Benefits of Tri-generation for District Energy Systems, University Campuses & Data-Centers - Case Studies
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Dalia El Tawy, Thermal Power Solutions Director, Siemens Energy
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Agenda

- Tri-generation or Combined Cooling, Heat and Power (CCHP)
  - Overview
  - Technology options – prime movers and chillers
- Tri-generation examples
  - Case studies – different applications and technologies
- Cogeneration and tri-generation existing capacity and potential opportunities
- Q & A
Tri-generation overview

Source: International Journal of Low-Carbon Technologies

Source: U.S. EPA – Combined Heat and Power Partnership
Tri-generation overview
Absorption chiller for CHP systems

**Source:** U.S. DOE – Combined Heat and Power Technology, Fact sheet series
Examples & Case-studies

Tri-generation

Applications & Technologies
University of New Hampshire CHP
Tri-generation landfill gas-to-energy project

- Student population: over 15,000
- Tri-generation: heating, cooling, & electrical power
- Up to 7.8 MW(e) electrical power output and up to 12MW of heating and cooling
- Unit continuous operation 8,500 hrs/yr
- Overall system efficiency of 77%
- Tri-fuel operation: natural gas, processed land-fill gas, & liquid fuel

ECOLine landfill pipeline to UNH campus Source: UNH website
Siemens SGT-300 gas turbine installed at the UNH Cogen plant
Riverbay Co-op City
Tri-generation plant in The Bronx, NY

- 60,000 residents at the Riverbay co-op development
- Development includes 14,000 apartments, 35 high-rises, 7 clusters of townhouses, 8 parking garages, 3 shopping centers, 1 high school, 2 middle schools and 3 elementary schools
- Tri-generation: electricity, heating, & cooling
- 40 MW natural gas-fired combined cycle CHP plant, installed in 2011
- Co-op City only needs 24 MW of power at peak usage periods. Extra capacity can be sold to the local electric utility providing an additional income stream
- Steam generated by the exhaust heat is also used to provide heat in the winter and cooling via absorption chillers in the summer (200,000 lbs per hour of steam)

“We decided to invest in an onsite cogeneration plant because we wanted to save money by producing our own electricity and capturing the waste heat to provide our residents with hot water and space cooling,” said Herb Freedman, a principal of Marion Real Estate, Inc., which manages Co-op City for the Riverbay Corporation.
Rya CHP – District heating & cooling plant
Tri-generation in Gothenburg, Sweden

The Rya combined-cycle district heating/district cooling plant in Gothenburg, Sweden, is powered by three SGT-800 gas turbines and one SST-900 steam turbine.

- 30% of the city’s electrical power (265 MW) is provided by the Rya combined cycle plant
- The plant also provides 35% of district heating for the city (295 MW) at an overall plant efficiency of 94%
- In the center of Gothenburg, a large-scale district cooling system (100 MW) is installed. It is partly driven by the district heating system via absorption chillers, partly by river water during the winter and by electrical chillers during summer peaks
Grand Hotel VIDGOF CHP
Power, heating, and cooling in Chelyabinsk, Russia

- The Grand Hotel VIDGOF, is a 20-story, five-star hotel in Chelyabinsk, Russia
- The five star hotel has 35,700 square meters of floor space
- The multi-level power plant acts as the energy center of the complex
- The four level plant houses the reciprocating engines and control room on the ground level (3.78 MW), two water boilers and a heat recovery system on the second level, and water treatment, pumping and cooling systems on the third level. The roof houses a compression cooling system and horizontal cooler units.
- The exhaust recovery system provides air conditioning - central air and central system ventilation
The Centre provides studio, production, and office facilities for its operations in the UK and abroad.

A continual demand for heating and electrical power from the offices, post production areas, computer suites, and studio lighting all contribute to a large electrical load and a need for standby power in case of main failures as well as a substantial chilling requirement to prevent the overheating of electronic equipment.

The gas turbine based CHP plant provides the BBC with an environmentally sensitive means of gaining substantial energy cost savings. A Heat Recovery Steam Generator provides the main source of steam, meeting the site’s heating, cooling and hot water needs. Steam is also used as a source of energy for absorption chilling. (4.9 MW electric power and 11,000 kg per hour of steam)
Cogeneration & Tri-generation

Existing capacity & potential opportunity in commercial applications and institutions in the US
Cogeneration and tri-generation
Commercial/institutional installations in the US

Existing CHP Capacity (MW)
- Refining: 19%
- Paper: 14%
- Metals: 5%
- Food: 8%
- Other Manufacturing: 6%
- Other Industrial: 6%
- Chemicals: 28%
- Commercial/Institutional: 14%

Existing Commercial CHP Sites by Business Type (2,567 sites)
- Healthcare: 368 Sites
- Wastewater and Solid Waste Facilities: 295 Sites
- Multifamily Buildings: 283 Sites
- Colleges/Univ.: 272 Sites
- Hotels and Recreation: 265 Sites
- K-12 Schools: 253 Sites
- Government/Military: 181 Sites
- Commercial (Office) Buildings: 134 Sites
- Utilities: 127 Sites
- District Energy: 49 Sites
- Other, 340 Sites

Source: DOE CHP Installation Database (U.S. installations as of December 31, 2014)
Cogeneration and tri-generation
Opportunity in the US

75+ GW Technical Potential of On-site Commercial & Institutional CHP

Source: DOE CHP Deployment Program, 2016
CHP/CCHP – the anchor of the microgrid
Summary

- Tri-generation offers cost effective and environmental friendly solutions in different applications based on proven technologies.

- Tri-generation has been successfully implemented in several district energy plants, university campuses, and data-centers in the US and globally.

- A significant opportunity for deploying cogeneration and tri-generation in the commercial applications still exists. CHP/CCHP is the anchor of the micro-grid and integration with renewable power sources.
Questions?

Dalia El Tawy
Director, Thermal Power Solutions
Distributed Energy Systems
Siemens Energy
Orlando, Florida, USA

Phone: (407) 920-6179
E-mail: dalia.el_tawy@siemens.com