NARUC

Summer Committee Meetings

Staff Subcommittees on Electricity, Gas, Energy Resources and the Environment, & Electric Reliability

Subcommittee Chairs

Kim Jones – Electricity

Pat Poli – Electric Reliability

Andreas Thanos – Gas

Karen Olesky – Energy Resources & the Environment

NARUC

Summer Committee Meetings

How to Heat a Home?

HOW TO HEAT A HOME

JULY 2016

LENNAR

1. ERI Path
2. Affordability
3. New Homes
4. Fuel and Technology
5. New Technologies
6. Advantages of Solar
7. 2015 International Energy Conservation Code

2015 **IECC – ENERGY RATING INDEX**

- Energy Rating Index measures total energy consumption (like miles per gallon for a car)
- Score from 100-0, and 100 is a home built under the 2006 IECC
- 2009 IECC backstop for envelope and is 15-20% more energy efficient than 2006 IECC
- No difference in code for multi-family versus low-rise residential
- All new homes are required to bring in air from outside by current code due to efficiency mandates requiring a tighter envelope, because tighter envelop
- Adopted by Alabama, Denver (Colorado), Illinois, Maryland, Michigan, New Jersey, New York, Texas, Utah, Vermont, Washington and Florida in process now

AFFORDABILITY – NATIONAL HOMEBUILDERS ASSOCIATION

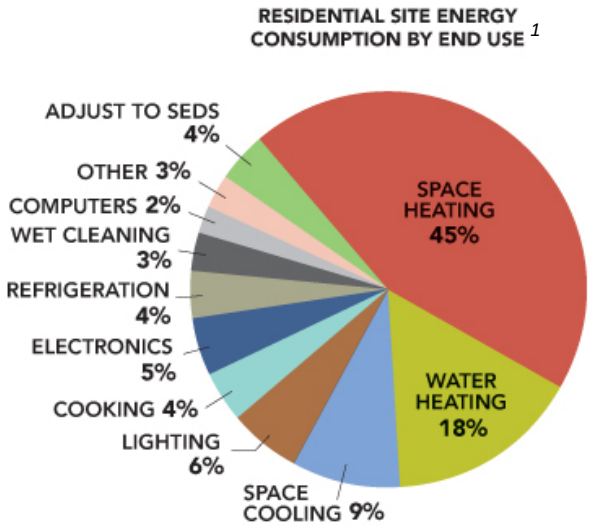
- Energy Code regulations have increased cost of home by ~$7,000 in the last three code cycles
- Increase homes by $1,000, then an immediate 206,000 potential home owners are priced out (see link below)
- Conversely, if reduce the cost of a home by $1,000 then 206,000 potential home owners can now afford a new home
- http://www.nahb.org/en/news-and-publications/Press-Releases/2014/august/1000-dollar-increase-in-home-prices-keeps-more-than-200000-households-out-of-the-market.aspx
- Homebuilders constantly looking for flexibility to meet these regulations and in the most cost-effective manner

Historically, space heating was 60-65% of a home's total energy consumption, but today it is below 50%

Plug-loads are consistently making up a higher percentage of the overall consumption, and eroding energy efficiency measures

95% of new homes are heated using natural gas, however, other technologies include heat pumps, electric heaters and fuel

A/C for space cooling, with natural gas for space heating is still the preferred, more economical package except in very hot climates



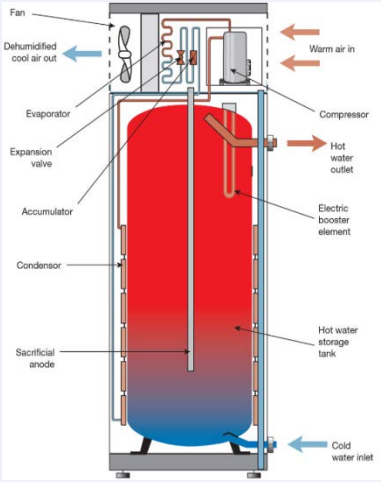
1. Source: Buildings Energy Data Book – U.S. Department of Energy

FUEL AND **TECHNOLOGY**

NATURAL GAS	• Most efficient heating source; burned at consumption point • Newer furnaces are ~96% efficient • Ideal for location where heating demand is high • New furnaces are power vented, reducing risks associated with chimneys
HEAT PUMPS	• Work just like an air conditioner (bring in outside air) • Cold coil becomes a hot coil • Becoming much more efficient • Outside temperature affects a heat pump's efficiency
ELECTRIC HEATING	• Ideal for locations where heating demand is low like Florida • Coupled with solar technology in Orlando, FL (first of its kind)

NEW **TECHNOLOGIES**

HYBRID HEAT-PUMP WATER HEATERS

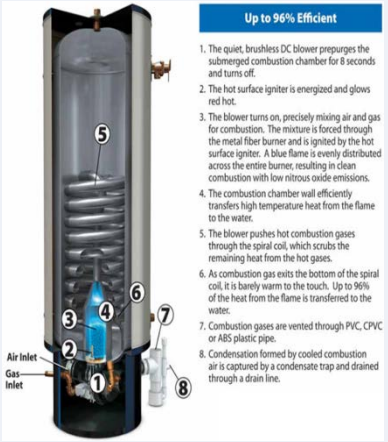


Price Range: ~$1,000
Most Efficient by 3X
Goal: Couple with Solar

TANKLESS GAS HEATERS

Price Range: ~$600
Tank Water Heater $300

HIGH EFFICIENY GAS AND WATER TANKS



Price Range: Too Expensive
Dual App: Space and Water Heating

SUNSTREET™

- *Purchase or Lease for 20 years*
- *Typical System 4-5kW*
- *Produces up to 60% of the home's electricity*
- *AO Smith Voltex 50-gallon hybrid electric water heater*
- *First program of its kind in Florida*

Conclusion

- 2015 IECC allows for a more options and more market-based compliance path under the “alternate compliance path” – leverages solar and efficient HVACs
- Direct use of natural gas seen as most efficient and economical
- At least 1/3 of New homes are 35%-40% of more energy efficient than in 2006 (RESNET Data)
- ERI is good policy because it doesn’t tie us to one compliance path; allows us to use most cutting edge technologies which rewards innovation

CONTACT INFO

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Residential Heating Systems

Rafi Sohail

Director, Regional Sales and Technical Support

NARUC – July 24, 2016

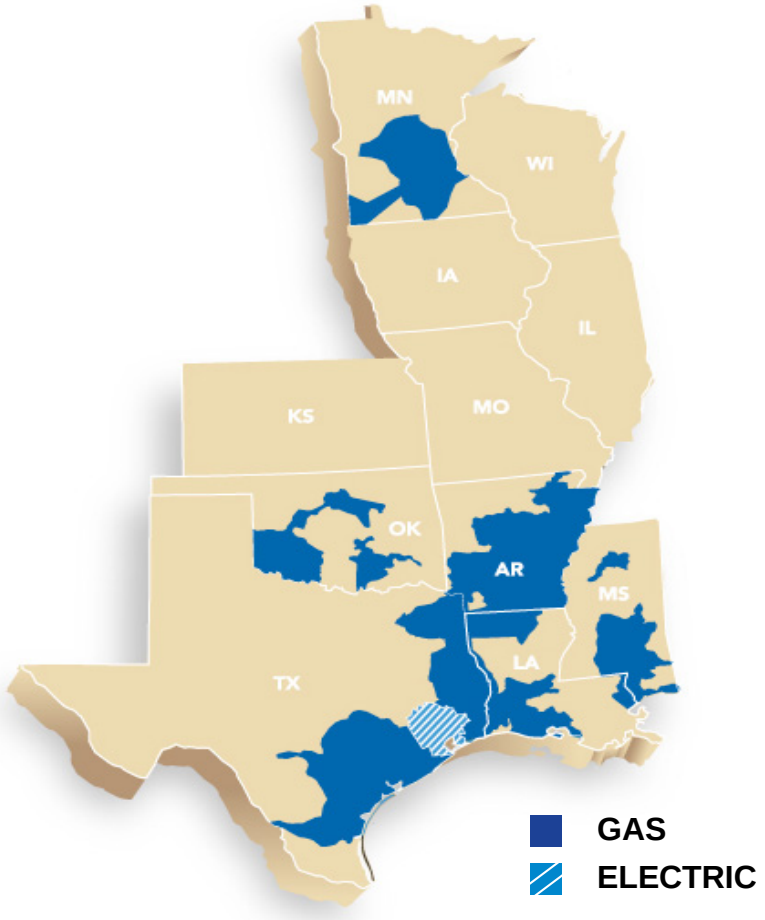
Contact:

Phone: 612-321-4779

Email: Rafi.Sohail@CenterPointEnergy.com

About CenterPoint Energy (CNP)

- Nation's top tier publicly traded natural gas and electric delivery company.
- 3.4 million natural gas utility customers in six states: AR, LA OK, MN, MS, and TX.
  - Natural Gas energy efficiency program in four states: AR, MN, MS, and OK
- 2.3 million electric utility customers in Houston area and offers electric energy efficiency programs.



Residential Heating Systems Selection Criteria

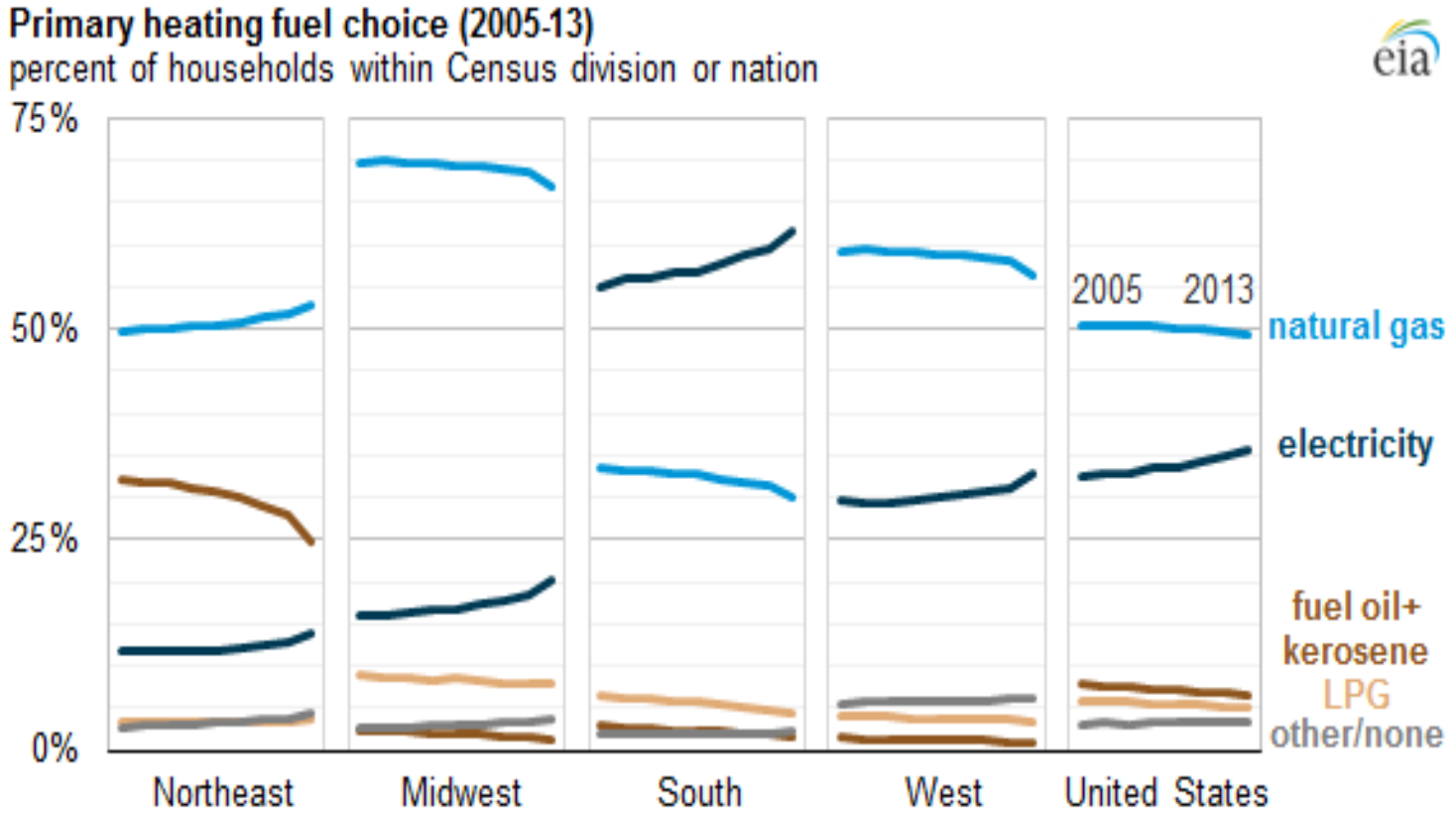
- Reliability of the system to operate when needed
- Durability of the system to last longer
- Minimum maintenance requirements
- Equipment and installation costs
- Operating costs savings
- Efficiency
- Environmental Benefits – low emissions

Residential Heating Systems
Natural Gas Technology Solutions

Residential – Single Family and Multi-family Options:

- Furnace/Boiler: Non-Condensing (~ 80% AFUE)
- Furnace/Boiler: Condensing (≥ 90% AFUE)
- Packaged HVACs
- Compact Furnaces and Boilers
- Combined Space and Water Heating

Residential Heating Systems
Natural Gas for Heating



Source: U.S. Energy Information Administration - DOE, based on CBACS, September 2014

Residential Heating Systems
Single-family Space Heating

- Single family (new construction) gas space heating market share compared to electric heating (CNP territory):
  - North: ≥ 98%
  - South: ≤ 60%

- Single family - types of gas heating systems:
  - North: Almost all are condensing (HE) furnaces
  - South: ≥ 90% are non-condensing (standard) furnaces.

Residential Heating Systems
Multi-family Space Heating

- Multi-family (new construction) gas space heating market share compared to electric heating (CNP territory):
  - North: ≥ 95%
  - South: ≤ 10%

- Multi-family - types of gas heating systems:
  - North: 80% are non-condensing packaged or small furnaces; 20% are centralized boilers.
  - South: 99% are non-condensing packaged or small furnaces.

Residential Heating System Equipment and Install Cost

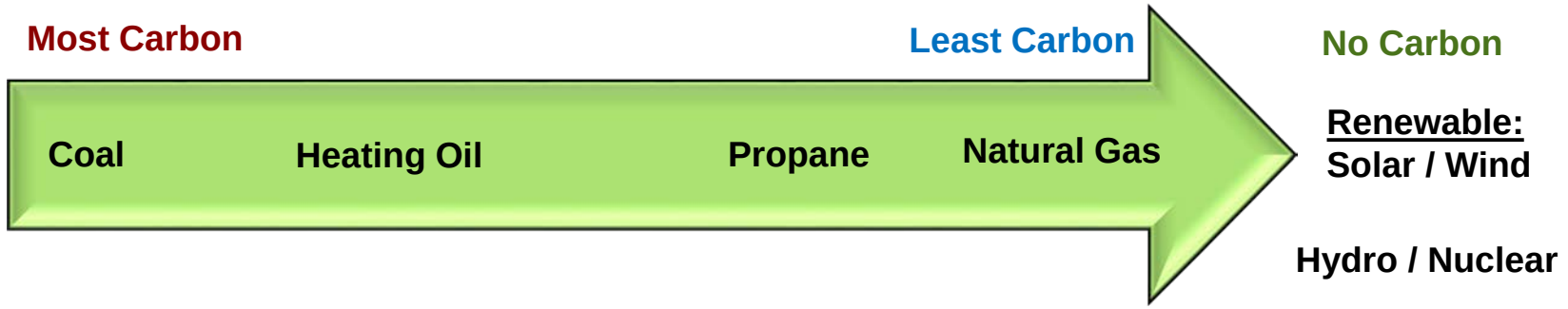
	Natural Gas Non-Condensing Furnace	Natural Gas Condensing (HE) Furnace	Electric Air Source Heat Pump	Electric Resistance Heater
Efficiency	80% AFUE	92% AFUE	8.5 HSPF	98% AFUE
MMBtu output heat requirement	30	30	30	30
Annual Operating Costs	$472	$411	$588	$1,142
First Cost	$1000 to $2,500	> $600 Incremental Cost to non-condensing Furnace	Comparable to gas furnace	Cheaper than gas furnace
Environmental – CO2 Emissions - Metric Ton / Yr.	2.0	1.7	2.6	5.0

Source: U.S. Average Residential Gas and Electricity in 2015 per EIA-DOE. Assuming Zone 4 single family home.
CO2 Emissions based on eGRID and AP 42 Report per EIA - DOE

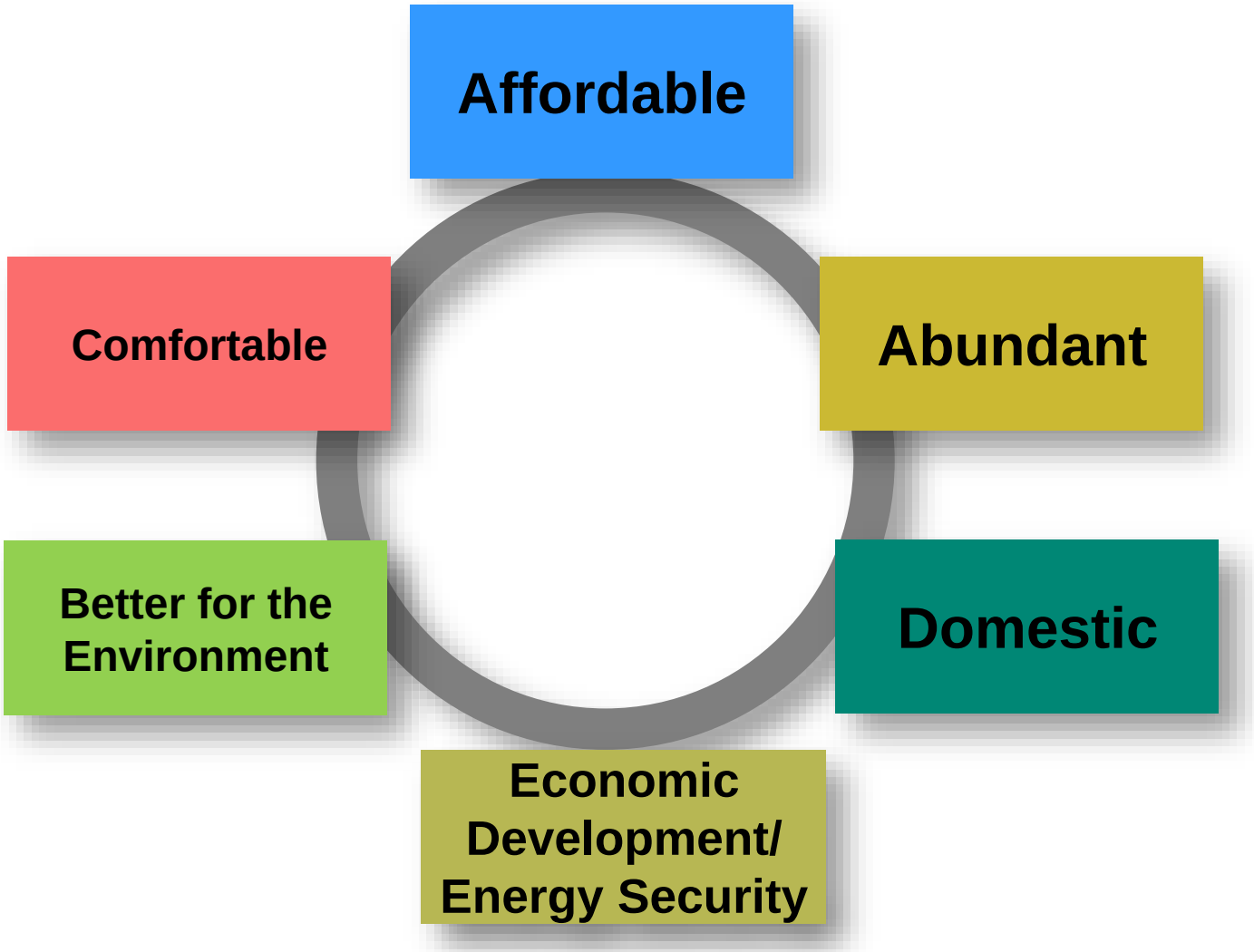
Environmental Impact

Carbon Footprint: A measurement of Greenhouse Gases (GHG) produced through the direct or indirect consumption of fossil fuels

Measured in lbs or metric tons of **CO_2** equivalent.



Residential Heating Systems
Natural Gas as Heating Option



How to Heat a Home?
NARUC - 2016

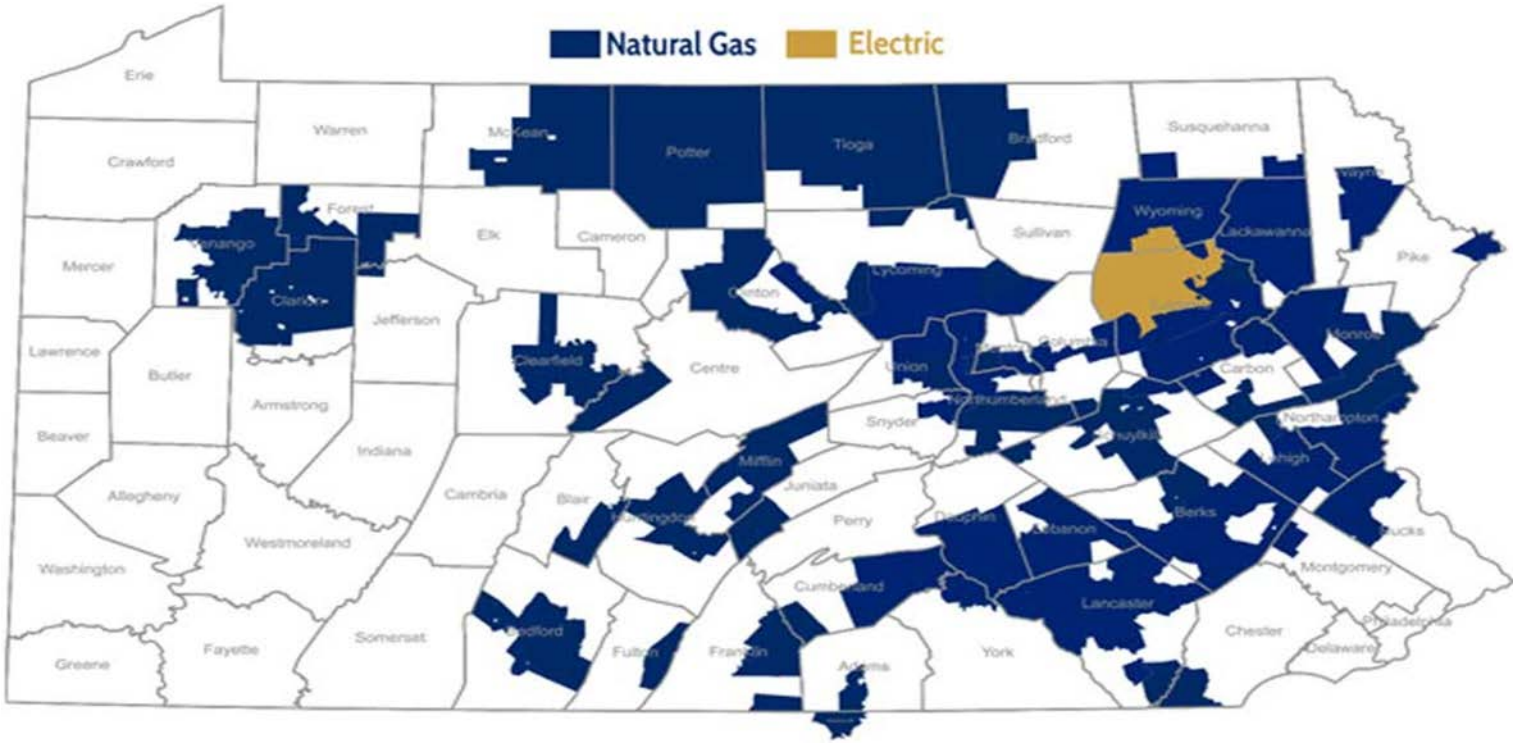
Bob Stoyko

Vice President Marketing & Customer Relations

UGI Utilities, Inc.

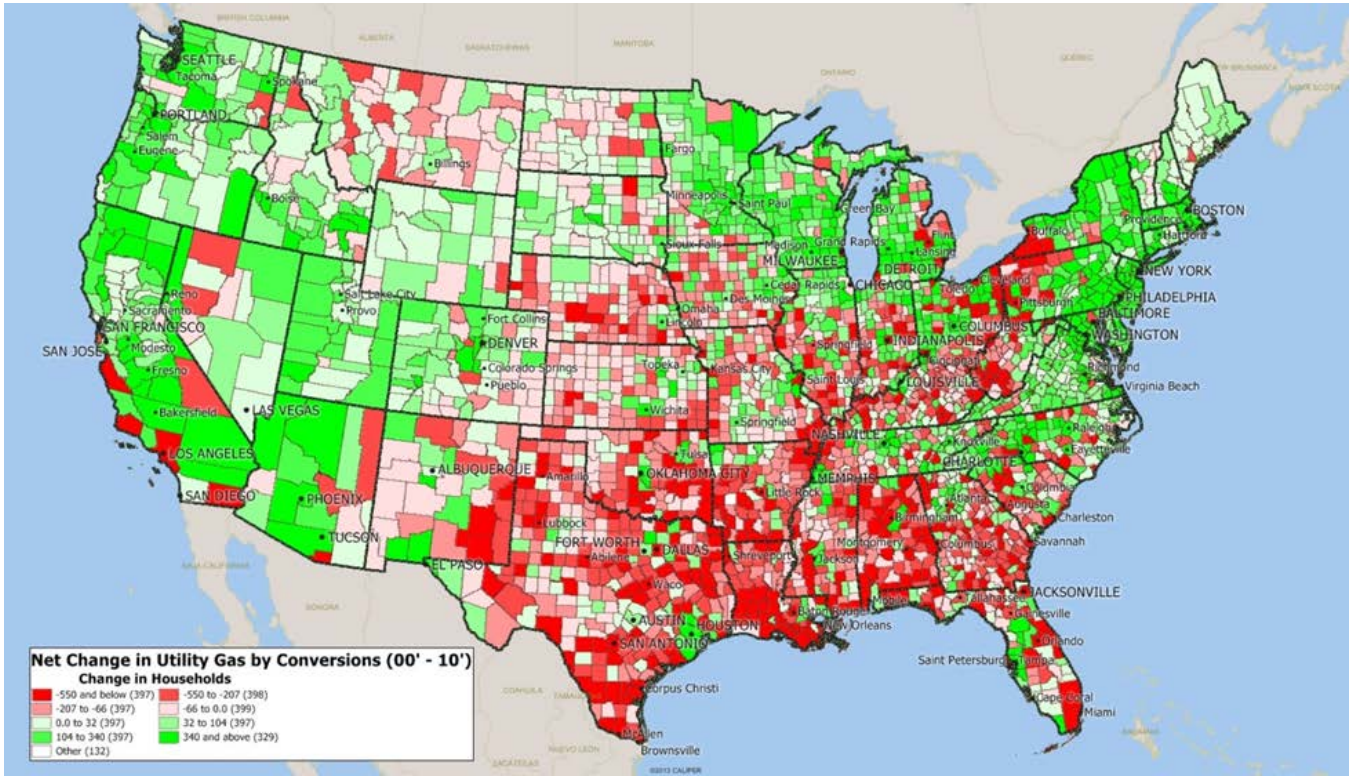
UGI Utilities serves a large portion of PA

Total Gas Customers	606,000
Total Electric Customers	62,000
Miles of UGI Gas Main Infrastructure	13,000 miles



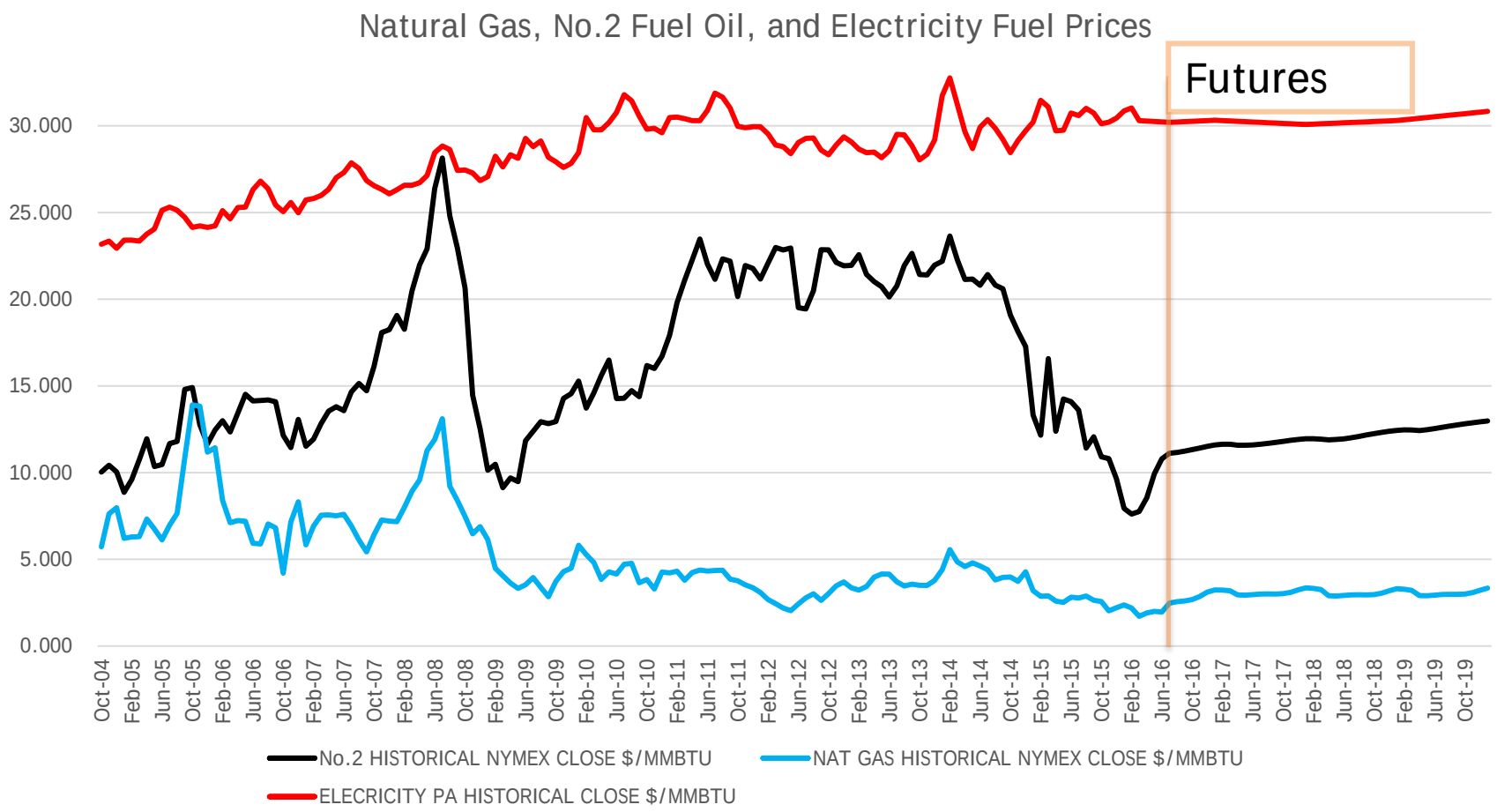
Conversions to-from Natural Gas

Conversions to (green) and from (red) natural gas from 2000-2010
(the darker the color, the greater number of conversions that may have occurred)



Source: U.S. Census Bureau

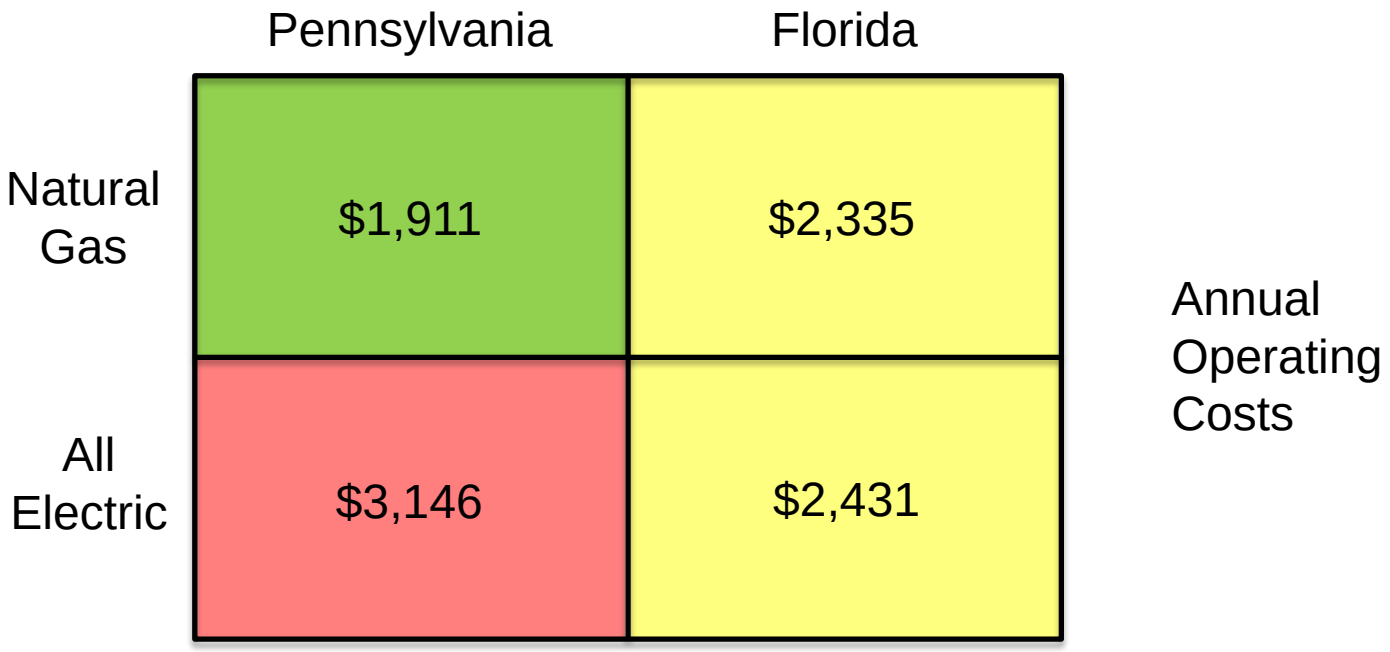
Residential Savings Gas vs. Oil



UGI Natural Gas Conversion Statistics

- More than 90% of the natural gas UGI Utilities delivers to our customers is produced in the Marcellus Shale Region
  - Marcellus NG priced at +33% discount to NYMEX
- Compared to 2008, UGI customers saved $343MM in 2015, attributable to lower priced gas from Marcellus Shale
- In 2015, the 53,000 households that recently converted to natural gas saved approximately $91MM

Natural Gas Economics 101



Average HVAC Equipment Installed Costs:

- Natural Gas Furnace/Electric A/C - $6,700 – $9,000
- Electric Heat Pump - $6,000 - $10,100

HVAC equipment selection and fuel choice economics vary based on location

Source to Site Energy Efficiencies

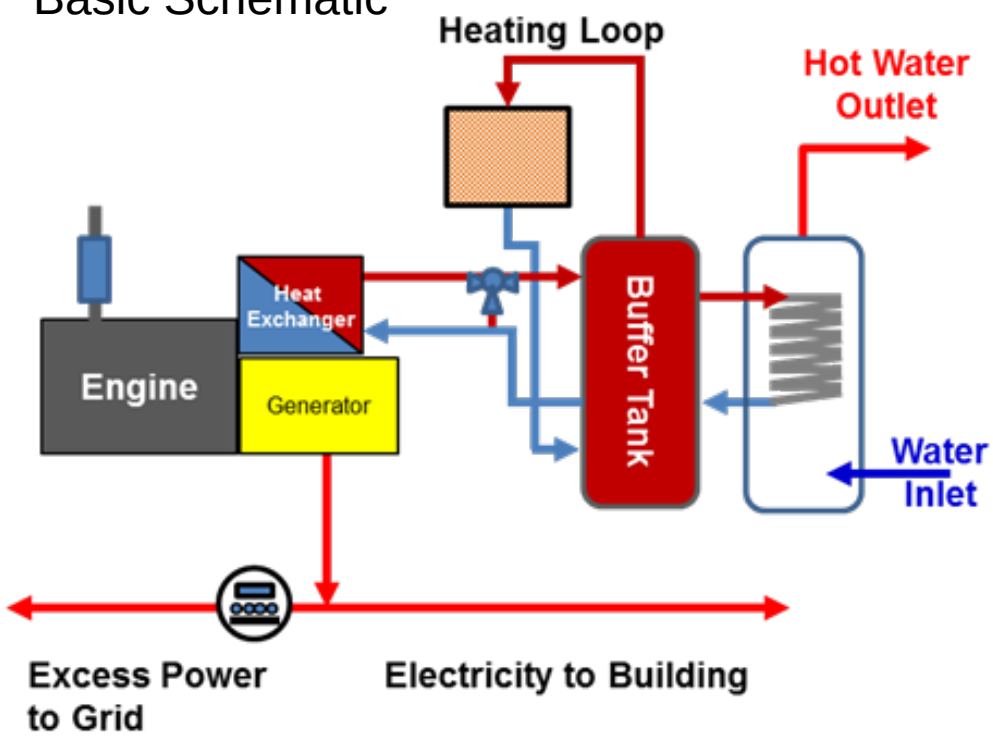
	Extraction, Processing & Transportation		Conversion[1]		Distribution		Delivered To Customer
Electricity 30% Efficient	**100 MMBtu** Source Energy	**- 5**	95	**- 61**	34	**- 4**	30
Natural Gas 92% Efficient	**100 MMBtu** Source Energy	**- 7**	No Conversion Necessary	**0**	93	**-1**	92

Three times more energy reaches the customer with natural gas.

What is CHP and CCHP?

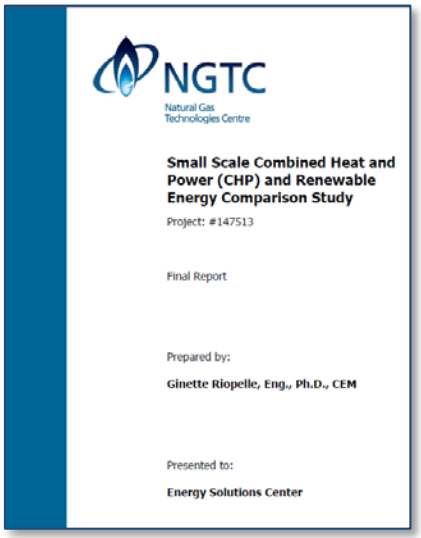
- CHP stands for Combined Heat and Power.
- CHP is the **sequential** production of **power** and **useful thermal** energy from a single energy source.
- CCHP stands for Combined Cooling, Heating and Power.

Basic Schematic



Small Scale CHP Compared to Renewables

12,000 Sq Ft - 10 KW DE System	Solar - PV	Wind	CHP
Installed Cost ($/KW)	$5,300	$6,000	$7,280
Annual Savings (/KW installed)	$156	$216	$592
Space Required (Sq Ft/KW installed)	76	785	1.4
CO2 Saved (/KW installed)	1,871	2,588	6,502
Ave. hours /year at max power	1,550	2,175	8,311



NGTC Study, 7/3/14

A small commercial application was evaluated for 10 KW of CHP compared to wind and solar power. The installed cost for CHP was slightly higher than wind or PV.

The annual cost savings, Carbon savings and space savings with CHP far exceeded wind and solar power.

Residential CHP Application

Greenwich, Connecticut

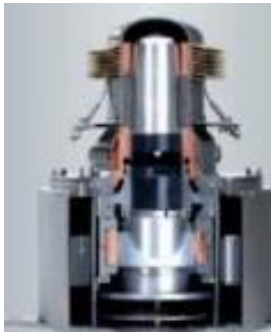
- Two floor family home of 9,000 Ft2 (464.5m2)
- Full in-floor radiant heating system in the house Sept to May.
- 28,000 gallon pool @ 85°F from May to Sept
- In 20 months of CHP usage:

40 MWh of electricity with total energy cost savings of $9,000

Other Types of CHP Systems

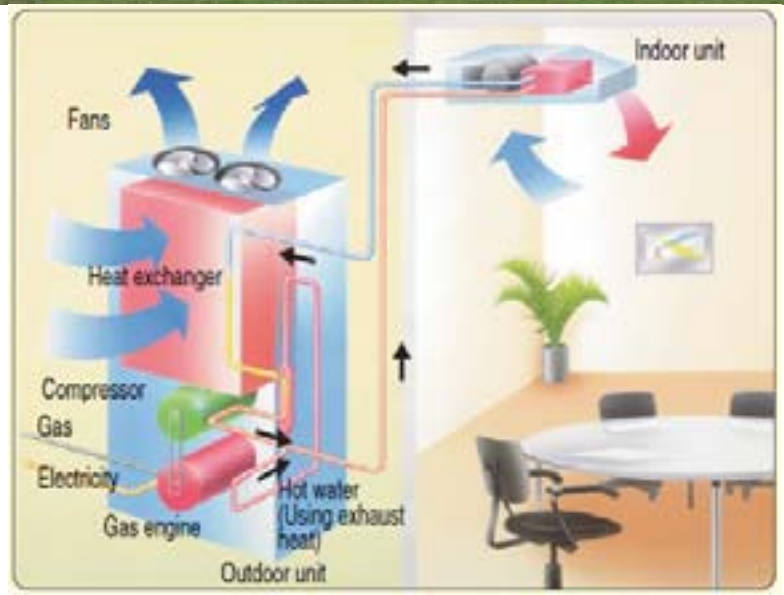
- Fuel Cells – available in sizes ranging from 5 KW to 3 MW
  - Very High Fuel Efficiencies with zero carbon
  - Equipment is costly, but financially viable in certain applications

- Stirling engines– available in sizes ranging from 1 KW Very High Fuel Efficiencies
  - CHP efficiency up to 90%
  - Expected market growth in the future



Natural Gas Fired Heat Pump

- Economic and environmentally friendly option, especially for larger homes (>4,000 sq. ft.)
- Can achieve COPs up to 2.0
  - Conventional water heater: .85
- Can recover additional waste heat to drive efficiencies +30% more than electric-motor heat pumps



QUESTIONS?

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NARUC 2016 Summer Committee Meetings

Maximizing Home Heating Alternatives in Multi-Family Residences

IOWA OFFICE OF CONSUMER ADVOCATE

Mark Schuling, Consumer Advocate (515) 725-7200

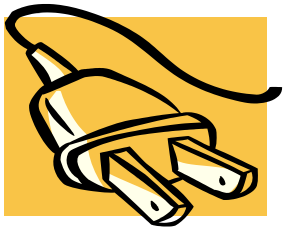
July 24-27, 2016, Nashville, TN

Office of Consumer Advocate

- The Iowa Consumer Advocate acts as attorney for and represents all consumers generally and the public generally in all proceedings before the Iowa Utilities Board.
- Iowa OCA has a staff of seven lawyers, three support staff, and nine technical staff, including economists, financial analysts and engineers.

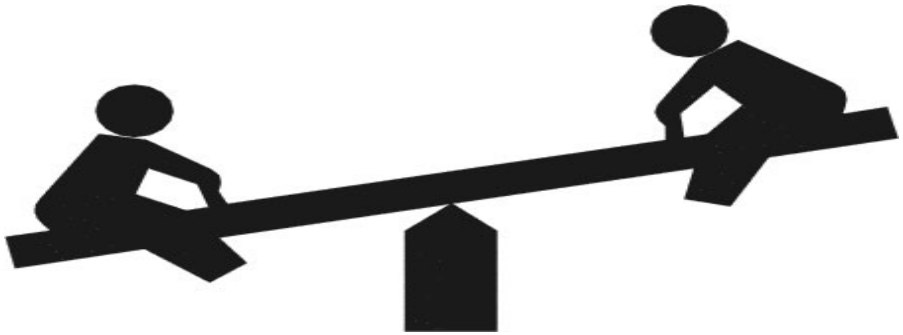
Multi-Family Discussion

- Market Barriers
- Energy Efficiency Options
- Landlord-Tenant Pilot Project including Master Metering
- Renovation Project including Master Metering
- Multi-Family Best Practices



Market Barriers

- Split Incentive
- Trust on Energy-Savings Calculations
- Lack of time in construction process or limited time in Emergency Replacements



Energy Efficiency Options

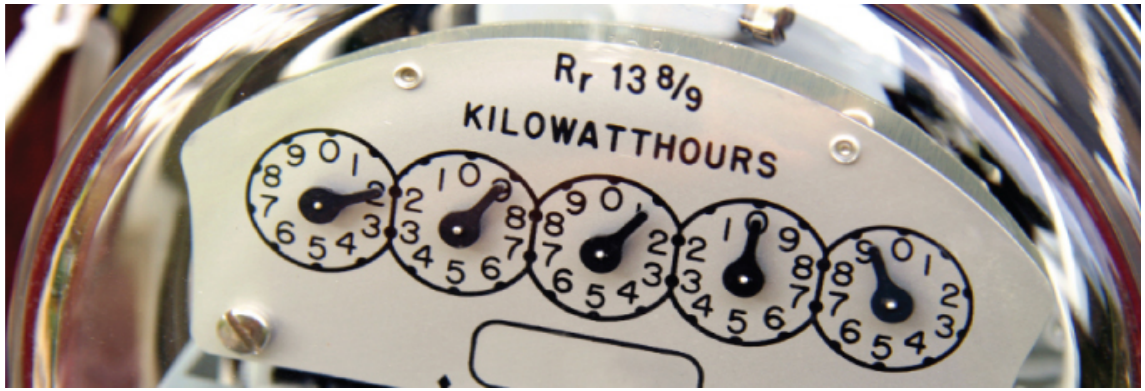
- Prescriptive and custom rebates for common areas based on Commercial programs.
- Prescriptive and custom rebates for residential units based on Residential programs.
- Enhanced rebates for low-income properties.

Landlord-Tenant Pilot Project

- Applicant with long track record of energy efficient and cost effective strategies.
- Requests Master Metering for certain energy saving strategies.
- Pilot created for Master Metering with revised residential rate.

Renovation Project including Master Metering

- Electric Master Metering requested for commercial/residential renovation.
- Installing centralized energy plan. Agreements reached on gas and water.
- Finding was insufficient evidence to support Master Metering .



Multi-Family Best Practices

- Cash incentives to building owners.
- Per unit and high performance incentives.
- Low-cost financing.
- Higher rebate for low-income properties.
- Target specific program elements to Multi-Family properties.


Questions

Full Fuel Cycle Analysis

> Ron Edelstein

> July, 2016

> NARUC Meeting

GTI Overview

ESTABLISHED 1941 (Gas Research Institute est. 1977)

- Independent, *not-for-profit* company established by natural gas industry
- Providing natural gas research, development and technology deployment services to industry and government clients
- Performing contract research, program management, consulting, and training
- Facilities
  - 18 acre laboratory in Des Plaines
  - 200,000 ft^2 with 28 labs
- Staff of 250
- Wellhead to the burner tip including energy conversion technologies

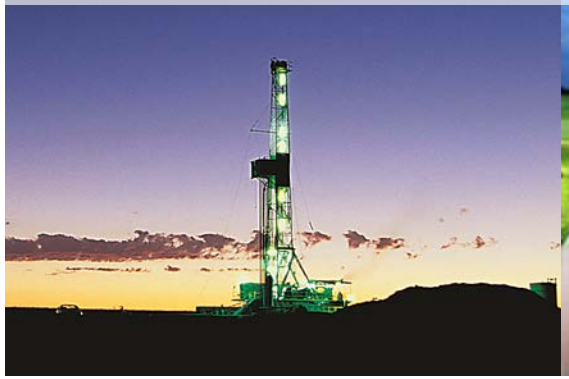
Training

Office & Labs

Pilot-Scale Gasification Campus

Energy & Environmental Technology Center

GTI: Addressing Key Issues Across the Energy Value Chain

SUPPLY	DELIVERY	END USE
		
Expanding the supply of affordable energy	Ensuring a safe and reliable energy delivery infrastructure	Developing technology for the efficient use of energy resources

Reducing carbon emissions to the environment

Supporting sustainable economic growth

Assumptions and Methodology

- Used www.cmictools.com as the analysis vehicle
- Used eGRID data RFCE region
- Used Baltimore, MD weather data

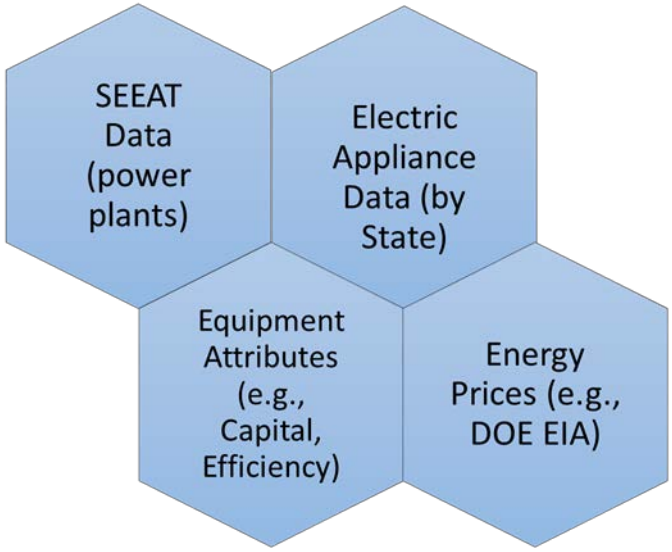
Caveats

- CO2 output from power plants depends on the local mix of power generation sources for that region.
- Instantaneous performance (COP) at a fixed temperature is not the same as heating season performance

Direct Gas Use Benefits Calculator

> Developing a tool for use by utilities and state personnel

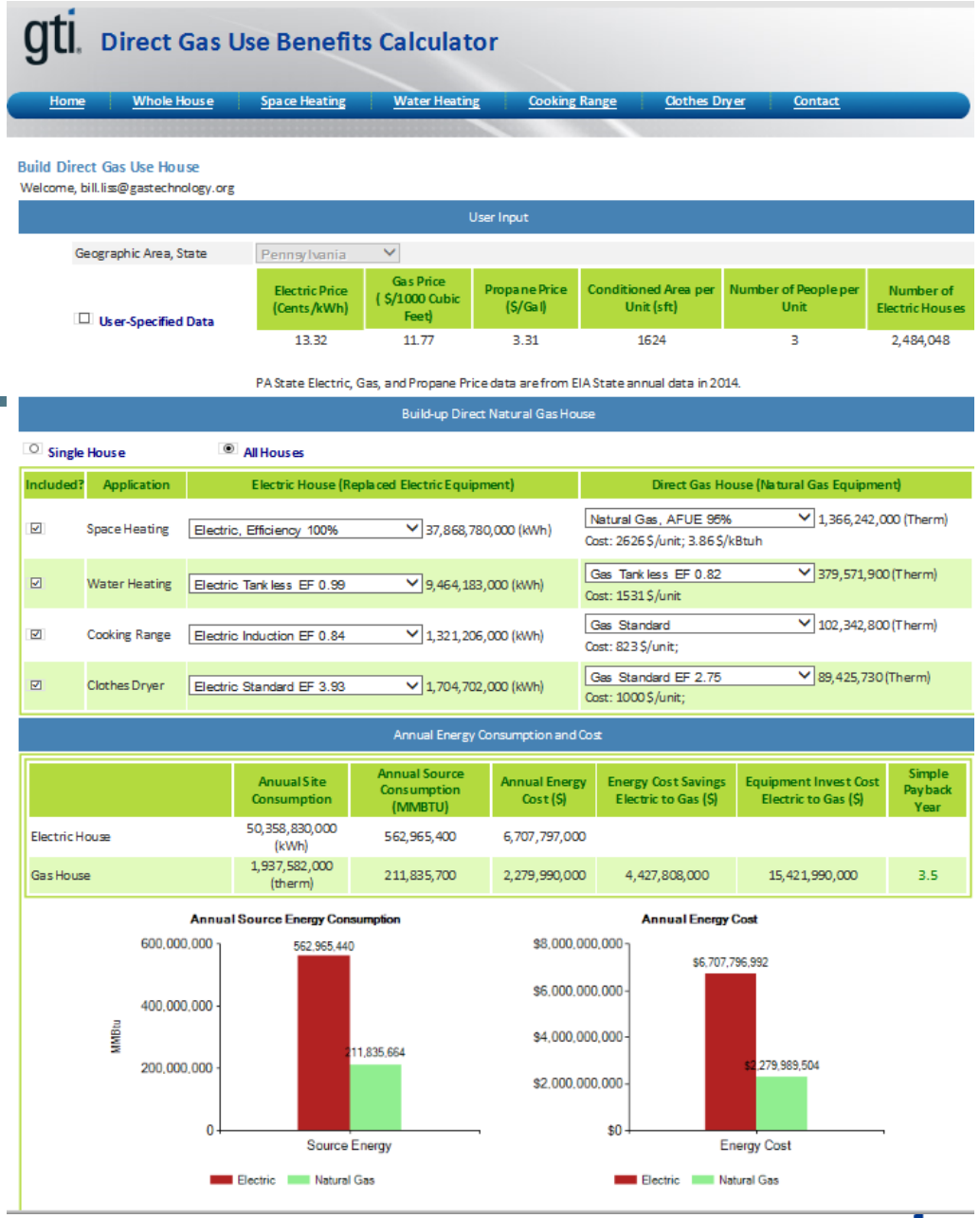
- Build on current Source Energy and Emissions Analytical Tool (SEEAT) to understand benefits of displacing low-efficiency electric resistance equipment
- Address opportunities related to Clean Power Plan, energy efficiency fuel switching, and other policy options for source energy efficient direct gas use



http://www.cmictools.com/cmicec/default.aspx

Direct Gas Use Benefits Calculator

- Users pick a state for analysis
- Pick whole house, switching from electric resistance to natural gas (space and water heating, cooking, drying) or each application separately
- Can run analysis for a single house or for all applicable homes in a state

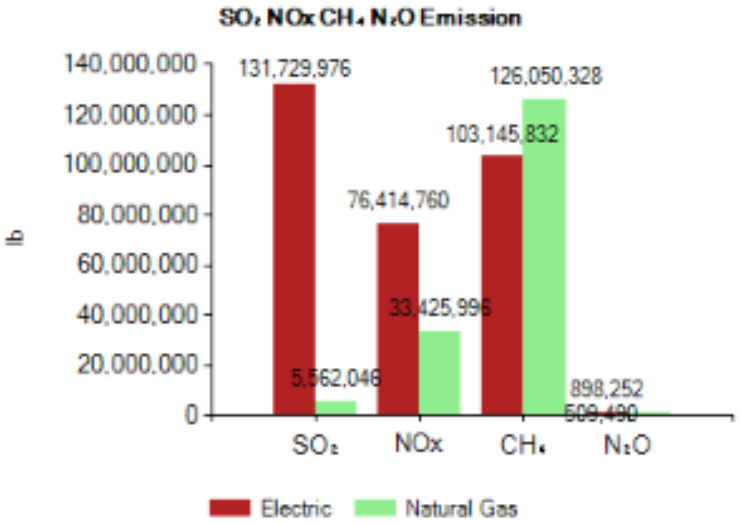


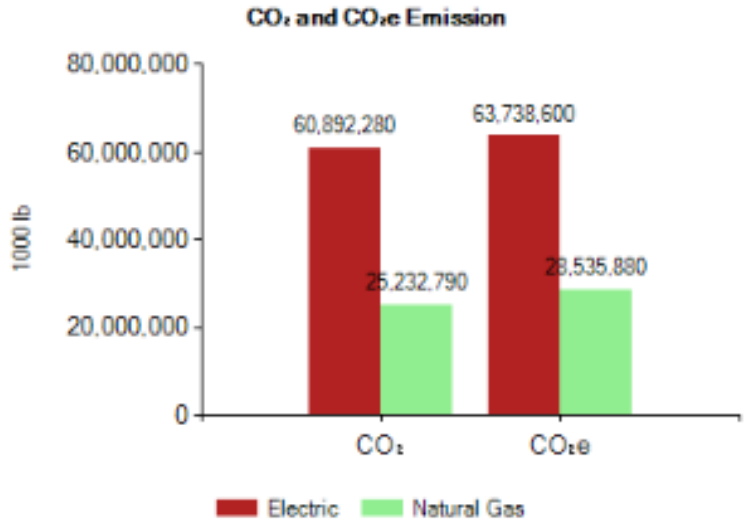
Direct Gas Use Benefits Calculator:
Emission Reductions

In the context of electric to gas fuel switching (e.g., as part of Clean Power Plan), Pennsylvania could realize cost-effective CO_2 equivalent emission reductions of 35 million pounds (along with NO_x and SO_x).

Annual Source Emissions

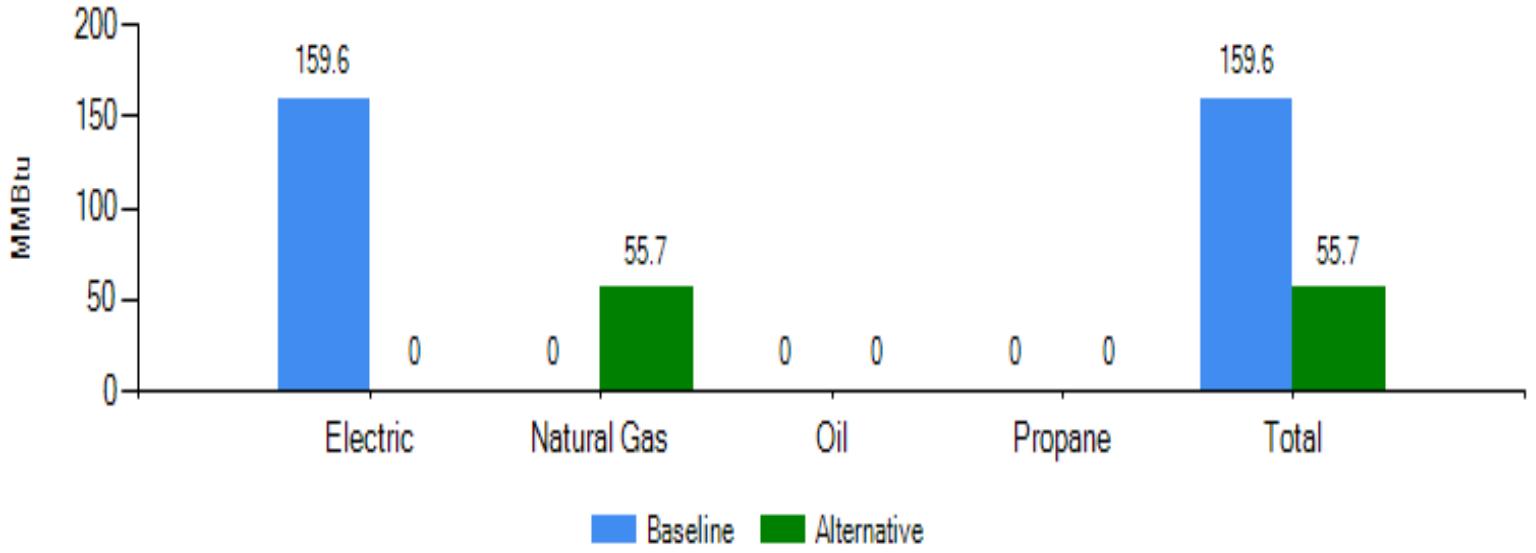
	SO_2 (lb)	NO_x (lb)	CO_2 (1000 lb)	CH_4 (lb)	N_2O (lb)	CO_2e (1000 lb)
Electric House	131,730,000	76,414,760	60,892,280	103,145,800.0	898,252.40	63,738,600
Gas House	5,562,046	33,426,000	25,232,790	126,050,300.0	509,490.30	28,535,880





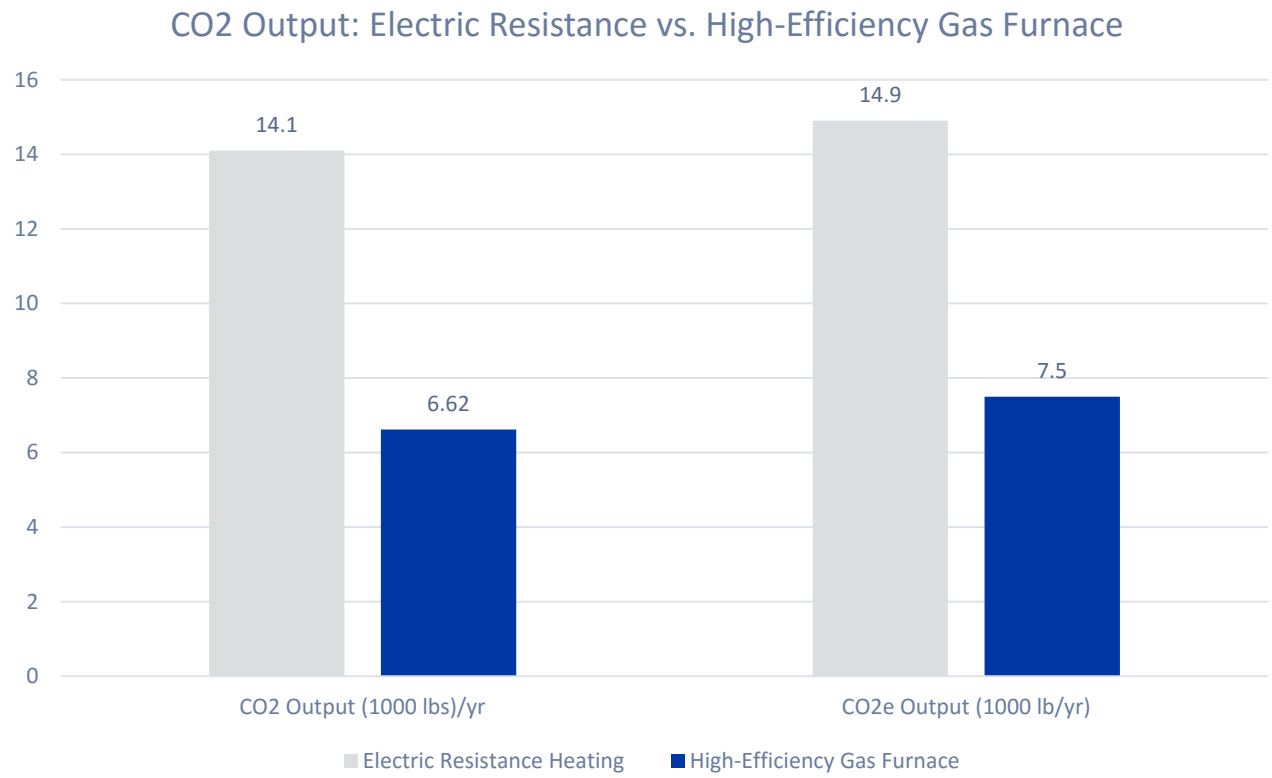
Note: All Emission calculations are based on GTI Source Energy and Emission Analysis Tool developed by Gas Technology Institute.

Full Fuel Cycle Energy Usage: Electric Resistance vs. High-Efficiency Gas

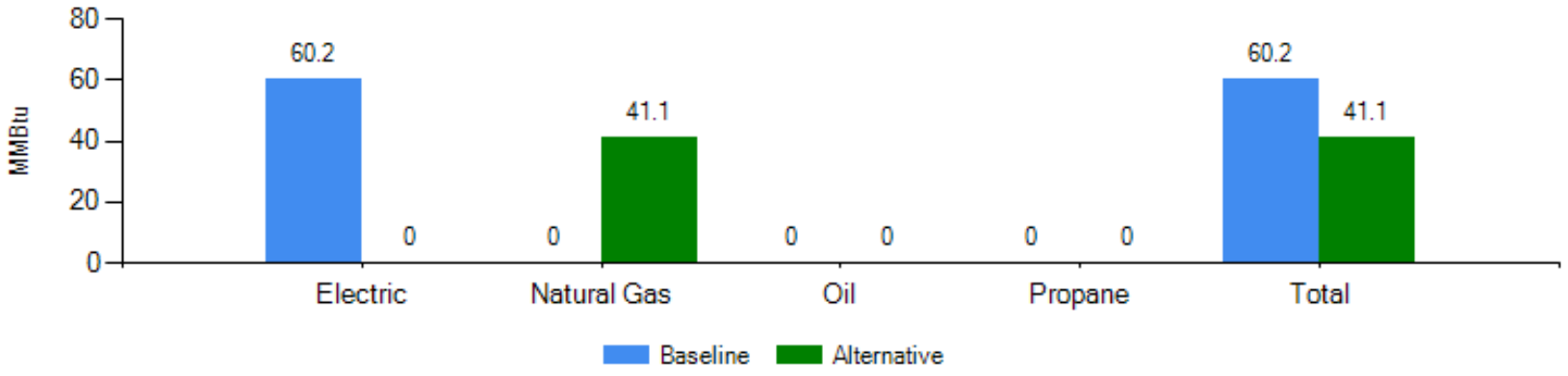


14,215 kWhr for Electric Resistance

Electric Resistance Heating vs. High-Efficiency Furnace

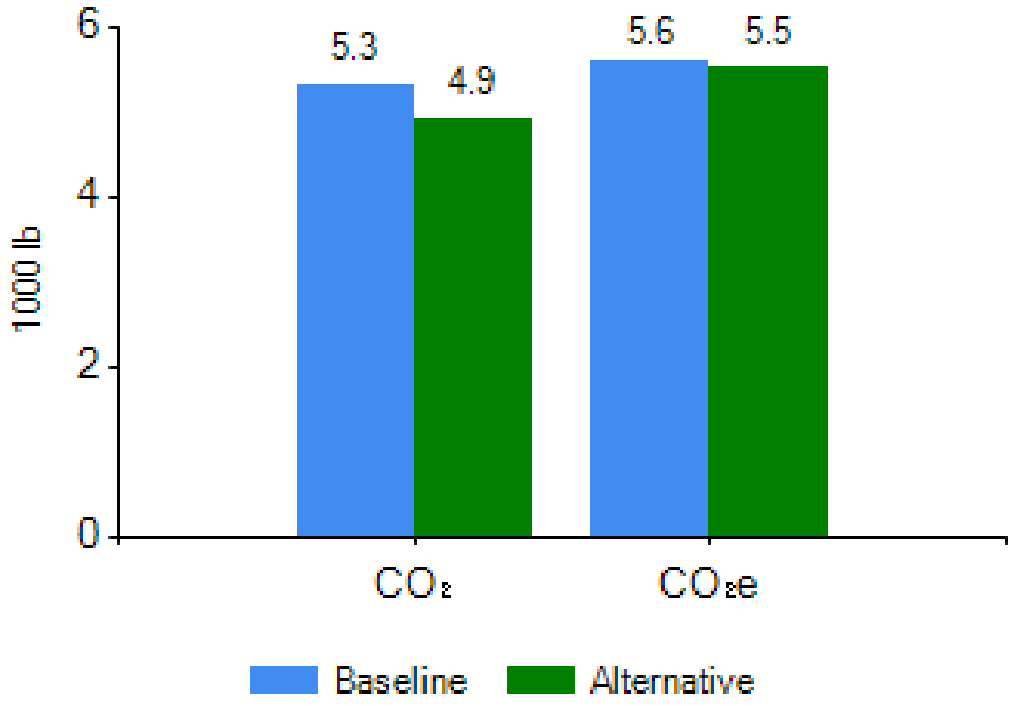


EHPs vs. GHPs: Full Fuel Cycle Energy Use

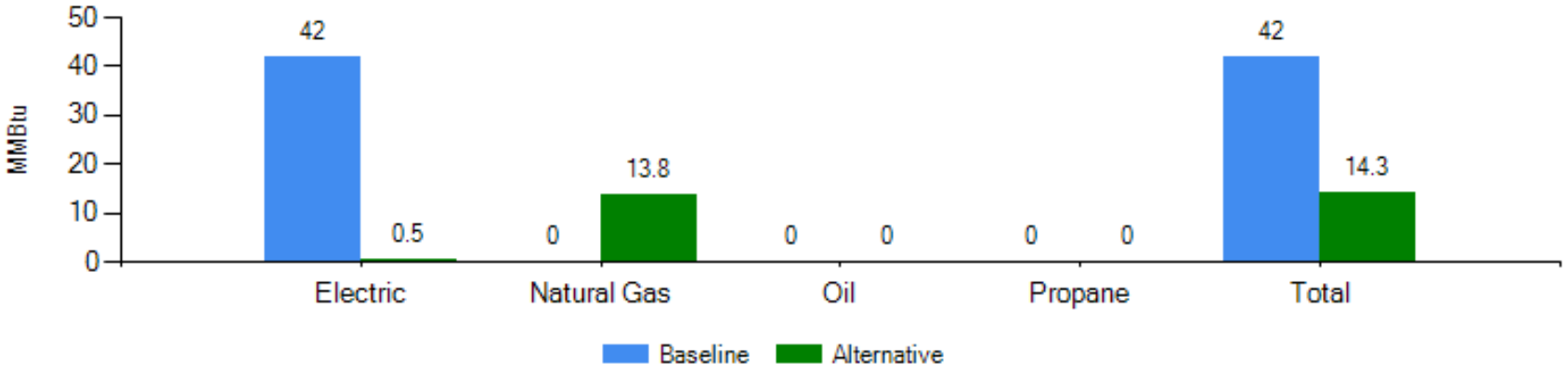


5,359 kWhr for EHPs

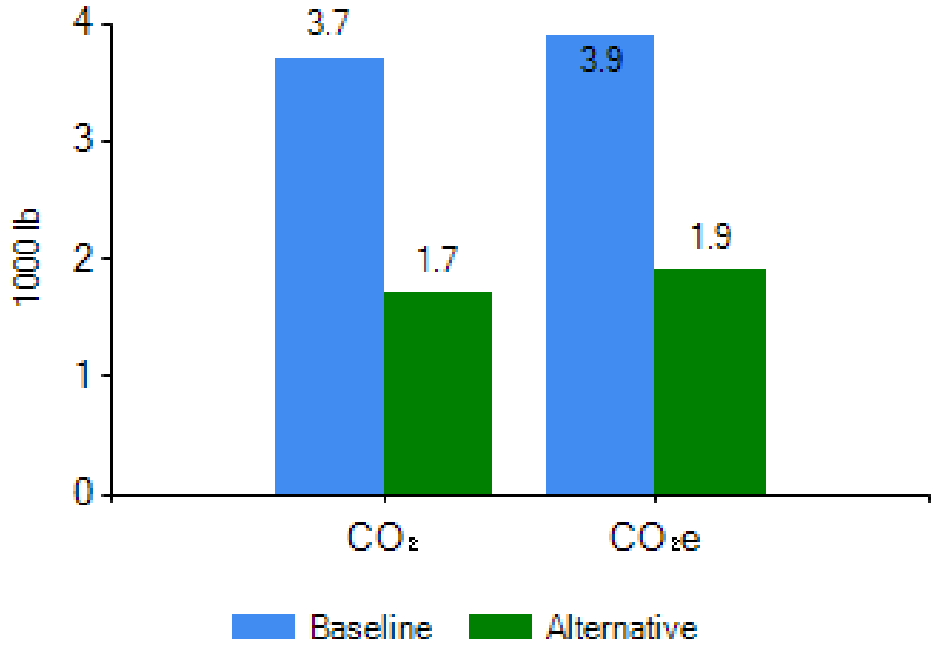
EHPs vs. GHPs: CO2 Output



Electric Resistance Water Heater vs. Condensing Tankless Gas Water heater

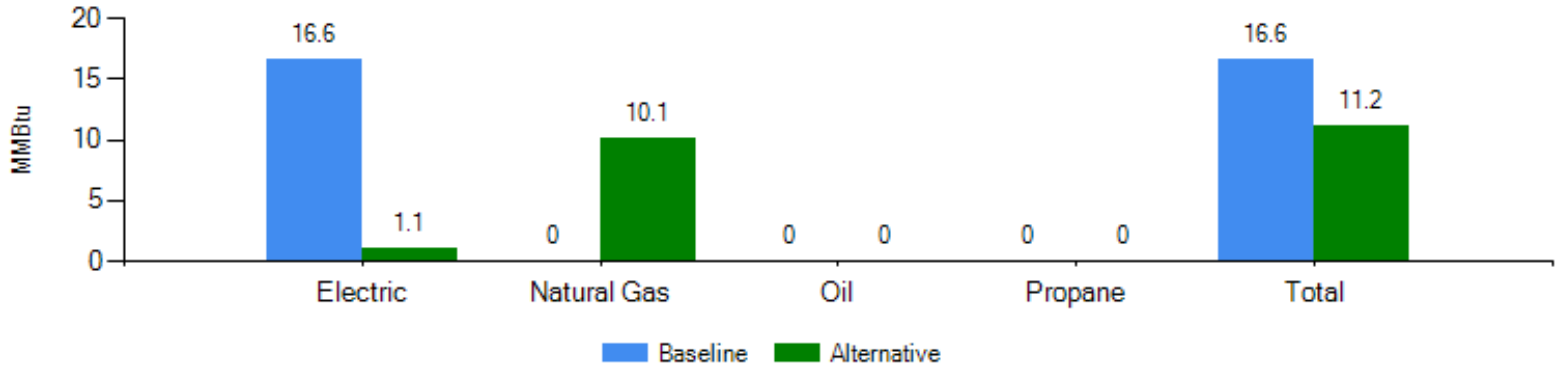


CO2 Output, Electric Resistance WH vs. Condensing Tankless WH



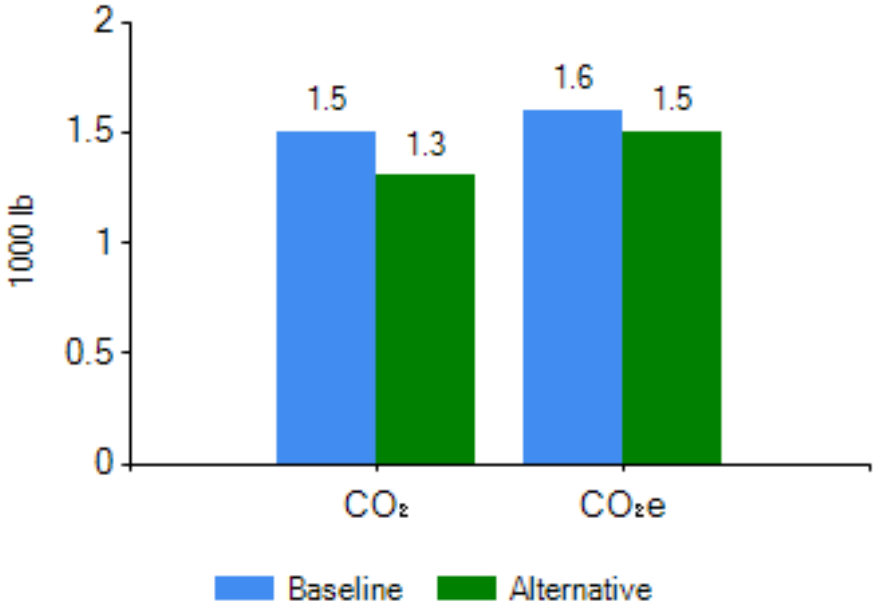
3,744 kWhr for EHPs

Energy Use: EHP WH vs GHP WH



1,482 kWhr for EHP WH

CO2 Output EHP WH vs. GHP WH



GHP and GHP Water Heaters

Conclusions

- Full fuel cycle analysis is the appropriate way to calculate energy efficiency and CO2 output
- Natural gas high-efficiency furnaces and water heaters and gas heat pump related technologies are amongst the most energy efficient technologies available or in the near future (GHP WH)
- Electric resistance technologies provide neither CO2 nor full fuel cycle advantages

Questions?

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How to Heat a Home

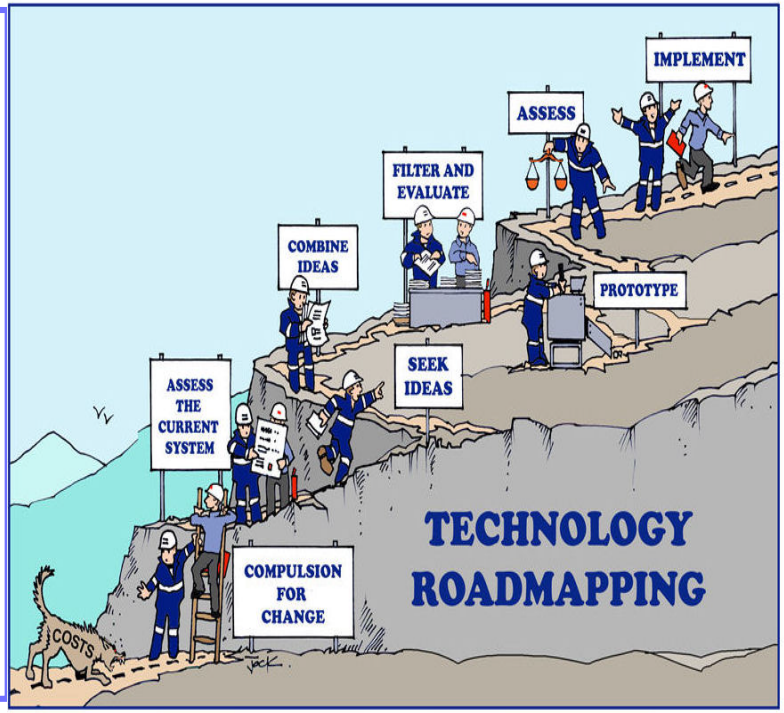
Barbara Tyran

Executive Director, Government & External Relations

July 24, 2016

Heating Technology Options

- Electric & Natural Gas
- Space & Water Heating
- Multi- & Single-family metering
- EPRI: Future Outlook



Heat Pump
Level 1 System

Indoor Unit

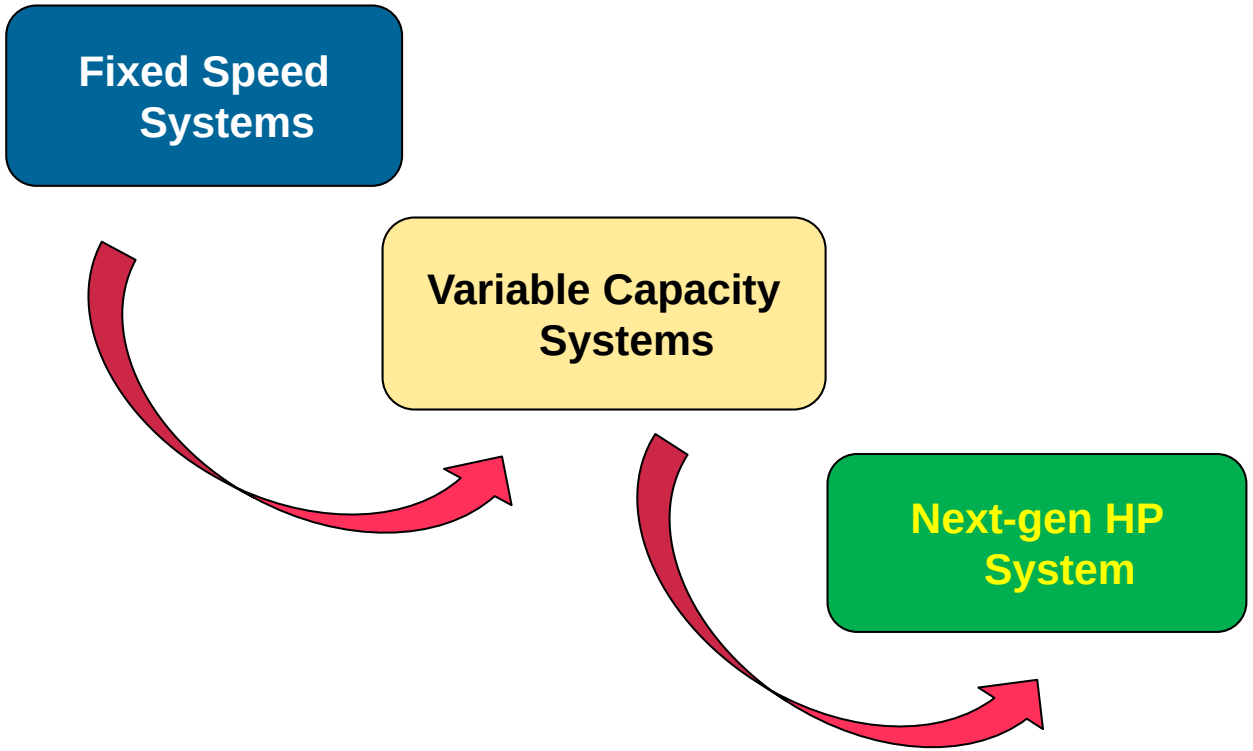
Outdoor Unit

Current Heat Pump Space Conditioning

- **Ambient discharge air feels “cold” (93 degrees F)**
- **Back-up resistant heat needed below 37 degrees F**
- **Coefficient of Performance (COP) = about 2.1 or 68% power system efficiency**
- **Fixed Speed On/off control**

Heat Pump Technology Evolution

Next Generation: Advanced Variable Capacity



New Heat Pump Space Conditioning

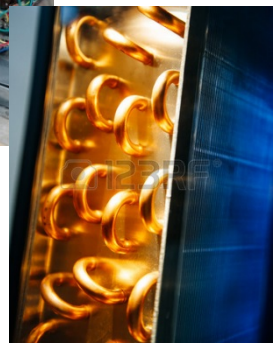
- **Ambient discharge air temperature: 105 degrees F giving skin sense of warm air**
- **Expanded operating hours down to 5 degrees F before back-up heat required**
- **COP increased to 2.4 or 79% power system efficiency**
- **Internet connected variable capacity**
- **Increasingly cleaner electricity generation mix**

Next Generation Heat Pump

EPRI Technology Innovation Breakthrough Project

Advanced Heat Pump Technology

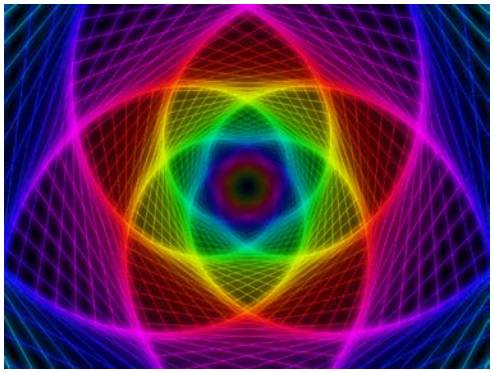
- **New options for customers**
  - Heating in cold climates
  - Extreme efficiency
  - Flexible capacity
  - Comfortable supply air temperature
- **New options for utilities**
  - Enhanced demand response
  - Modulates power up & down



The Next Generation Heat Pump

History

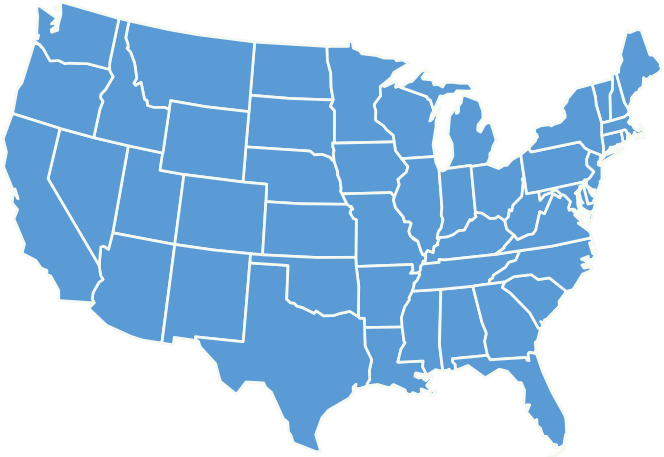
Next-Gen HP System



- EPRI Technology Innovation Project -- 2013
  - Prototype development and testing of **Level 1** systems: simple on/off capacity
  - RFP issued for construction of **Level 2** system—outstanding: enables modulated load management
- Transition to field test ~ Fall 2016

Fall 2016…

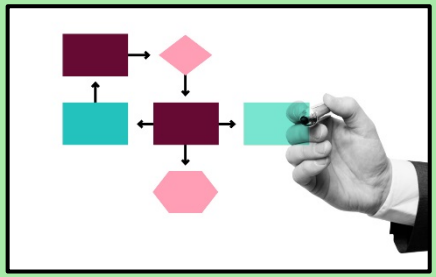
- **Major project launch**
  - **Field deployment and evaluation of Next-Gen Technology**
  - **Diverse geographic regions/utilities, manufacturers' systems**

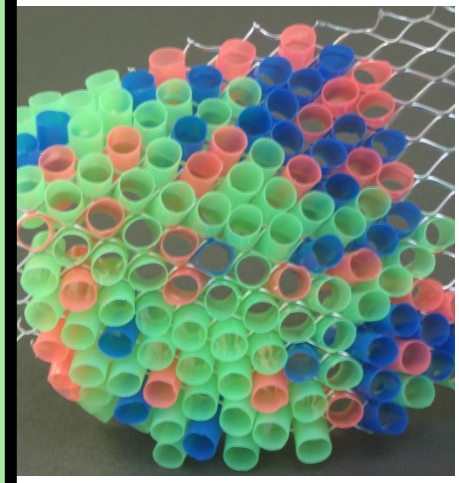


Future…

Field Deployment

- Establishing Next-gen HP Systems with Manufacturers
- Detailed Use Case Specification
- Test Protocol Development
- Laboratory Evaluation at EPRI
- Field Deployment
- Data Collection
- Data Analysis
- Program Implementation





Conclusions

- **Variable capacity heat pumps can offer potential electric heat solutions to Utility Winter Peaks**
- **Potentially eliminate backup electric heat when…**
  - **Sized appropriately**
  - **Unit settings are adjusted**
- **Promising future: improved efficiencies for extracting heat in one zone and transferring to another**

Together…Shaping the Future of Electricity

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