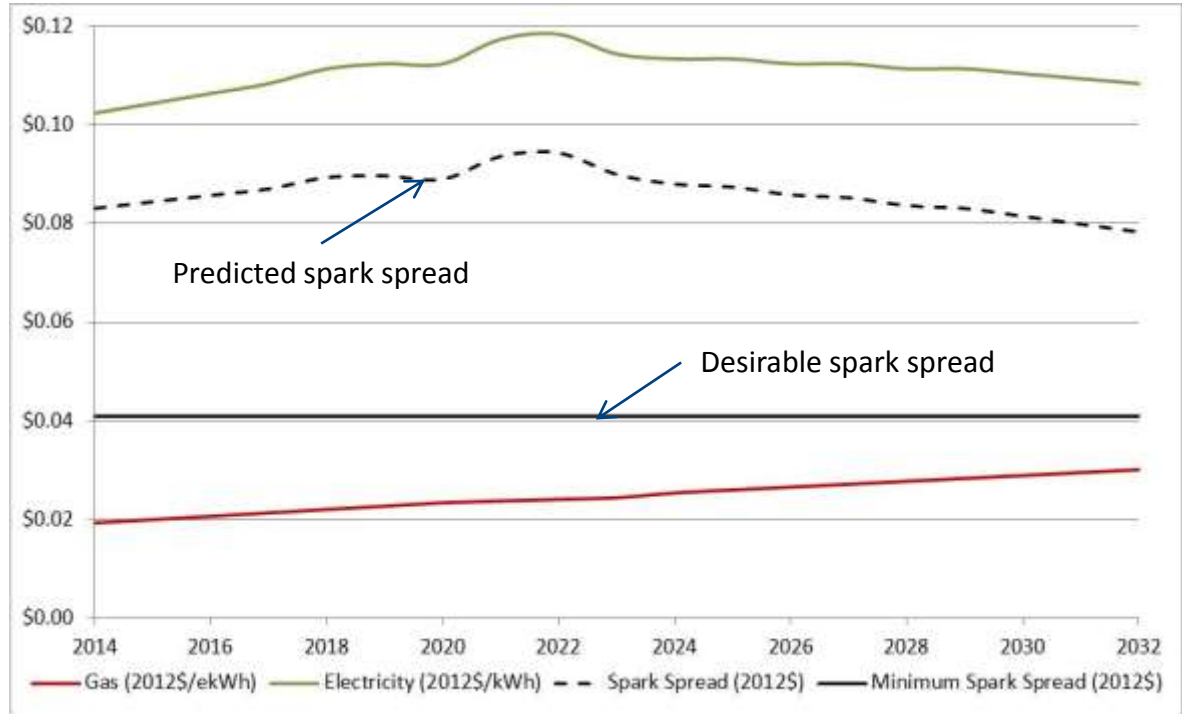
CHP Pre-feasibility Study - Norfolk

- **380 kW natural gas fired, reciprocating, internal combustion CHP plant**
- **Sized to meet base thermal load - hot water for DHW and space heating, and steam for process loads**
- **The CHP will provide 70% of the facility's electricity consumption**
- **Behind the meter generation**
- **Installed equipment cost of \$1,150,000 with net annual savings of \$230,000, resulting in a simple payback period of 5 years**
- **Potential for \$450,000 in incentives under the OPA's PSUI program which would reduce the simple payback period to 3 years**





Ontario Energy Price Forecasts



Inflation adjusted electricity and gas price forecasts predict that the spark spread will remain attractive for the foreseeable future



Who already has CHP?

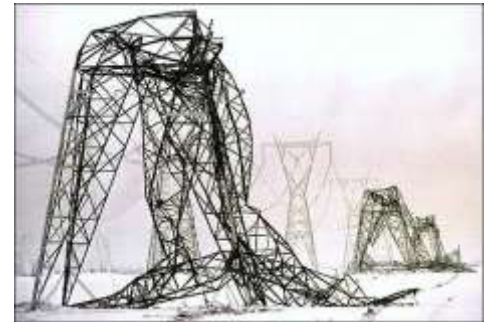
- A representative cross section of hospital sizes and Ontario climate zones
- Natural gas reciprocating engines ranging from 225 kW to 6.9 MW





Energy Reliability Benefits

- **In addition to emergency power, CHP can provide supplemental capacity to allow hospitals to maintain normal operations during periods of grid failure**
- **CHP plants have operated continuously during natural disasters such as Hurricane Sandy in New York**
- **Traditional backup generators do not always perform during emergencies**
- **Natural gas service is continuous and reliable (99.9998% reliability in 2012)**
- **Diversifies the hospital's fuel supply**





CHP Kept Critical Facilities Operating During Hurricane Sandy

Application	# Sites	Capacity (MW)
Hospitals	7	19.31
Universities	6	84.5
Multi-family	6	44.5
District Energy	3	79.9
Data Center	1	0.065
Assisted Living	1	0.075
Manufacturing	1	10.7
WWTP	1	2.8
<u>Government</u>	<u>1</u>	<u>19.3</u>
Total	27	268.6





Economic Impact of Grid Outages

- **1998 Ice Storm: \$5.5 Billion**
- **2003 Blackout: \$10 Billion**
- **Hurricane Sandy: \$70 Billion**
- **Hurricane Katrina: \$40 Billion**

CHP offers the opportunity to keep critical facilities running when the grid is impaired, enabling:

- **Continuity of Service**
- **Community Sustainability**
- **Disaster Preparedness**





CHP Design for Reliability

- **CHP systems designed for reliability will incur additional costs on the order of 10% of installation costs (\$45 - \$170/kW depending on complexity of system)**
- **These additional costs however provide important reliability benefits to the site, and to the community at large**



Uninterrupted Operation Requirements

- **Black start capability**
 - Allows the system to start up independently from the grid
- **Generators capable of grid-independent operation**
 - The system must be able to operate without the grid power signal
- **Ample carrying capacity**
 - System size must match critical loads
- **Parallel utility interconnection and switchgear controls**
 - The system must be able to disconnect from the grid, support critical loads, and reconnect after an event





CHP Implementation Guidelines

- **Preliminary (pre-feasibility) engineering study (up to \$10,000 in OPA funding available)**
- **Detailed engineering study (up to \$50,000 in OPA funding available)**
- **Connection Impact Assessment**
- **Project implementation**
 - **PSUI incentive payment (up to 40% of project costs funded by OPA)**
- **Measurement and Verification**



Preliminary Engineering Study

- **The purpose is to screen the facility to determine suitability for CHP**
- **Usually involves a walkthrough audit of the facility to review thermal loads**
- **Use of custom engineering calculations or a tool such as RETScreen to evaluate system size, lifecycle costs, and thermal and electrical cost savings**
- **Financial analysis determines whether or not proceed with a detailed engineering study**





Detailed Engineering Study

- **The purpose is to refine the results of the preliminary engineering study to identify the optimal CHP system configuration and sizing, and estimate final CHP system cost**
- **Involves a more detailed assessment of the thermal loads to determine thermal power requirements for individual systems such as laundry and DHW**
- **Outcomes include detailed cost and revenue estimates, equipment selection, and single line diagrams**





Project Implementation

- The detailed engineering study will provide sufficient information for the project to go to tender
- A contractor with specialized expertise in CHP projects will install and commission the plant
- The contractor should also ensure that the CHP plant is correctly integrated into the hospital's thermal and electrical systems, and adequately isolated from the grid





Measurement and Verification

- The purpose of measurement and verification is to ensure that the CHP plant is generating the expected thermal and electrical energy
- M&V data from the first year of operation will be required to support the incentive claim
- M&V should be a continuous process to allow for sub-optimal performance of the plant to be identified and remedied
- Costs and specifications for M&V equipment should be included early in project development





Conclusions

- **CHP is a commercially available technology with demonstrated financial and reliability benefits for the hospital sector in Ontario**
- **The use of CHP in hospitals is likely to grow, driven by:**
 - **A favourable price outlook**
 - **The increasing value of energy reliability**
 - **Available financial incentives**
- **Reliability benefits should be an integral part of the CHP business case for Ontario hospitals**



Questions?

