Presentation Outline

- Average Home Energy Use
- Finding Conversion Opportunities
- Evaluation Tools
- Economics of Natural Gas vs. Electric, Propane and Fuel Oil
- What It Takes to Physically Convert
- The Benefits of Converting to Natural Gas

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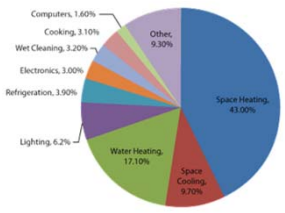
Residential Energy Consumption

- Opportunity Areas
  - Space Heating
  - Water Heating
  - Cooking



Source: Buildings Energy Data Book, Table 2.1.6

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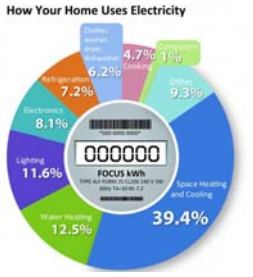
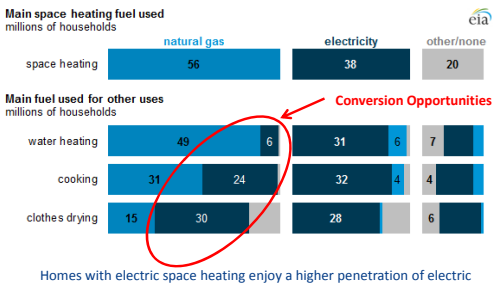
Residential Electric Energy Consumption



- Top Targets
  - Space Heating and Cooling 39.4%
  - Water Heating 12.5%
  - Clothes washer, dryer & dishwasher 6.2%
  - Cooking 4.7%

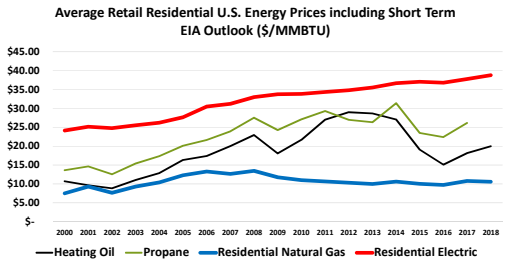
Source: Buildings Energy Data Book. Data for an all electric home.

Installed Appliances by Energy Type



Homes with electric space heating enjoy a higher penetration of electric water heating, cooking and clothes drying.

Energy Prices



Source: EIA

Finding the Opportunities

- Using your Customer Information System (CIS)
- Using your Mapping System (GIS)
- Mainline Extension Programs
- Mainline Replacement Programs
- Visual Queues

Querying your CIS System

- Query for premises with no summer base load
  - Indication that the water heater is non-gas
- Query for premises with summer load that stays constant throughout the year
  - Indication that the heating is non-gas
- Query for low heat load factor
  - Indication that a portion of the heating is non-gas
    - Heat pump, supplemental baseboard, wood, etc.

Use the Strength of GIS
(Geographic Information System)

- Merge meter set GPS with gas main & premises
  - The opportunity can be found where there is a gas main & houses but no meter
- Look for pockets of houses without a meter or gas service
  - May have been built during gas shortage days
  - Good – whole house conversion opportunities

Gas Main Extensions & Replacements

- These are good opportunities for conversion
- Look for un/under served locations that may have been missed when the original line was laid
- If the gas main extension is going to a large C/I conversion, pick up the small opportunities or non-gas lot plans along the way
- Incorporate the benefits of conversion with your consumer outreach & notification messages

Visual Clues

- Propane Tanks
- Alternative fuel delivery trucks
  - Propane
  - Fuel Oil
- Lack of venting for products of combustion
- No gas meter

Evaluation Tools

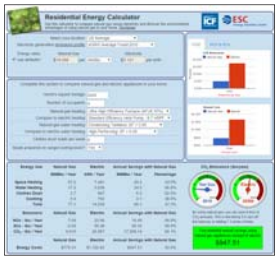
- Tools produced by ESC's Residential Consortium:
  - Energy & Carbon Calculator*
  - Oil to Propane Conversion Costs *
  - Outdoor Room Visualizer *
  - CSST Piping Costs
  - Appliance Payback Costs

*available on-line

Residential Energy Calculator

- Calculates
  - Energy Usage
  - Energy Cost
  - Emissions
- Available at:

http://www.energydepot.com/ResidentialEnergyCalculator



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Oil & Propane vs. Natural Gas

- Provides a simple cost analysis comparing Oil or Propane vs, NG
- Available at:

http://calculators.myescenter.com/oilpropane/Oil_and_propane_calculator_final.htm

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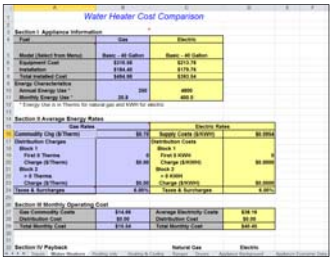
Residential Appliance Calculator

- Excel Calculators for:
  - Water Heaters
  - Heating
  - Heating & Cooling
  - Ranges
  - Dryers



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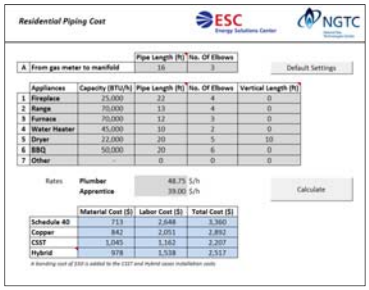
Corrugated Stainless Steel Tubing

- CSST
  - Simplifies the installation of house line piping in new and existing homes
  - Great for extending piping to new or converted equipment
  - Flexible material minimizes the need for fittings

CSST Piping Calculator



Outdoor Room Visualizer

- Allows a consumer to take a picture of their back yard and design an outdoor room.
- Helps a customer visualize what their room could look like.
- Available at:

www.outdoorroomdesign.com

Economics

- Conversion chart provides a rough estimate of the gas consumption post conversion
- Does not account for equipment efficiencies
- Fuel costs and savings should be estimated with the rates in effect in your area

Energy Conversion Chart

Comparative Thermal Values	1.00 million Btu	24.0 million Btu	0.0916 million Btu	0.125 million Btu	0.139 million Btu	0.150 million Btu	0.003412 million Btu
Natural Gas 1000 Btu/cu ft	1000 cu ft	24,000 cu ft	91.600 cu ft	125.000 cu ft	139.000 cu ft	150.000 cu ft	3.412 cu ft
Coal 12,000 Btu/lb	83.333 lb	2,000 lb	7.633 lb	10.417 lb	11.583 lb	12.500 lb	0.2843 lb
Propane 91,600 Btu/gal	10.917 gal	262.009 gal	1 gal	1.365 gal	1.517 gal	1.638 gal	0.0373 gal
Gasoline 125,000 Btu/gal	8.000 gal	192.000 gal	0.733 gal	1 gal	1.112 gal	1.200 gal	0.0273 gal
Fuel Oil #2 139,000 Btu/gal	7.194 gal	172.662 gal	0.659 gal	0.899 gal	1 gal	1.079 gal	0.0245 gal
Fuel Oil #6 150,000 Btu/gal	6.666 gal	160.000 gal	0.611 gal	0.833 gal	0.927 gal	1 gal	0.0227 gal
Electricity 3412 Btu/kWh	293.083 kWh	7,033.998 kWh	26.846 kWh	36.635 kWh	40.739 kWh	43.962 kWh	1 kWh

Make it Easy for the Customer

- Explain the entire process
  - Equipment conversion/replacement
  - House and buried house line piping
  - Venting - if required
- Operating cost benefits and payback
- Identify and rebates or incentives available and provide them any forms needed
- Develop an incentive through your company
- Work with local vendors (equipment and plumbers) to facilitate the process

Electric to Gas Example

- An electric dryer uses ~900 kWh per year
- If the cost of electric is $.15/kWh the dryer cost ~$135/year to run
- Convert the electric consumption to approximate gas consumption 900 x .003412 = 3 Mcf
- If delivered gas cost is $10.00/Mcf, the annual cost is $30 & the savings is ~$105 per year

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Propane to Gas Example

- A propane water heater uses ~250 gallons of propane per year
- If the cost of propane is $2.20/gal the water heater costs ~$550/year to run
- Convert the propane consumption to approximate gas consumption 250 x .0916 = 23 Mcf
- If delivered gas cost is $10.00/Mcf, the annual cost is $230 & the savings is ~$320 per year

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Fuel Oil to Gas Example

- A fuel oil furnace uses ~600 gallons per year
- If the cost of fuel oil is $2.50/gal the furnace costs ~$1,500/year to run
- Convert the fuel oil consumption to approximate gas consumption 600 x .139 = 83 Mcf
- If delivered gas cost is $10.00/Mcf, the annual cost is $830 & the savings is ~$670 per year

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Converting Fuels

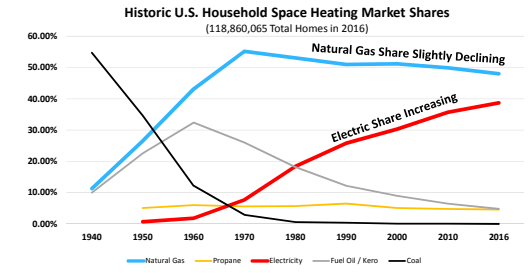
- **Natural Gas to #2 Oil**
  - $/MCF Gas X 138,690 BTU/Gal#2 / 1,028,000 BTU/MCF = $/Gal Equivalent
  - #2 Oil = 7.41 gallon per MCF
  - $10/MCF X 138,690 BTU/Gal/1028000 BTU/MCF = **$1.35/Gallon equivalent**
- **Propane**
  - $/MCF Gas X 91,700 BTU/Gal LP / 1,028,000 BTU/MCF = $/Gal Equivalent
  - $10/MCF natural gas equates to **$.89 per gallon equivalent propane**

(Assumes worst case EIA BTU values)

Conversion Opportunities

- Furnace / Heat Pump
- Baseboard
- Water Heater
- Dryer
- Range
- Pool heater
- Grill
- Fireplace
- Outdoor Lights

Trend in Heating Fuel Type for all Homes

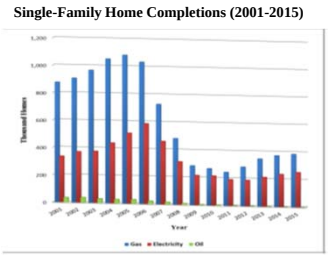


Areas of conversion Opportunity include homes heated with electric, propane, or oil.

U.S. Bureau of Census & U.S. Census Bureau American Community Survey 1 yr estimates for 2016

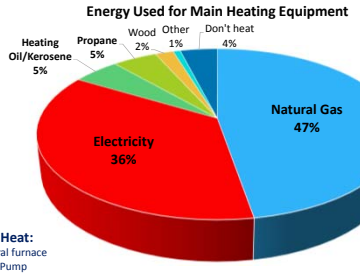
But……Gas* Heat is Preferred in New Construction

- The overall # of homes heating with natural gas has declined over the last several decades while electric heat increased.
- Gas* (Natural Gas & Propane combined) are the leading energies selected for heat in new construction homes



AGA's Residential Market Survey, 3/2017

Space Heating Areas of Opportunity



Propane
75% Central furnace
25% Other

Oil
63% Central furnace
27% Boiler

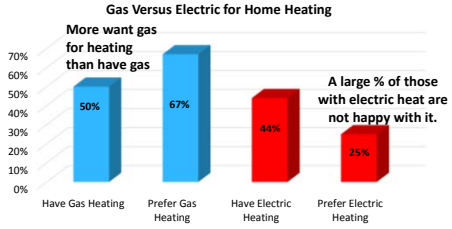
Electric Heat:
42% Central furnace
28% Heat Pump
21% Built-in electric units
9% other

Gas Heat:
81% Central furnace
12% Boiler
7% other

EIA's Residential Energy Consumption Survey released 2/2017

Consumer Preference

(Results from a national consumer preference study)



New Homeowner Energy Preference Survey 2016, Woodland O'Brien & Scott

Furnace

- Converting from Electric Furnace
  - Size, install and test internal house line piping to furnace location based on furnace input and distance
  - Remove electric furnace and replace with new, properly sized gas furnace
  - Install proper venting for products of combustion from new gas furnace
  - Install new thermostat compatible with new furnace

Furnace

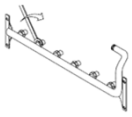
- Converting from Electric Heat Pump
  - Size, install and test internal house line piping to furnace location based on furnace input and distance
  - Remove air handling unit with electric resistance back-up and replace with new, properly sized gas furnace
  - Furnace fan must accommodate cooling
  - Condenser and A/C coil may be reused for cooling
  - Install proper venting for products of combustion from new gas furnace
  - Install new thermostat compatible with new furnace and A/C

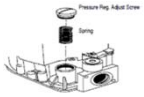
Furnace / Boiler

- Converting from Propane
  - Validate that furnace / boiler can be converted to natural gas – see warning labels
  - Validate that internal piping to furnace / boiler is separated from propane system and properly sized and tested for new gas burners
  - Modify existing burners and gas valve to accommodate natural gas (see next slide)
  - Assure that venting of products of combustion is properly sized and installed.

Propane to Natural Gas Burner Conversion

- ** Should only done by a qualified technician
- Basic Steps
  - Turn off gas to appliance
  - Replace propane orifice(s) with natural gas orifice(s)
  - Replace propane regulator spring in gas valve with natural gas spring
  - Adjust igniter location
  - Follow start-up procedure and adjust as needed





Furnace/Boiler

- Converting from Fuel Oil
  - Validate that furnace / boiler can be converted to natural gas
  - Size, install and test internal house line piping to furnace / boiler location based on input and distance
  - Replace existing oil burner (see next slide)
  - Assure that venting of products of combustion is properly sized and installed
    - Requires chimney cleaning or liner

Oil Burner Conversion

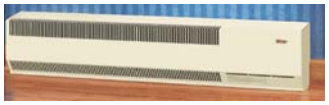
- Carlin Model EZ
  - 50,000 – 275,000 Btu
  - Costs (Residential)
    - Burner $ 450
    - Materials $ 233
    - Labor $ 190
    - Overhead $ 577
    - Total Installed Cost $1,459

Chimney Liner

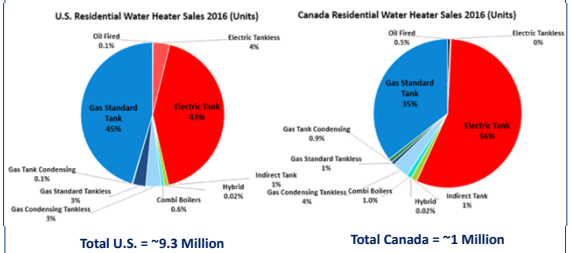
Typically
$500-$700

Baseboard

- Converting from Electric to Gas Baseboard
  - Size, install and test internal house line piping to baseboard location(s)
  - Remove electric baseboard(s) and replace with new gas baseboard(s)
  - Properly vent to outside



Water Heater Sales

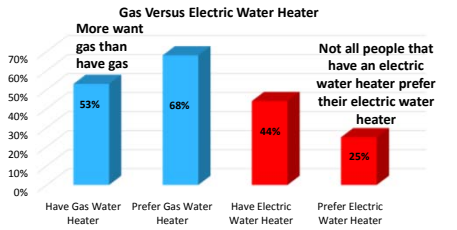


Total U.S. = ~9.3 Million

Total Canada = ~1 Million

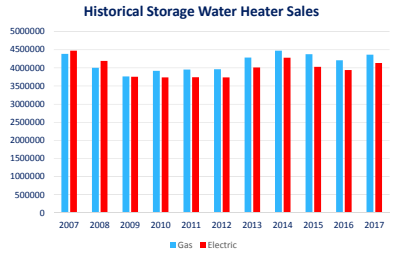
Consumer Preference

(Results from a national consumer preference study)



New Homeowner Energy Preference Survey 2016, Woodland O'Brien & Scott

Residential Gas & Electric Storage Water Heater Shipments in the U.S.



Roughly ½ of all tank water heaters sold are electric

AHRI Historical data through 2016 and extrapolated for 2017

Water Heater

- Converting from Electric
  - Size, install and test internal house line piping to water heater location (may be a new location to facilitate venting)
  - Remove electric water heater and install new gas water heater (may require rerouting of water piping if location is changed)
  - Install proper venting for products of combustion

Gas vs. Electric Tank Water Heater

AO Smith Signature 40 Gallon **Gas**, .57 UEF

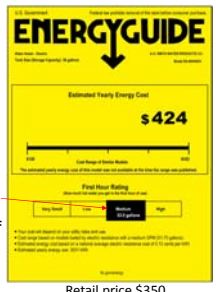
Retail price $409

These units are in no way equal, other than size and similar costs.

First Hour Rating
Gas 66 gallons
Electric 53 gallons

Recovery rates at 90°F
Gas 36 GPH
Electric 20.7-GPH

AO Smith Signature 40 Gallon **Electric**, .92 UEF



Retail price $350

Source: Lowes.com

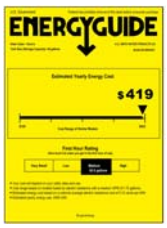
Gas vs. Electric Tank Water Heater

Comparing 40 gallon base model gas to similar electric tank water heater:

- Gas model provides 13 additional gallons of hot water in the first hour of use
- Gas model recovers almost twice as fast with 36 GPH compared to 20.7 GPH for electric model
- Gas model operating cost is ½ that of the electric unit.
- The Gas model does cost $59 more than the electric unit at the retail store, but payback is approx. 3.5 months.

Source: Lowes.com

Larger Electric AWH is needed to Produce the Same Hot Water as a Gas Tank AWH



50 Gallon: Retail $408
62 Gal first hour
20.7 GPH recovery

Gas 40 Gallon unit has a First Hour Rating of 66 gallons

Recovery rate of Gas model is 36 GPH

For all electric models in this example the recovery rate is still about ½ as fast as the gas model, & the annual operating costs are 2X the 40 gallon gas model.

55 Gallon: Retail $440
72 Gal first hour
20.7 GPH recovery

Source: Lowes.com

Water Heater Comparison Summary

AO Smith Signature Series AWHs	Electric	Electric	Electric	Gas
Size (Gallons)	40	50	55	**40**
Warranty (Years)	6	6	6	**6**
UEF Factor	.92	.93	.93	**.57**
Retail Price	$350	$408	$440	**$409**
Annual Energy Cost	$424	$419	$419	**$212**
Recovery Rate GPH	20.7	20.7	20.7	**36.4**
First Hour Rating (Gallons)	53	62	72	**66**

This table compares 4 AO Smith water heaters all from the same Signature line of products. All have the same warranty and the only difference is the fuel used and size. The retail price of water heaters increases with size increase.

Source: Lowes.com

Comparison Break Down

Rheem Basic AWHs	Electric	Electric	Electric	Gas
Size (Gallons)	40	50	55	**40**
Recovery Rate GPH	20.7	20.7	20.7	**36.4**
First Hour Rating (Gallons)	53	62	72	**66**

The single most important item that allows us to compare one water heater to another is the First Hour Rating. The First Hour rating tells the consumer how many gallons of hot water the unit will produce before it is considered cold.

Notice that the gas model recovers almost twice as fast as the electric models.

As soon as you try and install an electric tank water heater greater than 55 gallons, you are forced to a heat pump water heater as the only products that meet the minimum energy efficiency standard for this size water heater.

Source: Homedepot.com

Water Heater Minimum UEFs

				Current Minimum UEF			
		Volume (Gal)	4/16/15 EF	Very Small UEF	Low UEF	Medium UEF	High UEF
Gas Storage	≥20 and ≤55	30	0.63		0.54	0.60	0.65
		40	0.62		0.53	0.58	0.64
		50	0.60		0.51	0.57	0.63
	>55 and ≤100	65	0.75			0.77	0.79
		75	0.74			0.76	0.79
Gas Tankless	<2 and >50,000 Btu/h)	1.5	0.82			0.81	0.81
Electric Storage	≥20 and ≤55	30	0.95		0.92	0.93	
		40	0.95		0.91	0.92	
		50	0.95		0.91	0.92	
	>55 and ≤120	65	1.98			2.05	2.18
		80	1.97			2.04	2.16
		100	1.94			2.02	2.14
		120	1.92			2.00	2.12
Electric Tankless		<2	0.93	0.91	0.91	0.91	0.92
Oil Storage	≤50	30	0.62		0.49	0.57	0.65
		50	0.59		0.46	0.54	0.60
Grid-Enabled Water Heaters	>75	80	0.93			0.91	0.92
		100	0.89			0.90	0.91
		120	0.86			0.88	0.90

Water Heater

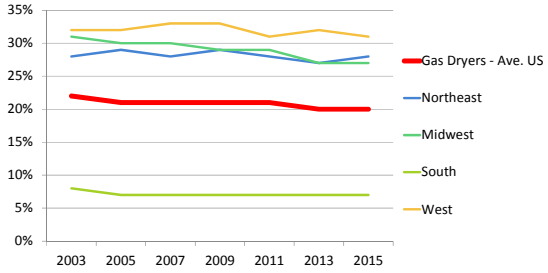
- Converting from Propane
  - The conversion from propane to natural gas is fairly easy in most appliances.
  - The conversion of a Flammable Vapor ignition Resistant propane water heater is not easy.
    - Often must replace the gas valve, pilot assembly and burner which could cost $500
    - It would not cost much more to install a new atmospheric natural gas water heater

Water Heater

- Converting from Fuel Oil
  - Validate that water heater can be converted to natural gas – see warning label
  - Note that it could be less money to install a new gas water heater than to convert an oil fired water heater

Dryer Market Penetration

(Represents the % of homes that have a dryer on piped gas of all homes that have a dryer)



AGA's Residential Natural Gas Market Survey, 3/2017, & American Housing Survey (AHS)

Dryer Market Penetration

(Represents the % of homes that have a dryer on piped gas of all homes that have a dryer)

Gas Clothes Dryers	2003	2005	2007	2009	2011	2013	2015
US	**22%**	**21%**	**21%**	**21%**	**20%**	**20%**	**20%**
Northeast	28%	29%	28%	29%	28%	27%	28%
Midwest	31%	30%	30%	29%	29%	27%	27%
South	8%	7%	7%	7%	7%	7%	7%
West	32%	32%	33%	33%	31%	32%	31%

Lots of opportunity to replace electric dryers with natural gas dryers.

Only 27% of homes with natural gas service have a gas dryer.

AGA's Residential Natural Gas Market Survey, 3/2017, & American Housing Survey (AHS)

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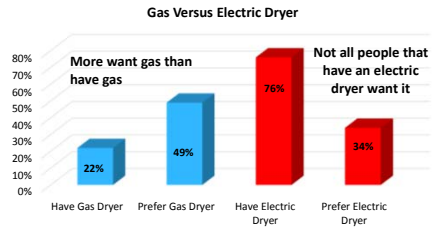
Consumer Preference - Dryers

(Results from a national consumer preference study)



New Homeowner Energy Preference Survey 2016., Woodland O'Brien & Scott

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Dryer Costs

$399

Maytag 7-cu ft Electric Dryer (White)

Source: Lowes.com

$499

Maytag 7-cu ft Gas Dryer (White)

- 8 Loads per week =~ 3.7 MCF/Year gas or 967 KWH electric *
- Gas Dryer costs $37/year at $10/MMBTU
- Electric Dryer costs $145/year at $.15/KWH
- **Save about $108/year with gas dryer = ~1 year payback**

* Usage from ESC's Residential Energy Calculator

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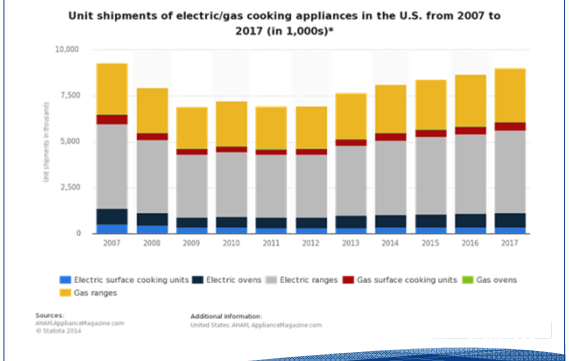
Dryer

- Converting from Electric
  - Size, install and test internal house line piping to dryer location based on burner input and distance
  - Check for proper electrical outlet for gas dryer
    - Look at where the washer is plugged in for 110V
  - Replace electric dryer with new gas dryer
  - Check for proper dryer venting installation

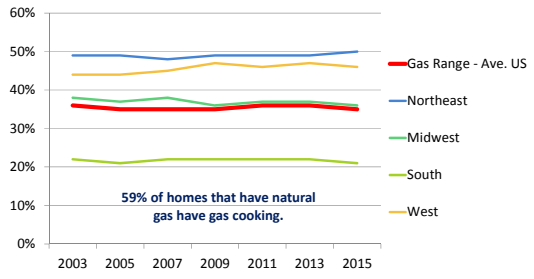
Dryer

- Converting from Propane
  - Validate that dryer can be converted to natural gas – see warning label
  - Validate that internal piping to dryer is separated from propane system and properly sized and tested for new gas burner
  - Modify existing burner and gas valve to accommodate natural gas
  - Assure that dryer vent is properly sized and installed



Range Market Penetration

(Represents the % of homes that have a gas cooking of all homes that have cooking equipment)

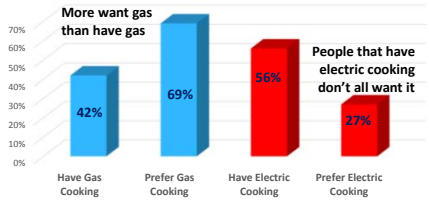


AGA's Residential Natural Gas Market Survey, 3/2017, & American Housing Survey (AHS)

Consumer Preference

(Results from a national consumer preference study)

Gas Versus Electric Cooking



New Homeowner Energy Preference Survey 2016., Woodland O'Brien & Scott

Range Costs

$399

Whirlpool Freestanding 5.1-cu ft Gas Range (White) (Common: 30-in)

Source: Lowes.com

$359

Whirlpool Freestanding 4.8-cu ft Self-Cleaning Electric Range (White)

- Cooking =~ 5 MCF/Year gas or 792 KWH electric *
- Gas range costs $50/year at $10/MMBTU
- Electric range costs $119/year at $.15/KWH
- **Save about $69/year with gas range = <1 year payback**

* Usage from ESC's Residential Energy Calculator

Range

- Converting from Electric
  - Size and install internal house line piping to range location
  - Replace electric range with gas range
  - No change in venting is required

Range

- Converting from Propane
  - Validate that range can be converted to natural gas – see warning label
  - Validate that internal piping to range is separated from propane system and properly sized and tested for new gas burners
  - Modify existing burners and gas valve to accommodate natural gas

Hearth Products

- Approx. 8% of all U.S. homes have a secondary wood heating source. (9.3 million homes)
  - ~ 40% are heating stoves
  - ~ 60% are fireplaces (5.5 million)
    - An existing wood fireplace may be a good opportunity to convert to gas.
- Free standing stoves are good for basements, 3 season rooms, or other un-heated spaces.

EIA's Residential Energy Consumption Survey data 2015

Fireplace

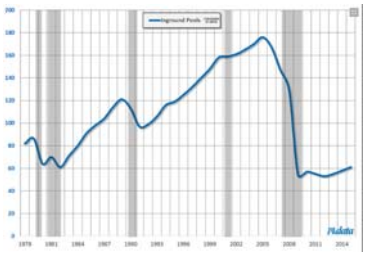
- Log Starter / Lighter – natural gas is used to start or assist burning of logs with or without the use of paper or kindling
  - Cleaner burning
  - Reduced emissions
  - Increases heat output
  - Improves draft

Fireplace

- Gas Log Sets
  - Installs in wood fireplace
    - Vented (functional chimney or flue)
    - Vent free (check codes)
    - Widths from 12” to 96” + custom sized sets
    - Outputs from 20,000 Btuh

Pool Heaters

New residential inground pool construction (thousands of units) in the US, 1978-2015. Shaded areas represent recession periods.



~ 60K/Year

https://aquamagazine.com/news/pkdata-report-25-million-new-pools.html#lightbox/1/

Pool Heater

- Converting from Propane
  - Validate that pool heater can be converted to natural gas – see warning labels
  - Validate that buried house line piping to heater is separated from propane system and properly sized and tested for new gas burners
  - Modify existing burners and gas valve to accommodate natural gas
  - Assure that venting of products of combustion is properly sized and installed

Outdoor Grill

- Converting from Propane
  - Verify that the grill has the dual-fuel designation and that there is a conversion kit available
  - Size, install and test proper buried house line piping to grill or quick disconnect location
  - Install conversion kit per manufacturer directions
    - Kits range from ~$40-$60

Outdoor Lamps, Torches

- Can replace electric lighting or add supplemental lighting
- Install lamp(s) per manufacturer specifications

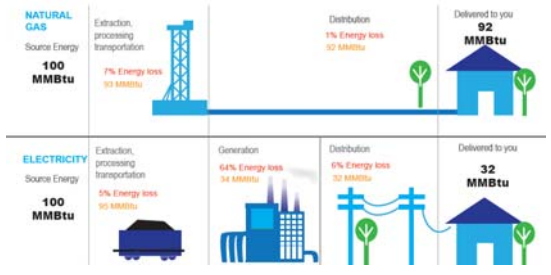
Gas Convenience Outlets
Makes Installation or Redesign 'Plug & Play'

Burnaby Mfg.

Benefits of Conversion

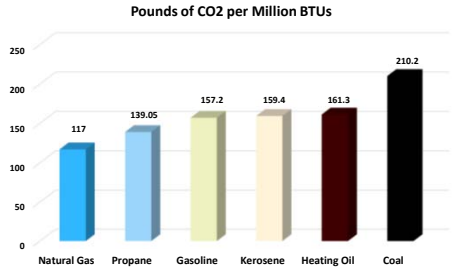
- Lower operating costs
- Convenience
  - No fuel storage
  - No delivery scheduling
- More controllability and comfort
  - Quicker response and demand tracking
- Good for the environment
  - Overall efficiency – Source to Site
  - Less Greenhouse Gas

Source to Site Efficiency



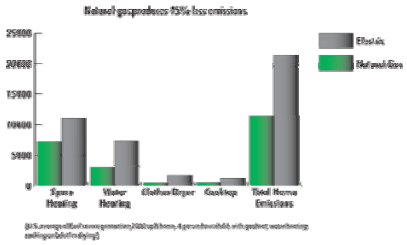
AGA Policy Handbook

Environmental Benefits



https://www.eia.gov/environment/emissions/co2_vol_mass.php

Natural Gas vs. Electric



Learn More

- ESC – www.escenter.org
- US Energy Information Administration – www.eia.gov
- Energy Star – www.energystar.gov
  - EPA program helping businesses and individuals save money and protect the climate through superior energy efficiency


Thank you …
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