

# Distributed Combined Heat and Power in the APEC Region: Examples and Potential

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# Presentation Overview

- ▶ Introduction to the Pacific Northwest National Laboratory
- ▶ Realizing the potential of combined heat and power
- ▶ Examples of combined heat and power (CHP) across the APEC region
- ▶ Smart grid as a driver for distributed combined heat and power



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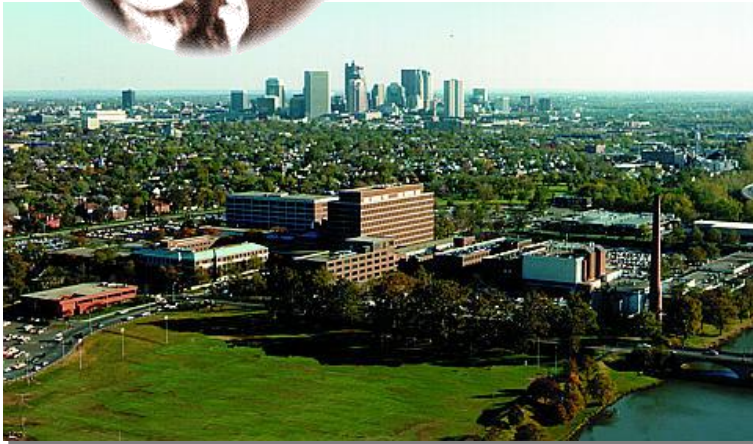
# PNNL is operated for DOE by Battelle



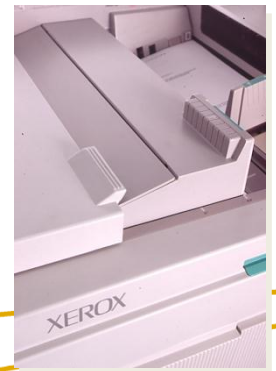
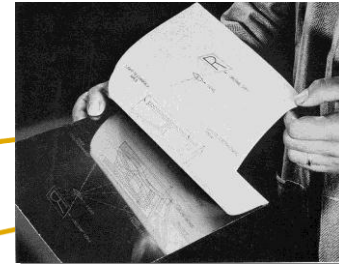
- ▶ Founded in 1925 as a charitable trust through the Will of Gordon Battelle
- ▶ Ohio industrialist; believed research could make American industry more competitive

## ▶ Core Purpose

Translate scientific  
discovery into innovative  
applications



*Battelle headquarters  
Columbus, OH*



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# PNNL's Mission & Business Facts

Mission: Perform basic and applied research in support of energy, environmental, and national security for our nation.



▶ ~\$1.1 billion  
business volume

▶ ~4,700 staff

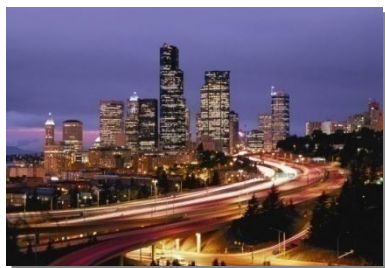


  
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# Increase U.S. energy capacity and reduce dependence on imported oil

*PNNL will provide science, technologies and leadership to:*



Transitioning to a renewable, nuclear, and hydrogen energy base while reducing dependence on imported oil. . .

- ▶ **Energy Efficiency & Renewable Energy (EERE)**
  - Increase the efficiency of powering vehicles and buildings; and improve economic viability of biofuels
- ▶ **Clean Fossil Energy**
  - Enable economically and environmentally sustainable “air and water” neutral hydrocarbon conversion, carbon capture and sequestration
- ▶ **Electric Infrastructure**
  - Improve grid reliability and productivity
- ▶ **Nuclear Energy**
  - Enable expansion of nuclear energy through a viable closed nuclear fuel cycle



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# Combined heat and power potential is derived from savings in electricity generation and transmission

## ▶ Electric Power Generation

- Thermal power plants discard up to 70% of their energy input as waste heat
- Large power plants are usually located large distances from demand centers for their waste heat



## ▶ Electric Power Transmission

- Energy is always lost in electric power transmission
- Transmission lines are expensive and becoming difficult to site



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# Combined heat and power saving opportunities exist across all major end use sectors

- ▶ The industrial sector was the first to adopt CHP solutions
- ▶ The commercial sector utilizes CHP at the building level
- ▶ CHP options are available for the residential sector at both the building and appliance level



# Combined head and power systems have multiple drivers

- ▶ Increased overall energy efficiency
- ▶ Reduction in overall operating expenses
- ▶ Increased reliability
- ▶ Increased energy security at both the local and national levels
- ▶ Emission reductions
- ▶ Mitigation of future carbon cost impacts



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# CHP Energy and Savings Potential\*

Category	10 MW CHP	10 MW PV	10 MW Wind	Combined Cycle (10 MW Portion)
Annual Capacity Factor	85%	22%	34%	70%
Annual Electricity	74,446 MWh	19,272 MWh	29,784 MWh	61,320 MWh
Annual Useful Heat	103,417 MWh <sub>t</sub>	None	None	None
Footprint Required	6,000 sq ft	1,740,000 sq ft	76,000 sq ft	N/A
Capital Cost	\$20 million	\$60.5 million	\$24.4 million	\$10 million
Annual Energy Savings	308,100 MMBtu	196,462 MMBtu	303,623 MMBtu	154,649 MMBtu
Annual CO <sub>2</sub> Savings	42,751 Tons	17,887 Tons	27,644 Tons	28,172 Tons
Annual NO <sub>x</sub> Savings	59.4 Tons	16.2 Tons	24.9 Tons	39.3 Tons

\*Combined Heat and Power: A Clean Energy Solution, August 2012, U.S. DOE, U.S. EPA  
<http://www1.eere.energy.gov/manufacturing/distributedenergy/>

# CHP in the industrial sector

- ▶ China Steel Corporation (CSC) in Kaohsiung, Chinese Taipei
  - CSC is largest integrated **steel** maker in the Chinese Taipei
  - The CSC Kaohsiung plant provides 2/3 of its electricity through cogeneration and sells surplus steam to its industrial neighbors
  - Steam sales provided \$NT600 million in 2006



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# CHP in the commercial sector

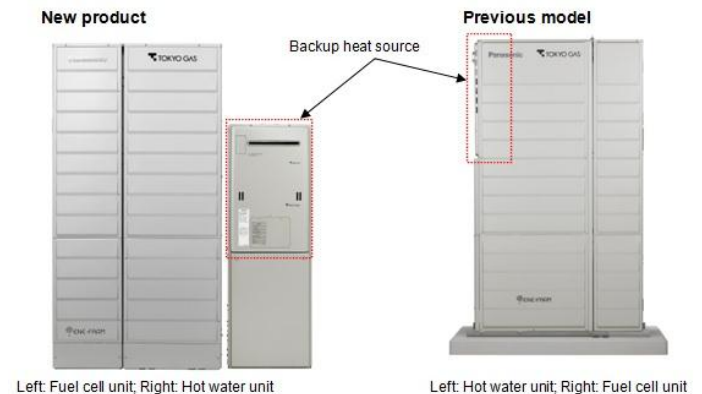
## ▶ CHP plant at Royal North Shore Hospital, Sydney, Australia

- 4 MW gas fired CHP unit
- Heat exchanges to supply hospital's hot water needs
- Includes 4 MW standby diesel power
- Estimated CHP efficiency of 85%
- Operating 6500 hours/year (74% capacity factor)



# CHP in the residential sector-Japan

- ▶ Fuel Cell hydrogen CHP demonstration in Japan (ENE-Farm)
  - The PEMFC units are sized at about 1 KW electric and 1 KW thermal capacity
  - More than 20,000 units have been installed
  - The capital cost is about ¥1 million
  - Up to 95% total efficiency (LHV)



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# Both technical and regulatory barriers remain to increased CHP deployment\*

- ▶ Unclear Utility Value Proposition
- ▶ Limited CHP Supply Infrastructure
- ▶ Market and Non-Market Uncertainties
- ▶ End-User Awareness and Economic Decision-Making
- ▶ Local Permitting and Siting Issues

\*Combined Heat and Power: A Clean Energy Solution, August 2012, U.S. DOE, U.S. EPA  
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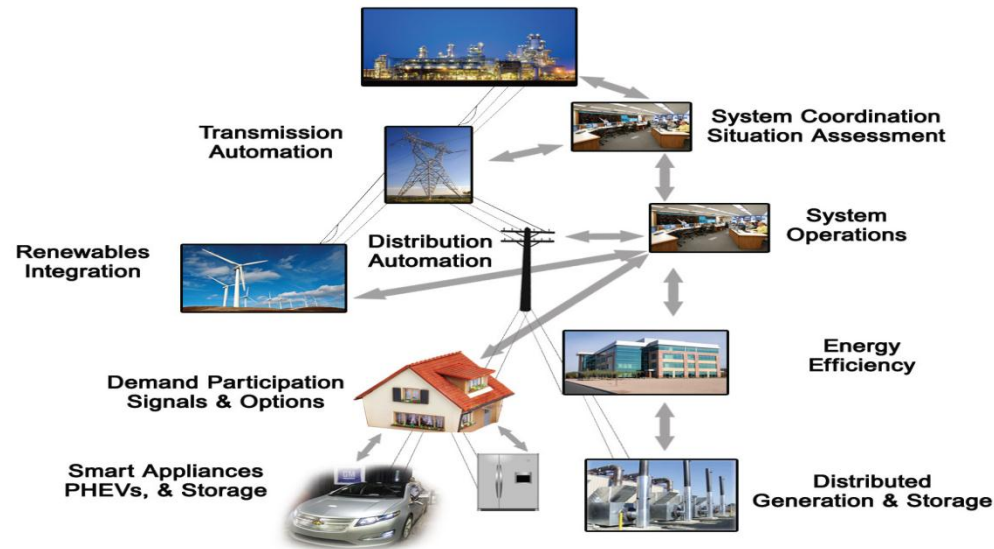
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# The Smart Grid can be a key enabling technology for distributed combined heat and power across all end use sectors

- ▶ The smart grid enables CHP units to obtain the maximum value for their power generation
- ▶ The smart grid enables CHP units to provide power back to the grid during emergency situations
- ▶ The smart grid provides accountability
- ▶ The smart grid allows consumers to fully understand the impact of their energy choices and understand the value of distributed energy systems



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**Thank you for your attention!**

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