Emerging Technologies: Residential Cogeneration

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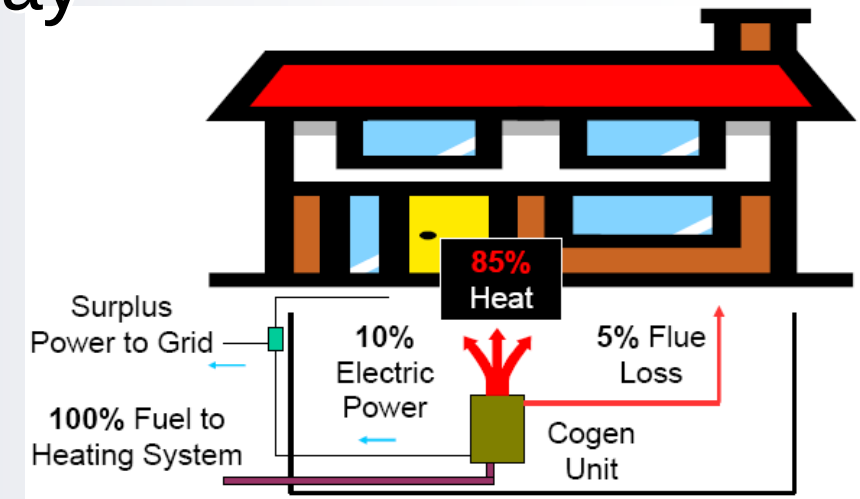
Presentation Goals

- Around the world with residential cogen
- Introduction of analysis tool
- Initial results
- Conclusions

Why Evaluate Residential Cogeneration?

- New technologies
- Changes to energy markets
- Regulatory changes
- Installations underway



Source: ECR International

Japan: Honda IC Engine

Unit Type: IC Generator/Hot water/Radiant Floor

- Status of market
  - 25,000 currently operating in Japan
- Efficiencies:
  - Thermal Efficiency: 65%
  - Electrical efficiency: 20%
  - Combined: 85%
  - Electrical Output: 1kW
- Cost in Japan: $ 7,500

Source: Honda

Japan: Tokyo Gas Fuel Cell

Unit Type: Fuel Cell Generator/Hot Water

- Market Status
  - Plans to test/own/maintain 200 units
- Efficiencies:
  - Thermal Efficiency: 45%
  - Electrical Efficiency: 33%
  - Combined: 78%
  - Electrical Output: 1kW
- Cost in Japan: $8,500

Yokohama city,
a stand-alone house


Saitama city,
a stand-alone house

Source: Tokyo-Gas

England: PowerGen / WhisperGen

Unit Type: IC/Stirling Engine Generator and Boiler

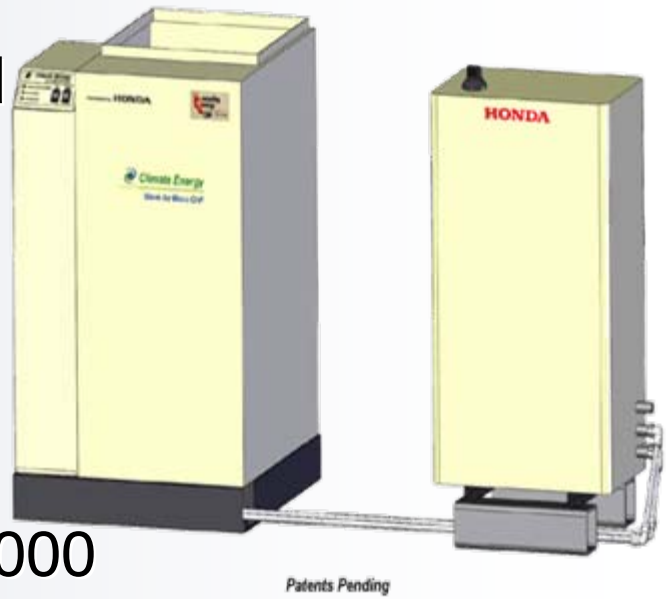
- Market Status
  - Commercial sales since 2005
- Efficiencies:
  - Thermal Efficiency: 70-80%
  - Electrical Efficiency: 10-20%
  - Combined: 90%
  - Electrical Output: 1 – 1.2kW
- Estimated Cost: $5,500

Source: WhisperTec

Massachusetts: Climate Energy Cogen Unit

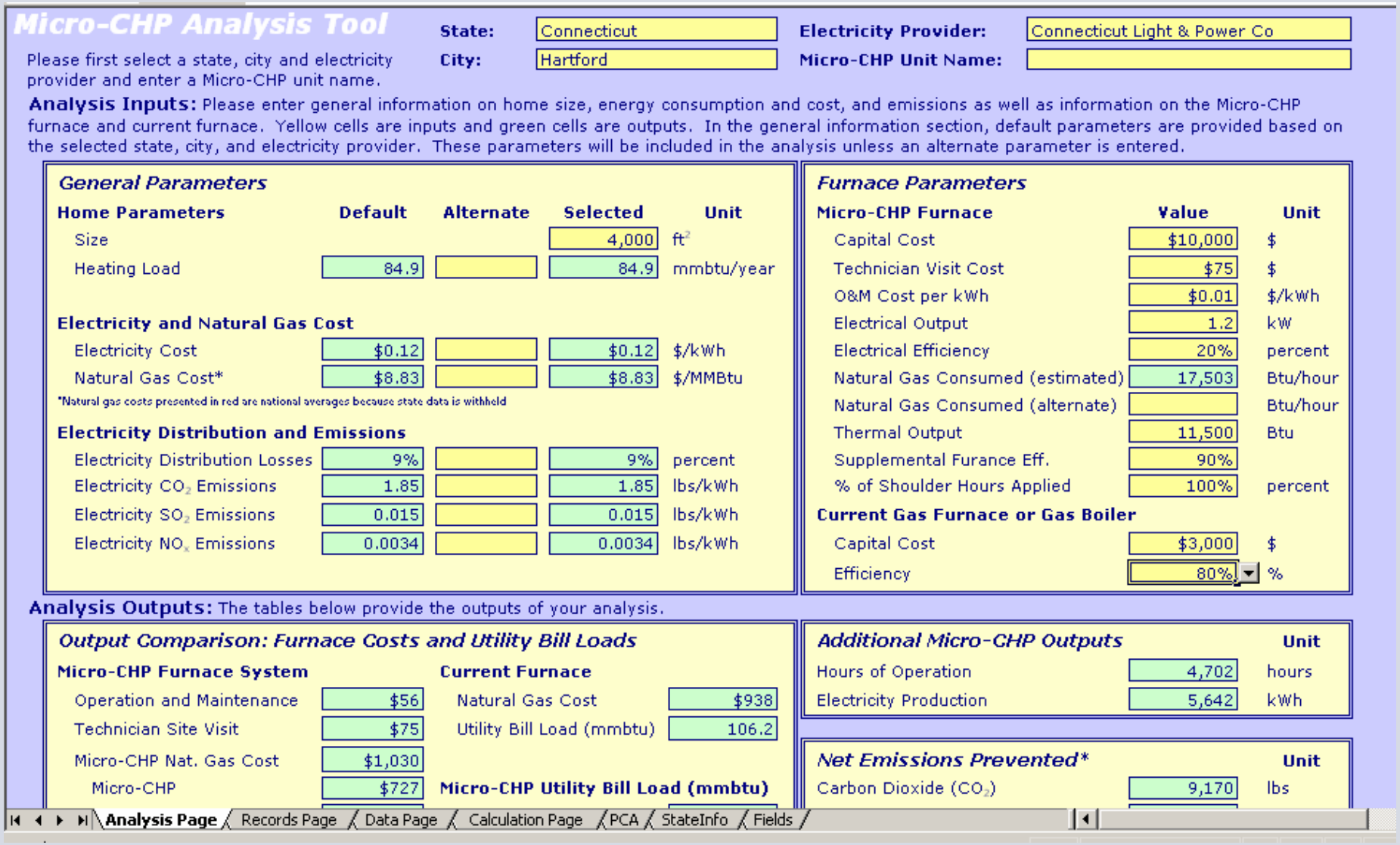
Unit Type: IC Engine/Hot Air System (Replaces furnace)

- Market Status
  - Testing 25 units in household
- Efficiencies
  - Thermal Efficiency: 65%
  - Electrical Efficiency: 20%
  - Combined: 85%
  - Electrical Output: 1.2 kW
- Estimated Cost: $10,000 - $12,000



Source: Climate-Energy

EPA's Micro-CHP Model



Micro-CHP Analysis Tool

Please first select a state, city and electricity provider and enter a Micro-CHP unit name.

State:	Connecticut	**Electricity Provider:**	Connecticut Light & Power Co
City:	Hartford	**Micro-CHP Unit Name:**	

Analysis Inputs: Please enter general information on home size, energy consumption and cost, and emissions as well as information on the Micro-CHP furnace and current furnace. Yellow cells are inputs and green cells are outputs. In the general information section, default parameters are provided based on the selected state, city, and electricity provider. These parameters will be included in the analysis unless an alternate parameter is entered.

General Parameters

Home Parameters	Default	Alternate	Selected	Unit
Size			4,000	ft^2
Heating Load	84.9		84.9	mmbtu/year
Electricity and Natural Gas Cost				
Electricity Cost	$0.12		$0.12	$/kWh
Natural Gas Cost*	$8.83		$8.83	$/MMBtu
Electricity Distribution and Emissions				
Electricity Distribution Losses	9%		9%	percent
Electricity CO_2 Emissions	1.85		1.85	lbs/kWh
Electricity SO_2 Emissions	0.015		0.015	lbs/kWh
Electricity NO_x Emissions	0.0034		0.0034	lbs/kWh

*Natural gas costs presented in red are national averages because state data is withheld

Furnace Parameters

Micro-CHP Furnace	Value	Unit
Capital Cost	$10,000	$
Technician Visit Cost	$75	$
O&M Cost per kWh	$0.01	$/kWh
Electrical Output	1.2	kW
Electrical Efficiency	20%	percent
Natural Gas Consumed (estimated)	17,503	Btu/hour
Natural Gas Consumed (alternate)		Btu/hour
Thermal Output	11,500	Btu
Supplemental Furance Eff.	90%	
% of Shoulder Hours Applied	100%	percent
Current Gas Furnace or Gas Boiler		
Capital Cost	$3,000	$
Efficiency	80%	%

Analysis Outputs: The tables below provide the outputs of your analysis.

Output Comparison: Furnace Costs and Utility Bill Loads

Micro-CHP Furnace System		Current Furnace	
Operation and Maintenance	$56	Natural Gas Cost	$938
Technician Site Visit	$75	Utility Bill Load (mmbtu)	106.2
Micro-CHP Nat. Gas Cost	$1,030		
Micro-CHP	$727	**Micro-CHP Utility Bill Load (mmbtu)**	

Additional Micro-CHP Outputs

		Unit
Hours of Operation	4,702	hours
Electricity Production	5,642	kWh

Net Emissions Prevented*

		Unit
Carbon Dioxide (CO_2)	9,170	lbs

Analysis Page | Records Page | Data Page | Calculation Page | PCA | StateInfo | Fields

Hartford, CT Results

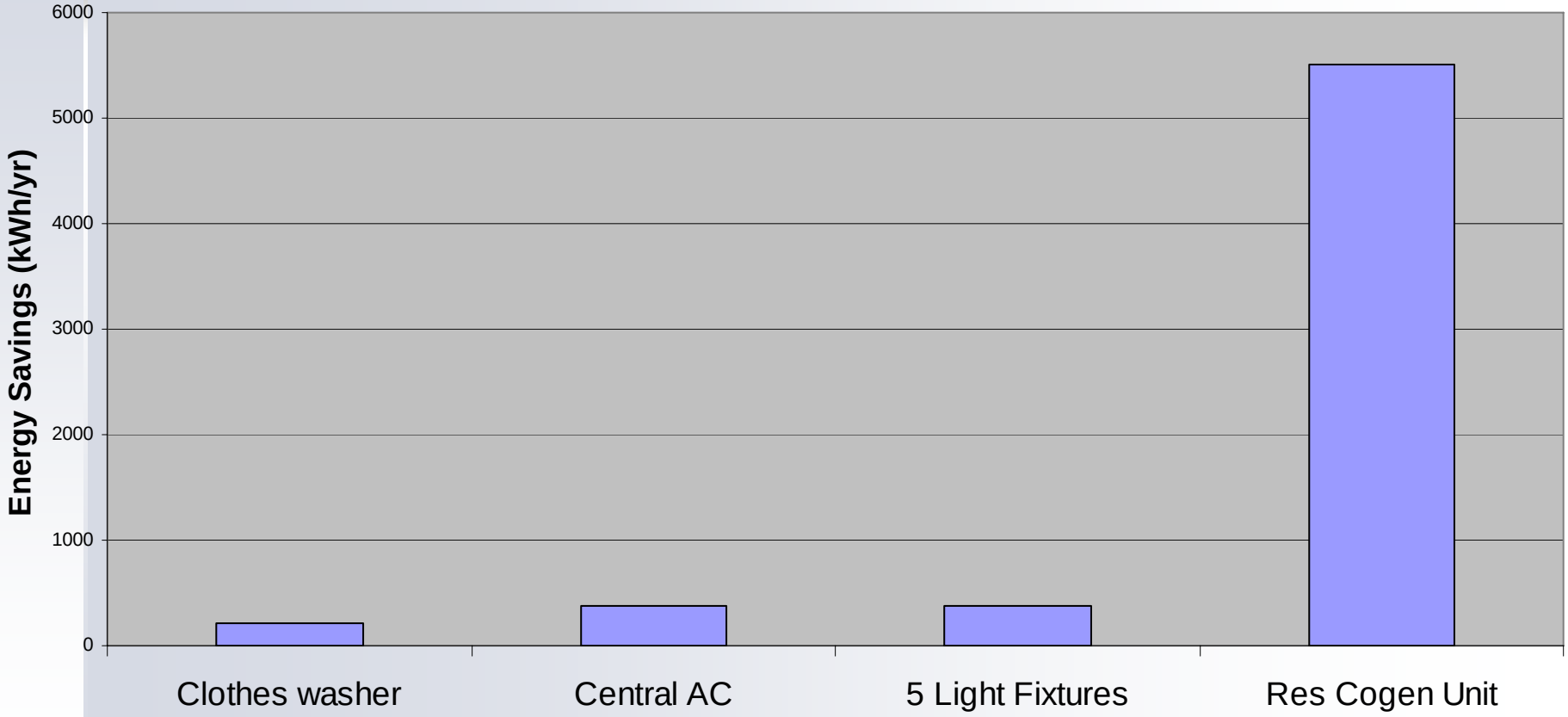
- Reduction in electricity: 5,501 kWh/year
- Reduction in electric bill: $836/yr
- Increase in gas consumption: $91 (10%)
- Total unit savings: $745
- Emissions reduction:
  - 38% CO2
  - 94% NOx
  - 99.9% SO2

Summer Peak Comparison

- Summertime Demand Response operation
- Emission Comparison vs. Peaking Power Plants

Fuel Type Generator	Oil	Natural Gas CT w/ H2O NOx
NOx	92 % Decrease	86% Decrease
CO2	13% Decrease	17% Increase
SO2	99% Decrease	same

Savings Comparison: ENERGY STAR vs. Cogen



Cost Effectiveness?

- Key drivers for cost effectiveness:
  - High local electric rates
  - Go North: Higher HDD = More run time
  - Capital cost of unit
  - Net metering legislation state

Closing Thoughts

- Big players in the game
- 1kW – international consensus size
- Significant electric savings
- CT/Japan: environmental savings
- Motors are cheaper than fuel cells, but, *remember the Prius!*

Thank You!

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