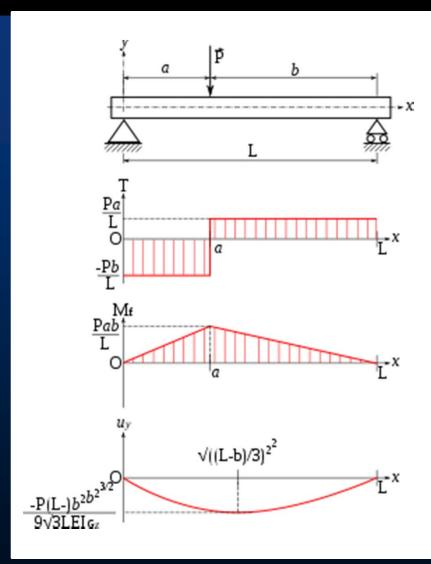


Duncan Prahl, RA
IBACOS
BA Tech Update, April 29, 2013
Denver CO



Caveats About Me:

- I'm an Architect
- I love math and science, but I'm not going to marry it
- My engineering skills are primarily based on osmosis and graphics
- "Close enough is good enough"

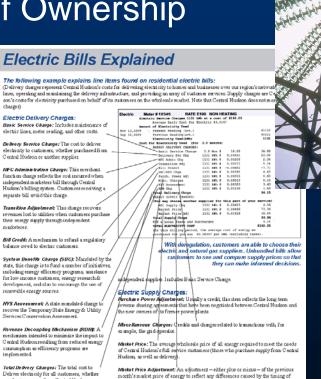




Utility Unbundling

- True costs becoming "transparent"
- Allows for next level of analysis
- Cash flow, Total Cost of Ownership







billing and collection.

Continued on next page

purchasing energy from Central Hudson or en

Martha's Vineyard Community





Specifications

Building System Specification

Below Slab R-20 extruded polystyrene (XPS) foam

Foundation Walls R-20 poly iso foam

Framed Wall R-31 cellulose in 9-1/2" double stud wall

Windows U-value = 0.19, south windows SHGC = 0.62, all others SHGC = 0.48

Air Leakage for Houses 1, 117 to 184 cfm 50

3, and 4

Air Leakage for House 2 236 cfm 50

Roof R-50 unvented attic in 14" deep engineered I joist roof rafter

HVAC – Main Living Space 2-ton mini-split with single head in living room, HSPF 10, SEER 18,

programmable thermostat

Supplemental Heating –

Second-Floor Bedrooms

Supplemental Heating – 600-W radiant electric panel, individual non-programmable thermostat

First-Floor Master Bedroom in bedroom controlling that panel

Ventilation 70-cfm continuous ~55% sensible heat recovery, 35-W fan

Water Heating 50-gallon electric tank type, 0.94 energy factor (EF)

Photovoltaics 5.04-kW grid connected



All Electric Houses in Cold Climates

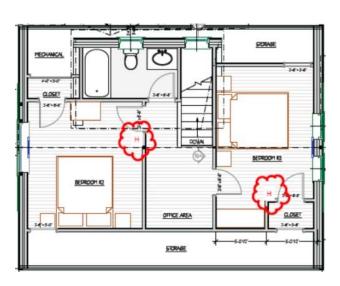
in each bedroom controlling the panel in that bedroom

400-W radiant electric panels, individual non-programmable thermostat

Martha's Vineyard Community



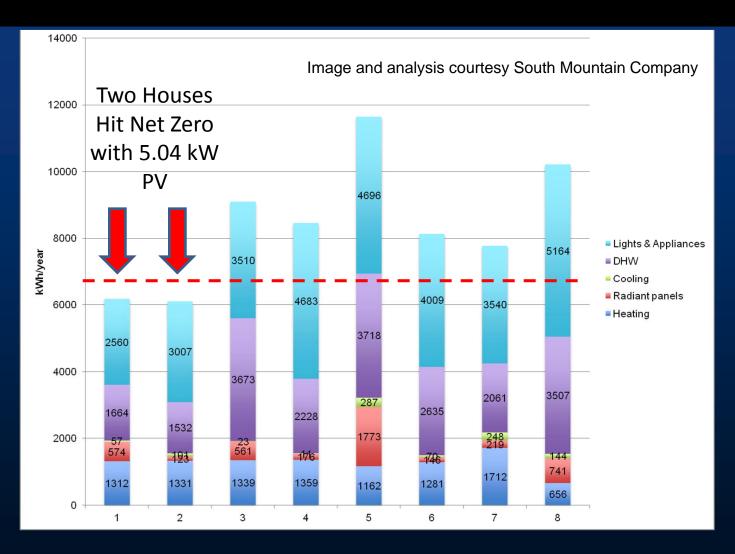




Images courtesy South Mountain Company

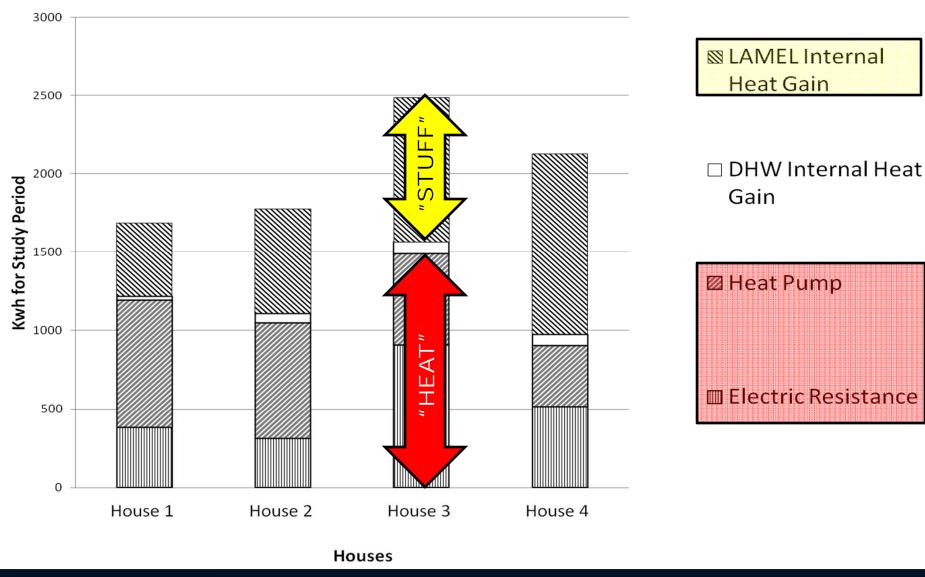


Annual Energy by End Use





Heating Energy Use, Houses 1 through 4, Nov 2010 to Jan 2011



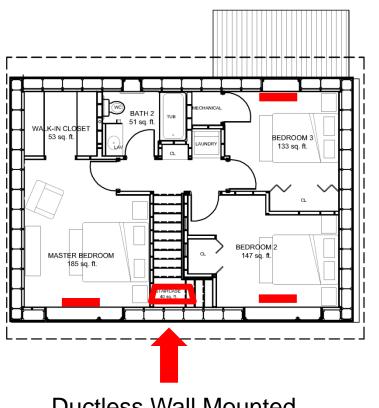


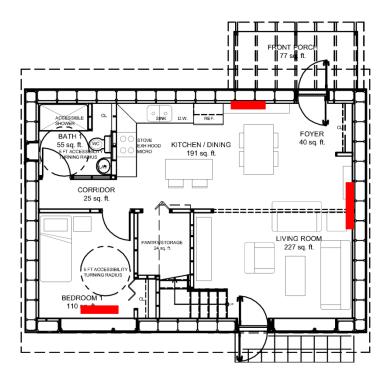
Fairview House, Urbana IL





Fairview House, Urbana IL





Ductless Wall Mounted Heat Pump

Electric Resistance Heater

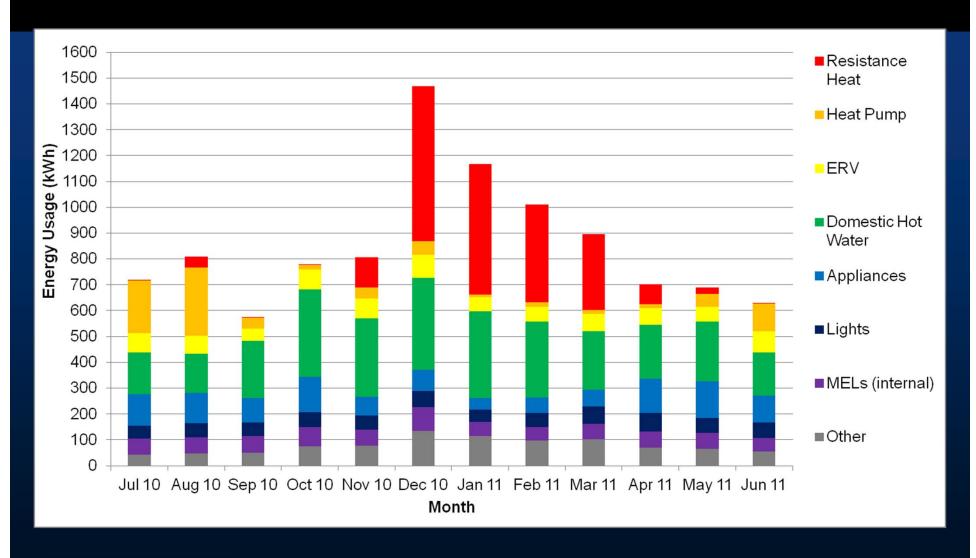


Fairview House, Urbana IL

Building	Illinois House - 1450 sf (135 m²) 3 Bedroom – Passive
Assembly	House
Foundation	Slab on Grade
Slab	2-3/4 in. (70 mm) XPS perimeter insulation R- 14 (U=0.07),
	16 in. EPS under Slab R-64 (U=0.02)
Basement	NA
walls	
Floor over	NA
basement	
Walls	14 in. (356 mm) engineered I joist @ 24 in. (0.6 m) OC, with
	R-1.5 fiberboard sheathing; blown in fiberglass R-57
	$(U_0=0.034)$
Windows	Triple glazed, insulated fiberglass frame, U-0.20, SHGC
	0.23
Roof	16 in. (0.4 m) engineered I joists @ 24 in.(0.6m) OC; blown
	in fiberglass R-64 (U₀=0.017)
Air tightness*	58 cfm @ 50 PA
	(~0.01 ACH nat.)

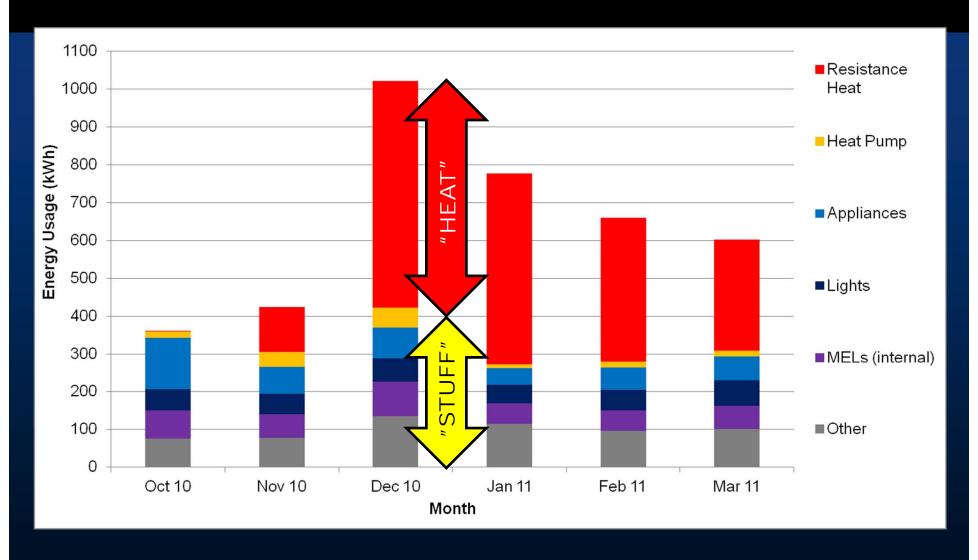


Urbana, IL. Annual Site Energy (kWh)





Heating vs. Internal Gains





Extenuating Circumstances

- What do electric utilities want as load?
 - Good power factor
 - Good load factor
- So:
 - No induction cooking (lousy power factor)
 - No "spiky loads" (resistance heat elements)



Going All Electric (or mostly)

Assumptions:

- You can get a heat pump (minisplit, central unit) installed properly and cost competitively, minimum heating COP 2+
- HPWH (big tank, optimized for HP operation) COP 2+
- You are going to pay an Electric Service Charge anyhow
- Natural gas distribution adds \$1,000 to cost of lot (adds to house cost)
- Gas service charge \$8 / month (BEopt default, low I think) to \$20/month (probably where things are going)



Non Scientific Survey of Gas Service Charges (Hint: Google "Natural Gas Service Charge")

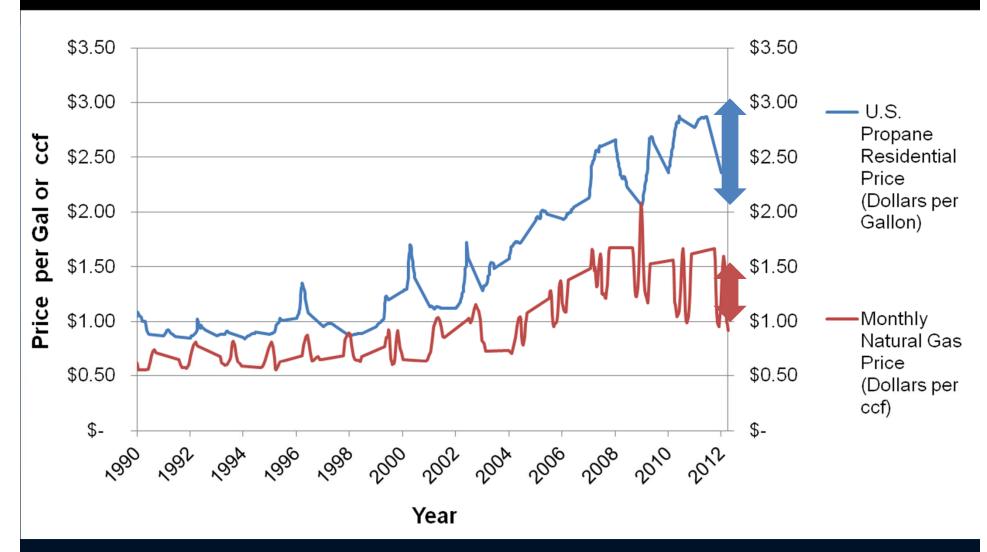
Utility	\$\$/ Month	Utility	\$\$/ Month	Utility	\$\$/ Month
Oklahoma Natural Gas Company	\$13	NJ Natural Gas Company	\$8	Dominion East Ohio	\$21
Duke Energy Ohio	\$15	PG&E	\$3	Washington Gas - DC	\$8
Centerpoint Energy	\$14	Yankee Gas	\$15	Washington Gas - MD	\$10
Kansas Gas Service	\$15	Midwest Natural Gas	\$12	Washington Gas - VA	\$11
Georgia Natural Gas	\$5	Central Hudson Gas & Electric	\$17	Duke Energy Kentucy	\$16
DTE Energy	\$11	Con Ed	\$19	Virginia Natural Gas	\$11
Peoples Gas	\$22	Keyspan Gas	\$15	Atlanta Gas Light CO	\$11
Consumers Energy	\$11	Northshore Gas	\$22	Florida City Gas	\$9
		Chattanoga Gas	\$15		

Average ~\$13 /month



All Electric Houses in Cold Climates

EIA Gas and Propane Prices





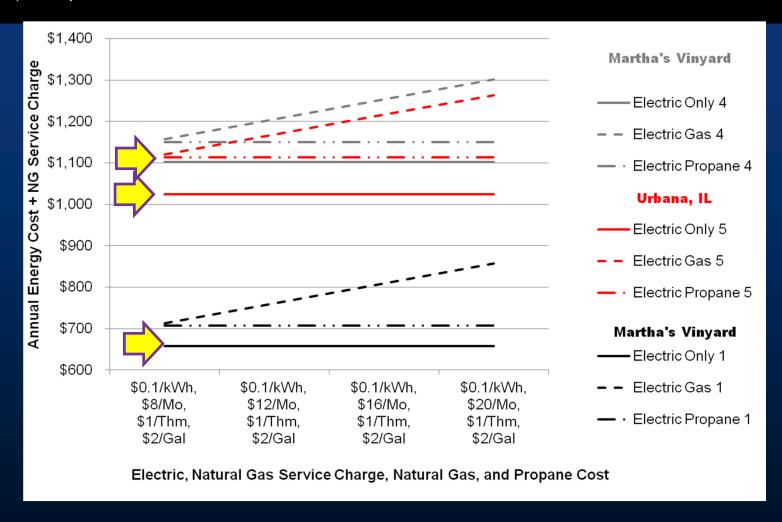
Do some "Architect Math"

- Take metered data, convert Lighting Appliances and Misc. Electric (LAME) loads to Internal Gains using BA HSP Protocol formulae
- Turn some LAME Loads to Fossil Fuel (Range & Dryer) using BA HSP values based on house size and # of BR
- Add gas meter charges in \$4 increments, starting at \$8/mo
- Compare to propane at \$2 & \$3/gal
- Lot costs \$1,000 more for natural gas infrastructure, meter set, hot tap, etc. (~\$7/mo for a 30 year loan, 7%)
- Convert space heat to fossil fuel (90% furnace)
 - site kWh → Btuh x 90% eff x fuel Btu content



Cheap Electric Cheap Gas Cheap Propane

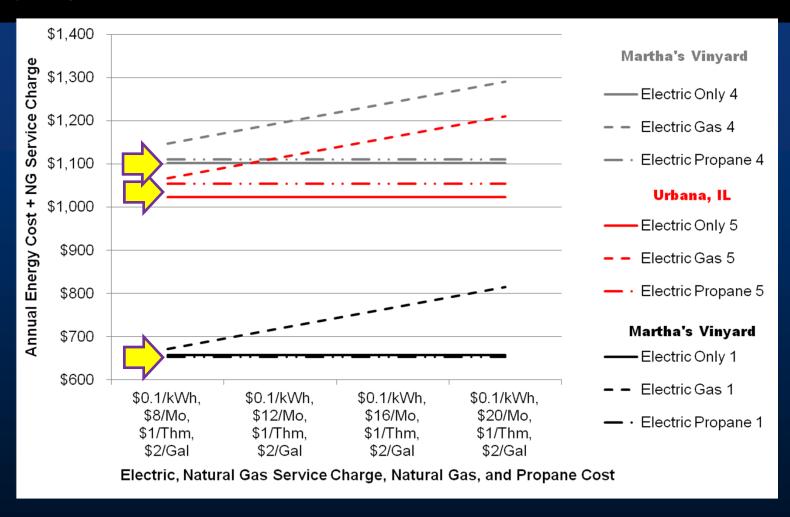
Fossil Fuel Range and Dryer... Go Electric





Cheap Electric Cheap Gas Cheap Propane

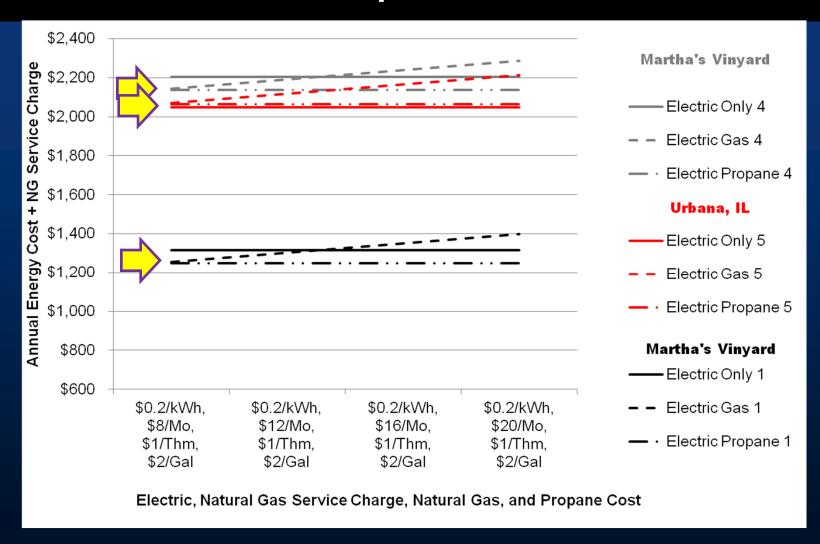
Add Heating Load Go Electric





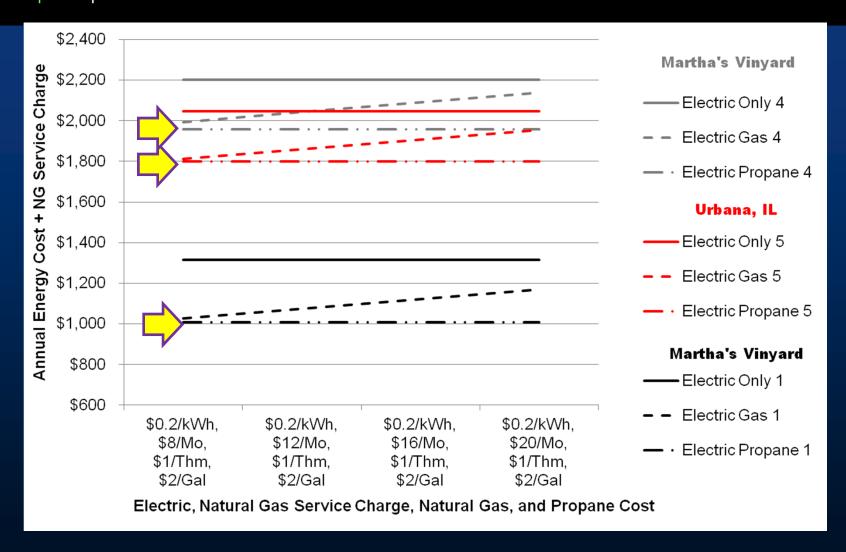
Expensive Electric Cheap Gas Cheap Propane

Fossil Fuel Range and Dryer... Go Propane





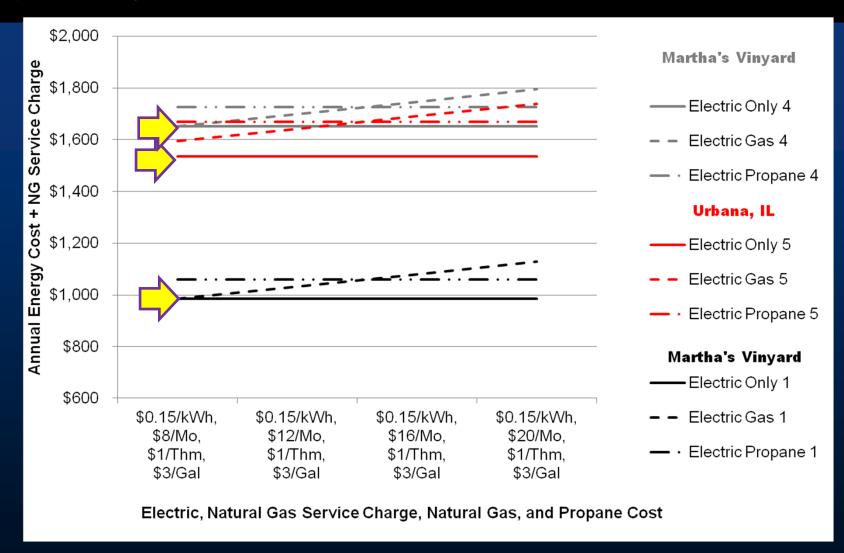
Add Heating Load.... Go Propane





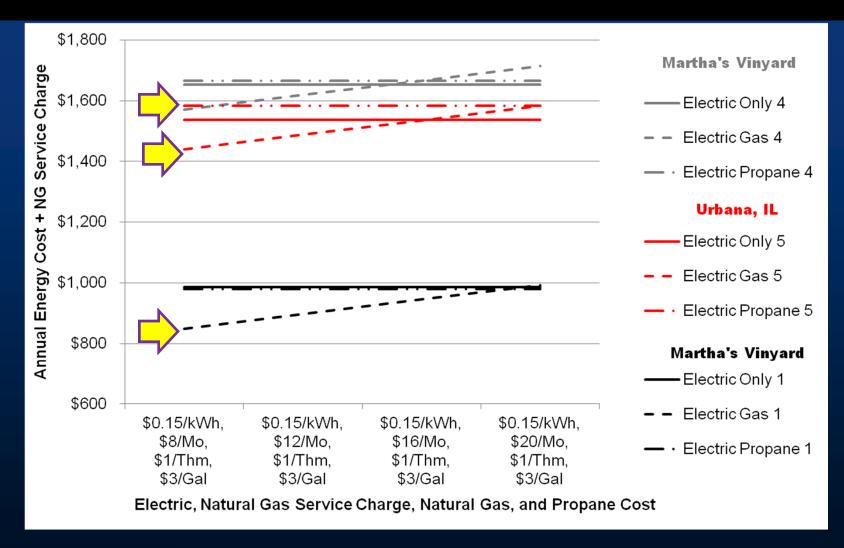
Moderate Electric Cheap Gas Expensive Propane

Fossil Fuel Range and Dryer... Go Electric





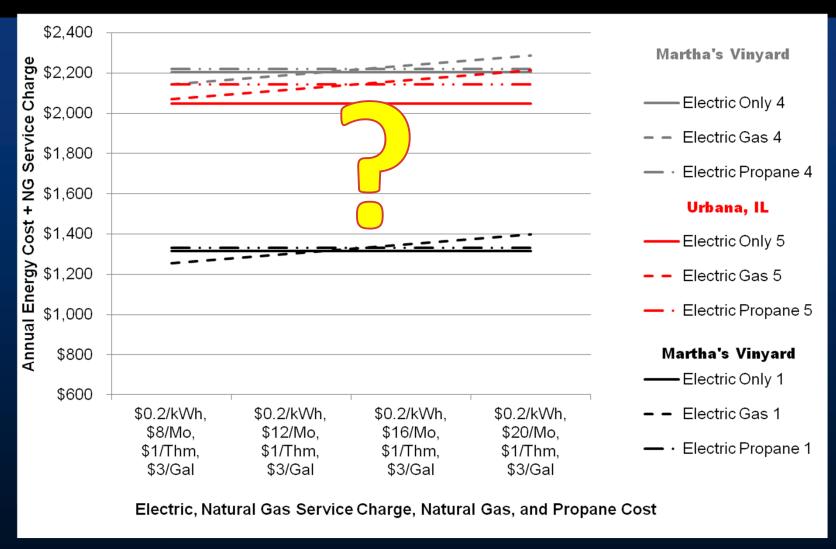
Add Heating Load Go Gas





Expensive Electric Cheap Gas Expensive Propane

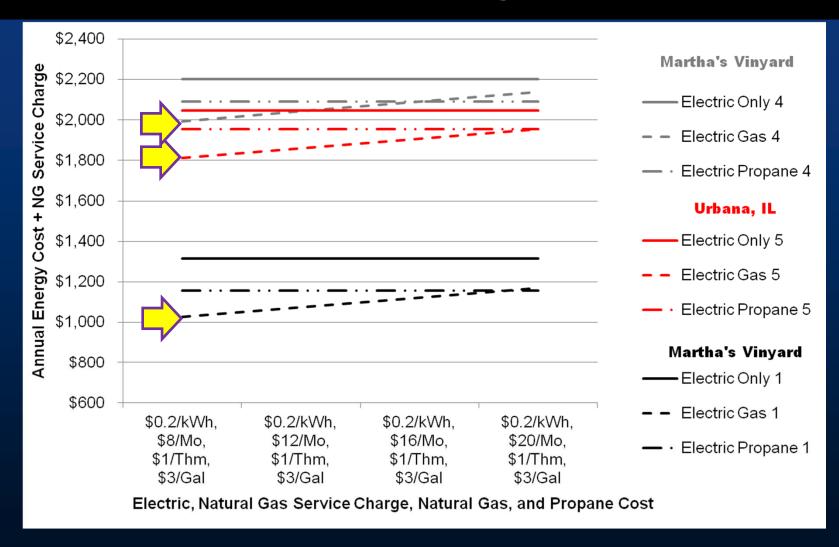
Fossil Fuel Range and Dryer... Go Figure





Expensive Electric Cheap Gas Expensive Propane

Add Heating Load Go Gas (if service charge is less than \$20)





Where does that leave us?

- Internal gains from LAME are providing ~50% of the annual heating loads
- As loads have dropped, other costs should be considered as part of total cost of ownership.
- Local & regional policy may drive fuel choices (e.g. regional GHG reductions or peak loads impacting electric utility strategy)
- The future of distributed natural gas may not be too far off...

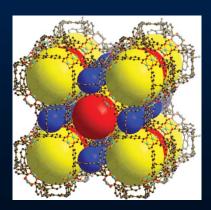


Future of Natural Gas Storage

- ARPA-E aggressively funding (~\$30M) natural gas for vehicular applications, including advanced storage
 - Goal to get approximate Btu density of gasoline from natural gas using "low" pressure distribution
- Gas utilities change from distribution infrastructure to "home delivery"?









Your Car may change the game

- If policy is moving us towards natural gas vehicles,
 then having distribution infrastructure may be desirable
- Cost of infrastructure typically recovered through the monthly service charges / distribution charges
- Due to fixed cost of infrastructure, low usage may drive fixed costs up for consumer.
- Recommendation:
- Still install infrastructure, but consider offering an "off grid" fossil fuel option for buyers



Thank You

Questions?

