



# *AkAES Advisory Group: Meeting #4*

## Energy Cost Drivers in AkAES Communities

Neil McMahon

4/4/2016

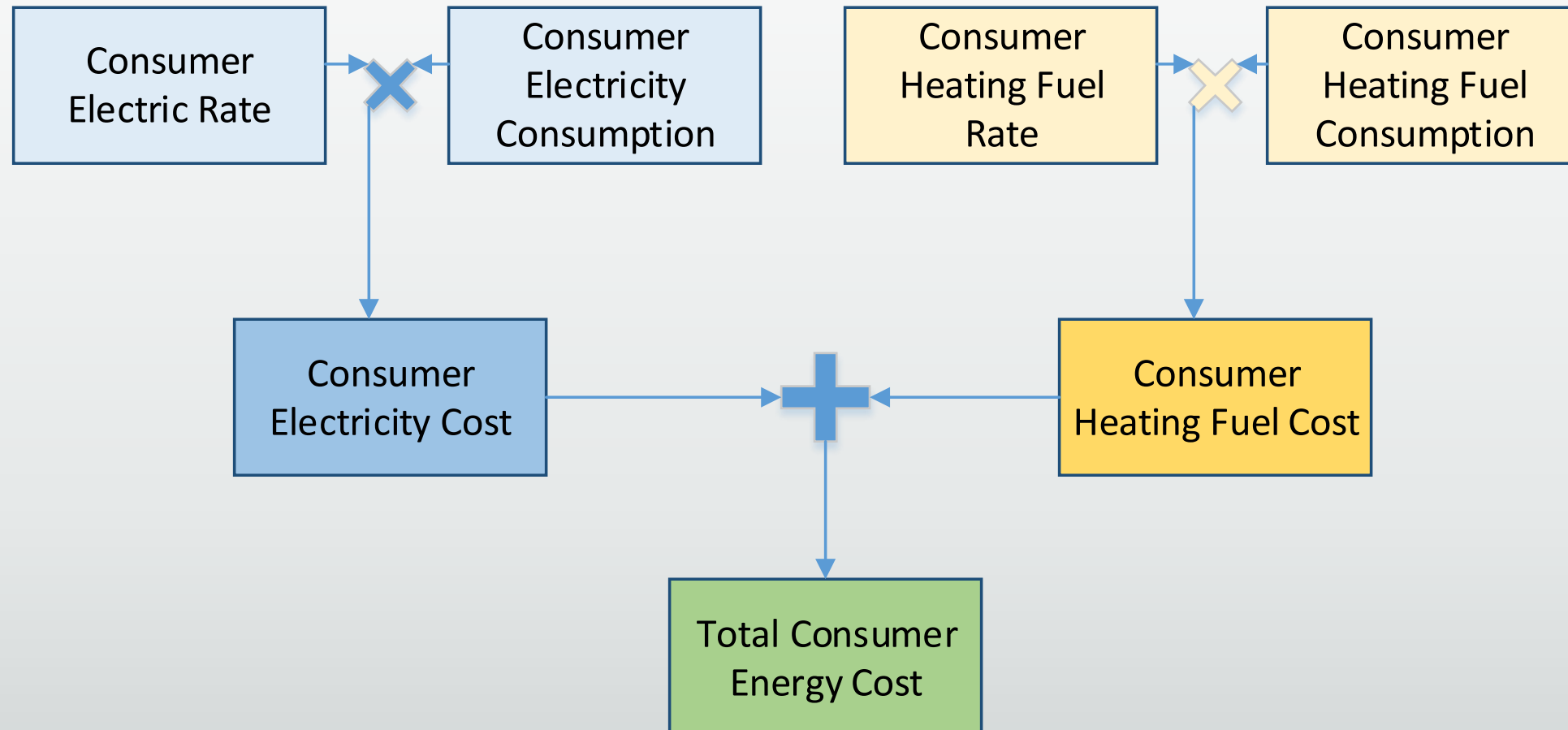
# AkAES Report Outline

- ✓ What is the Alaska Affordable Energy Strategy?
- ✓ What does the energy and demographic profile of the AkAES region look like?
- ✓ What is Affordable Energy?
  - **What Drives the Cost of Energy?**
  - What is needed to maintain the status quo?
  - What strategies can be used to make energy more affordable?
  - What revenue sources are available?
  - What Legislation is being proposed?
  - Appendices

# Why Try to Understand the Cost Drivers?

- Hard to understand how to most cost-effectively reduce costs without knowing what leads to those costs.
  - Where in the supply chain does the state have the most leverage to cost effectively reduce costs?
- Try to understand the entirety of electricity and thermal costs
  - Retail unit price (\$/gallon, \$/kWh)
  - Consumer consumption

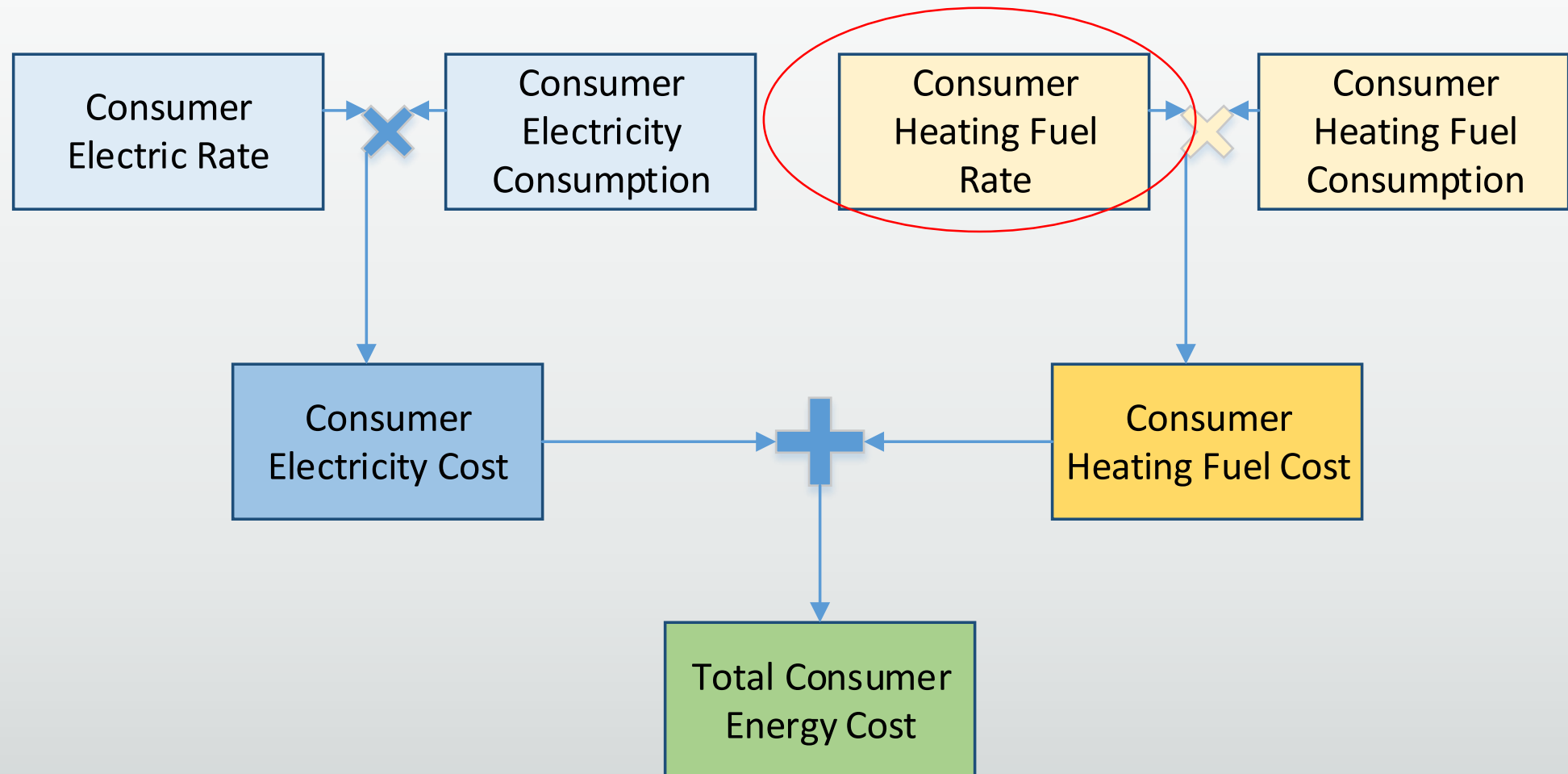
# Factors That Lead to Consumer Energy Costs



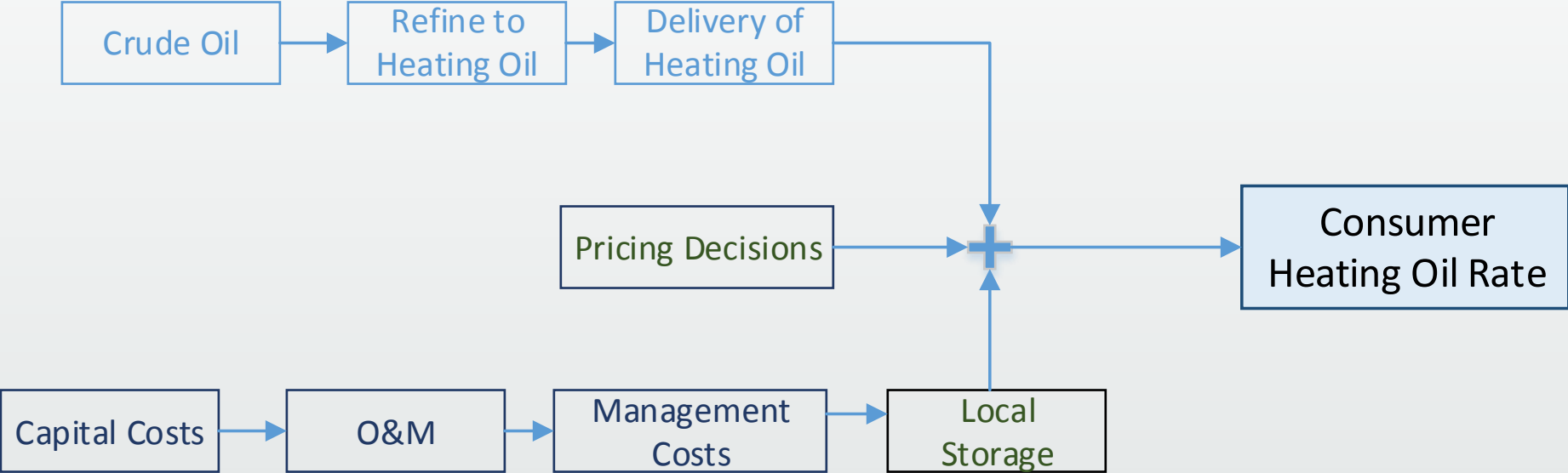
# Heating Fuels

The Drivers for Unit Cost and Consumption

# Factors That Lead to Consumer Energy Costs



# Factors That Lead to Consumer Heating Oil Rate



# Regional Heating Fuel Costs

	2014		2015		2012		2014	
	Heating oil		Firewood (\$/cord)		Electricity (\$/kWh)		Propane (\$/Gal)	
AEA Energy Region	High	Low	High	Low	High	Low	High	Low
<b>Aleutians</b>	\$ 7.65	\$ 4.00	N/A	N/A	\$ 1.08	\$ 0.30	\$ 12.71	\$ -
<b>Bering Straits</b>	\$ 7.44	\$ 4.85	\$ 210	\$ 210	\$ 0.70	\$ 0.36	\$ 17.41	\$ 6.82
<b>Bristol Bay</b>	\$ 8.21	\$ 4.60	N/A	N/A	\$ 0.95	\$ 0.46	\$ 12.97	\$ -
<b>Copper River/Chugach</b>	\$ 7.26	\$ 2.05	N/A	N/A	\$ 0.77	\$ 0.30	\$ 16.23	\$ -
<b>Kodiak</b>	\$ 5.92	\$ 4.36	N/A	N/A	\$ 0.65	\$ 0.19	\$ 8.94	\$ -
<b>Lower Yukon-Kuskokwim</b>	\$ 11.00	\$ 5.15	N/A	N/A	\$ 1.70	\$ 0.52	\$ 19.48	\$ -
<b>North Slope</b>	\$ 8.75	\$ 2.75	N/A	N/A	\$ 0.15	\$ 0.08	\$ 19.83	\$ 7.63
<b>Northwest Arctic</b>	\$ 10.29	\$ 6.25	N/A	N/A	\$ 0.89	\$ 0.43	\$ 14.25	\$ 8.40
<b>Railbelt</b>	\$ 7.24	\$ 3.65	\$ 375	\$ 245	\$ 0.93	\$ 0.15	\$ 6.39	\$ 3.92
<b>Southeast</b>	\$ 5.85	\$ 2.63	\$ 200	\$ 200	\$ 0.78	\$ 0.10	\$ 6.24	\$ 2.32
<b>Yukon-Koyukuk/Upper Tanana</b>	\$ 9.25	\$ 2.05	\$ 495	\$ 200	\$ 1.02	\$ 0.48	\$ 13.98	\$ -

Data Sources:  
 Heating oil & Propane: AHFC/DCRA surveys in Alaska Energy Data Gateway  
 Firewood: AEA contacts with regional LIHEAP providers  
 Electricity: Alaska Energy Statistics (2012)



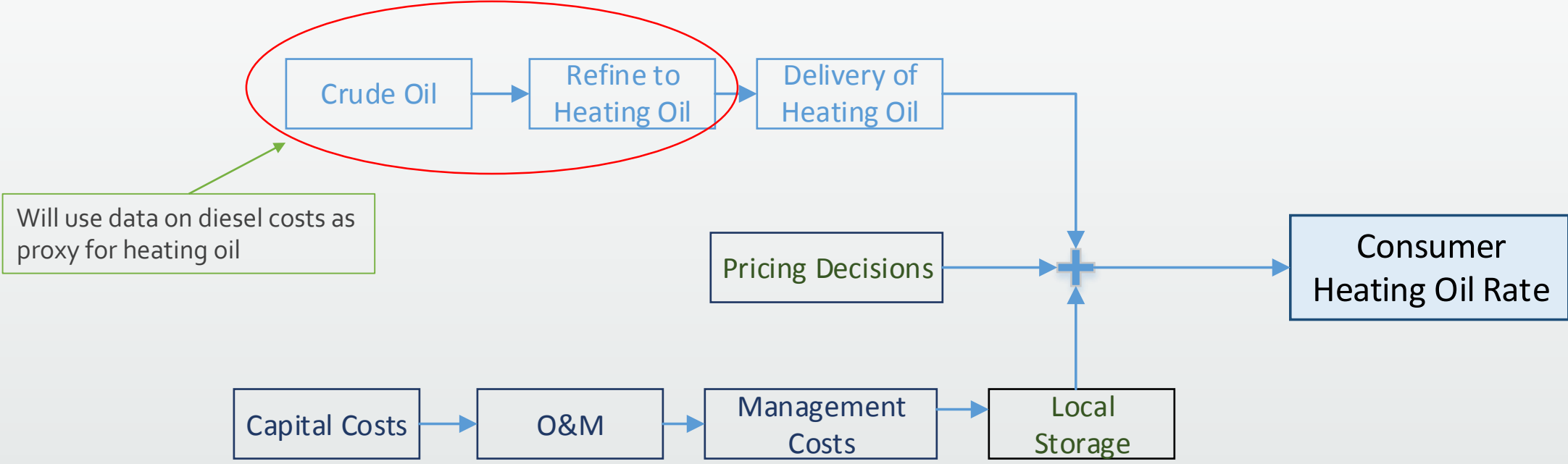
# Electricity and Equivalent Heating Oil rates

Electricity (\$/kWh)	Electricity efficiency	Heating oil Efficiency	Equivalent Heating Oil (\$/Gal)
\$ 0.05	99%	80%	\$ 1.64
\$ 0.08	99%	80%	\$ 2.45
\$ 0.10	99%	80%	\$ 3.27
\$ 0.13	99%	80%	\$ 4.09
\$ 0.15	99%	80%	\$ 4.91
\$ 0.18	99%	80%	\$ 5.72
\$ 0.20	99%	80%	\$ 6.54
\$ 0.23	99%	80%	\$ 7.36
\$ 0.25	99%	80%	\$ 8.18
\$ 0.28	99%	80%	\$ 8.99
\$ 0.30	99%	80%	\$ 9.81

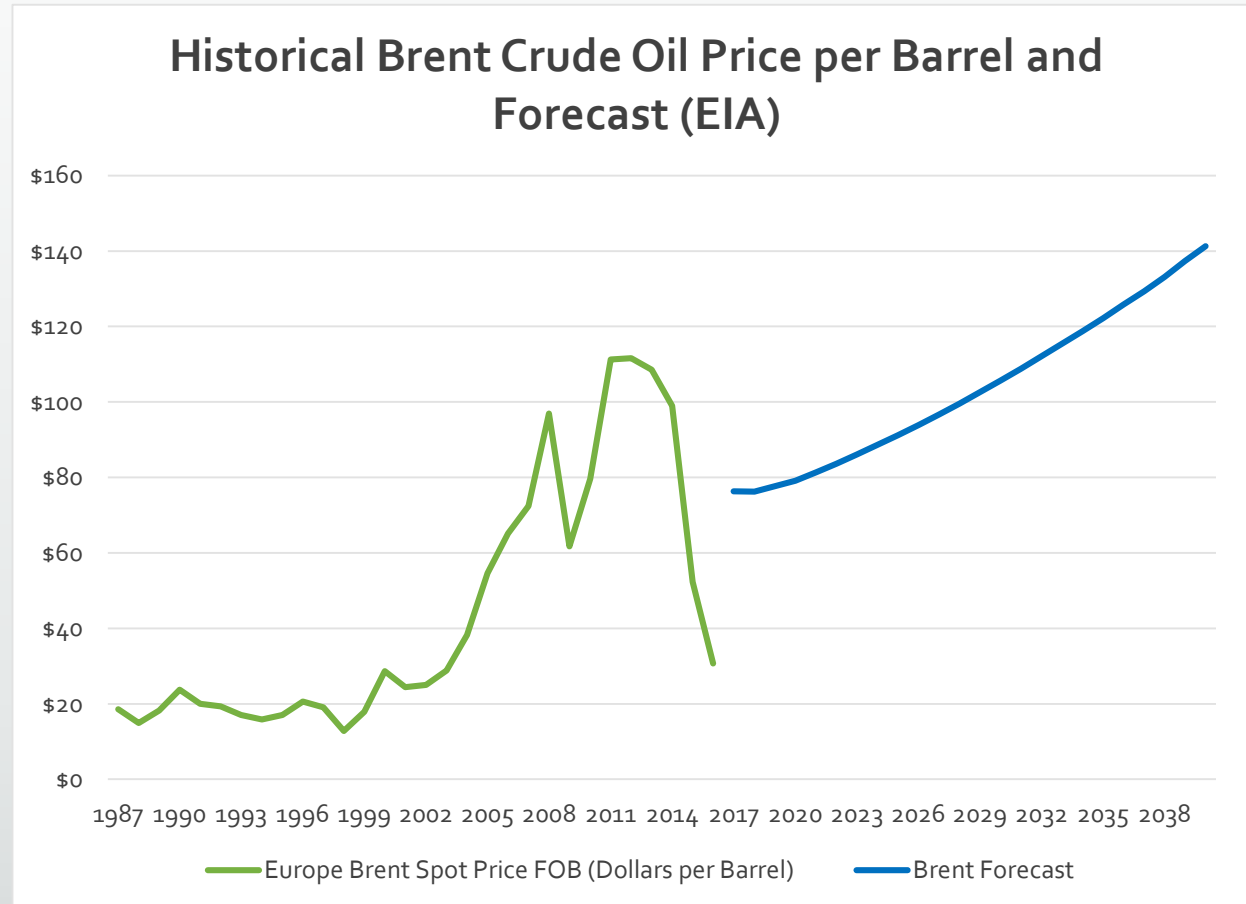
Electricity has to be very inexpensive to compete with heating oil

Rest of presentation will focus on heating oil

# Factors That Lead to Consumer Heating Oil Rate

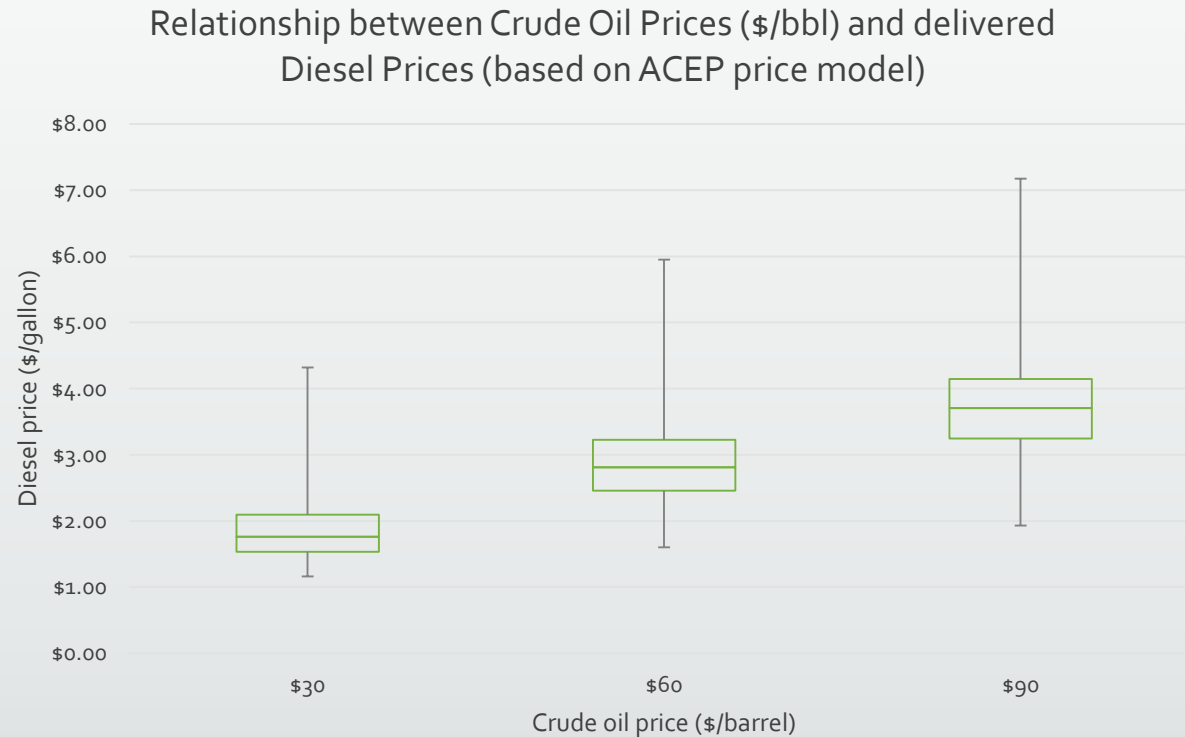


# Crude Oil Price



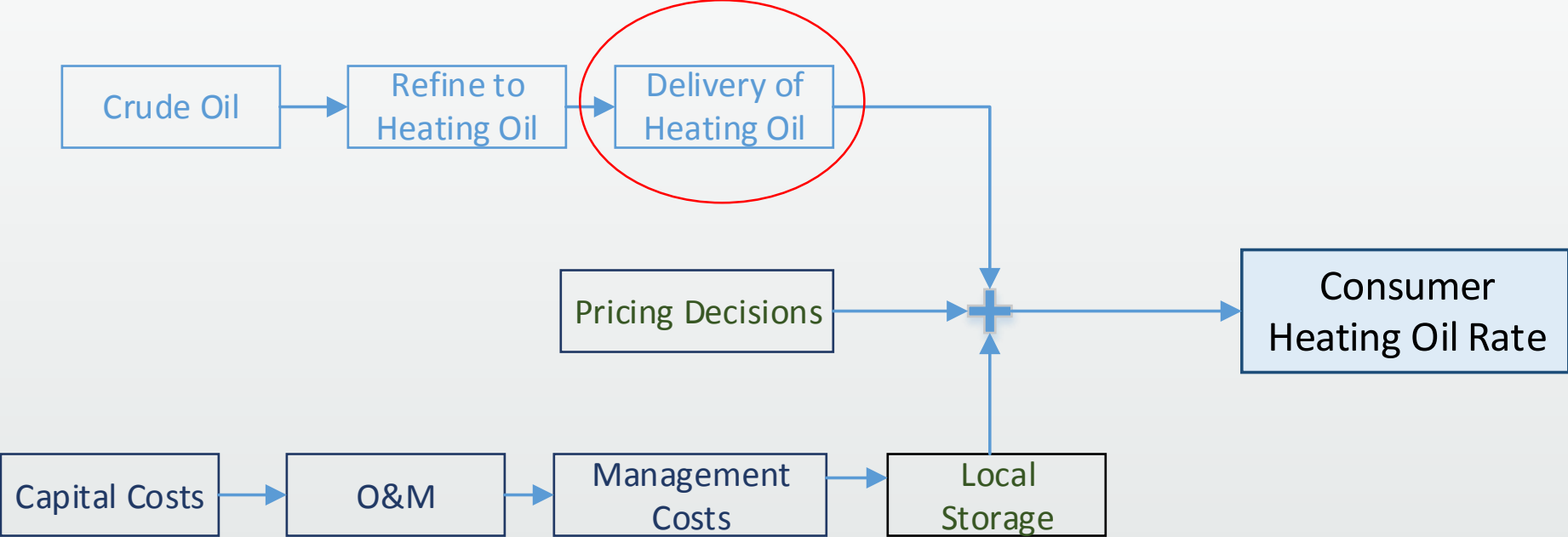
- Highly volatile in past 15 years
- Difficult to predict
  - 2015 EIA prediction in blue
    - Obviously inaccurate for current year

# Crude Oil and Utility Diesel



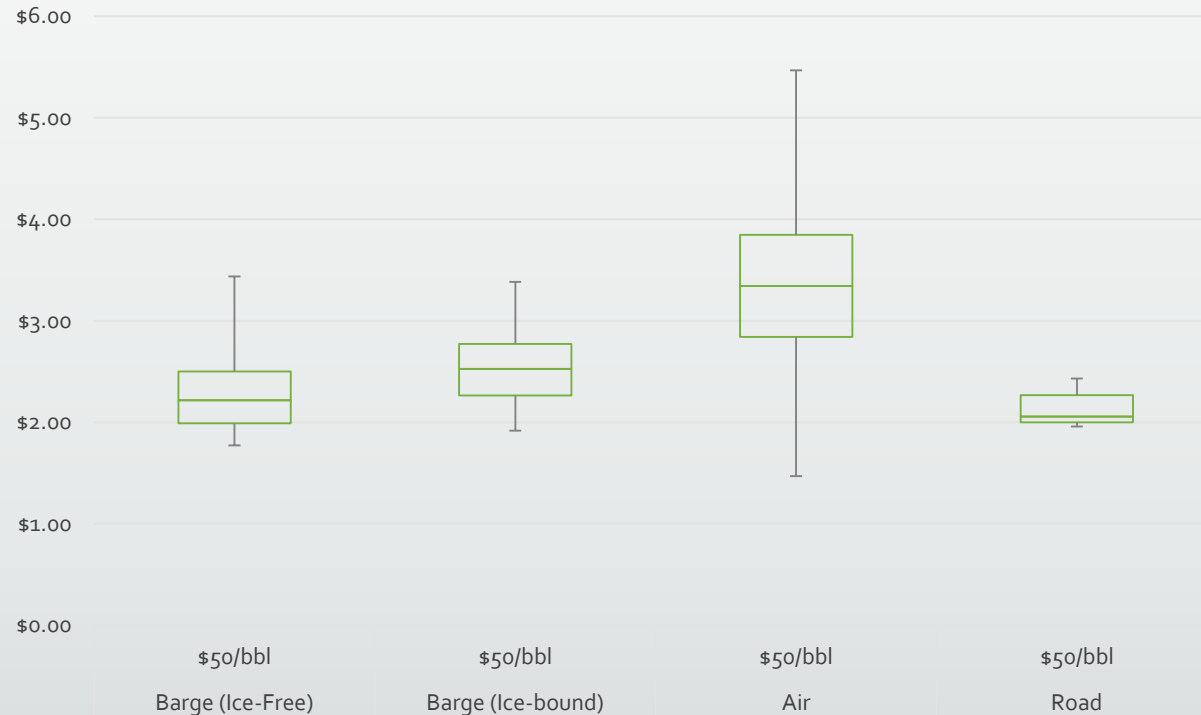
- Not one-to-one ratio between crude oil and diesel prices— from \$30-\$90/bbl the price of crude triples but the price of diesel does not quite double
  - Delivered price of fuel includes a number of different costs
  - Even if diesel was free, still cost to deliver & store

# Factors That Lead to Consumer Heating Oil Rate



# Mode of Transportation

Delivered Price of fuel to PCE communities by transportation mode  
(2014 ACEP model)



- Barge: wide range of costs
  - Ice-free: SE, Kodiak, Aleutians
  - Ice-bound: Interior rivers, north of Alaska Peninsula
- Air: ranges from least expensive to most expensive
  - Mostly communities without barge access
- Road: Generally least expensive

# Barge Costs

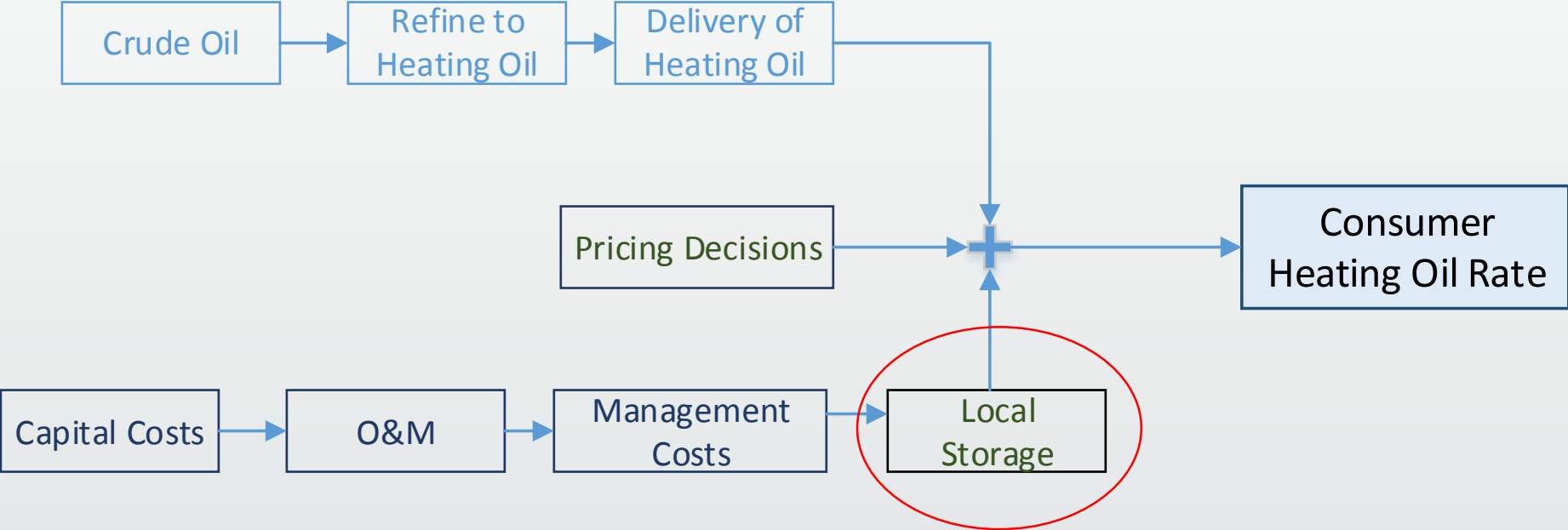
Transportation Costs for Ice-Bound Barging (\$/gallon)		
Linehaul	Capex	\$ 0.20
	Opex	\$ 0.25
Lightering	Fuel Transfers & Wharfage	\$ 0.06
	Capex	\$ 0.26
	Opex	\$ 0.34
Other	Local challenges	\$ 0.15
	Working capital	\$ 0.03
	Admin	\$ 0.07

Ice-bound chosen as the extreme case of delivering costs

- Linehaul: large ocean-going barges.
  - Carry 2-3M gallons. Require 18-25' draft
- Lightering
  - Smaller barges for river/coastal deliveries
  - 200-300,000 gallons
- Neither linehaul or lightering barge OPEX are particularly sensitive to fuel costs
- Other
  - Local challenges
  - Financing costs for unpaid for fuel
  - Administration for fuel delivery

Adapted from ISER 2010.

# Factors That Lead to Consumer Heating Oil Rate





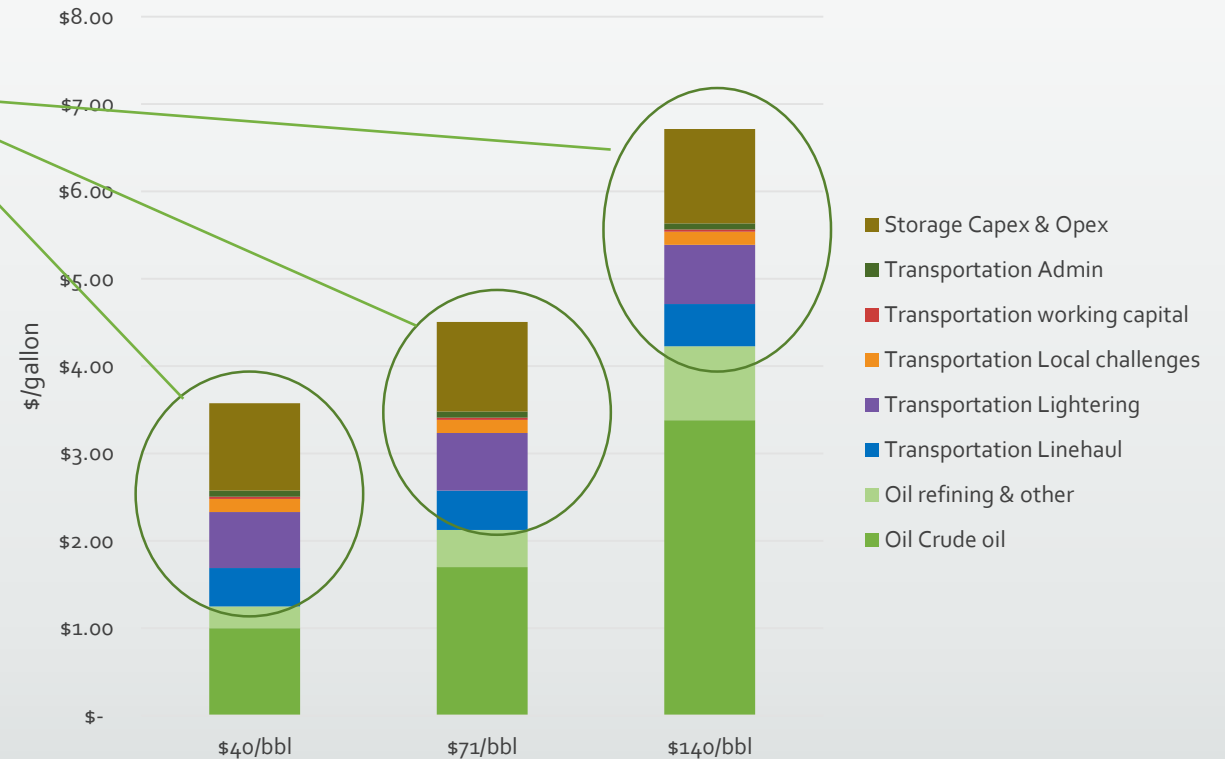
# Storage & Total Costs

Storage Costs (\$/gallon)	
Capex	\$ 0.60
Opex	\$ 0.30
Working Capital	\$ 0.10

- Storage:
  - Capital costs generally not booked
  - Operation costs not specifically reported to RCA

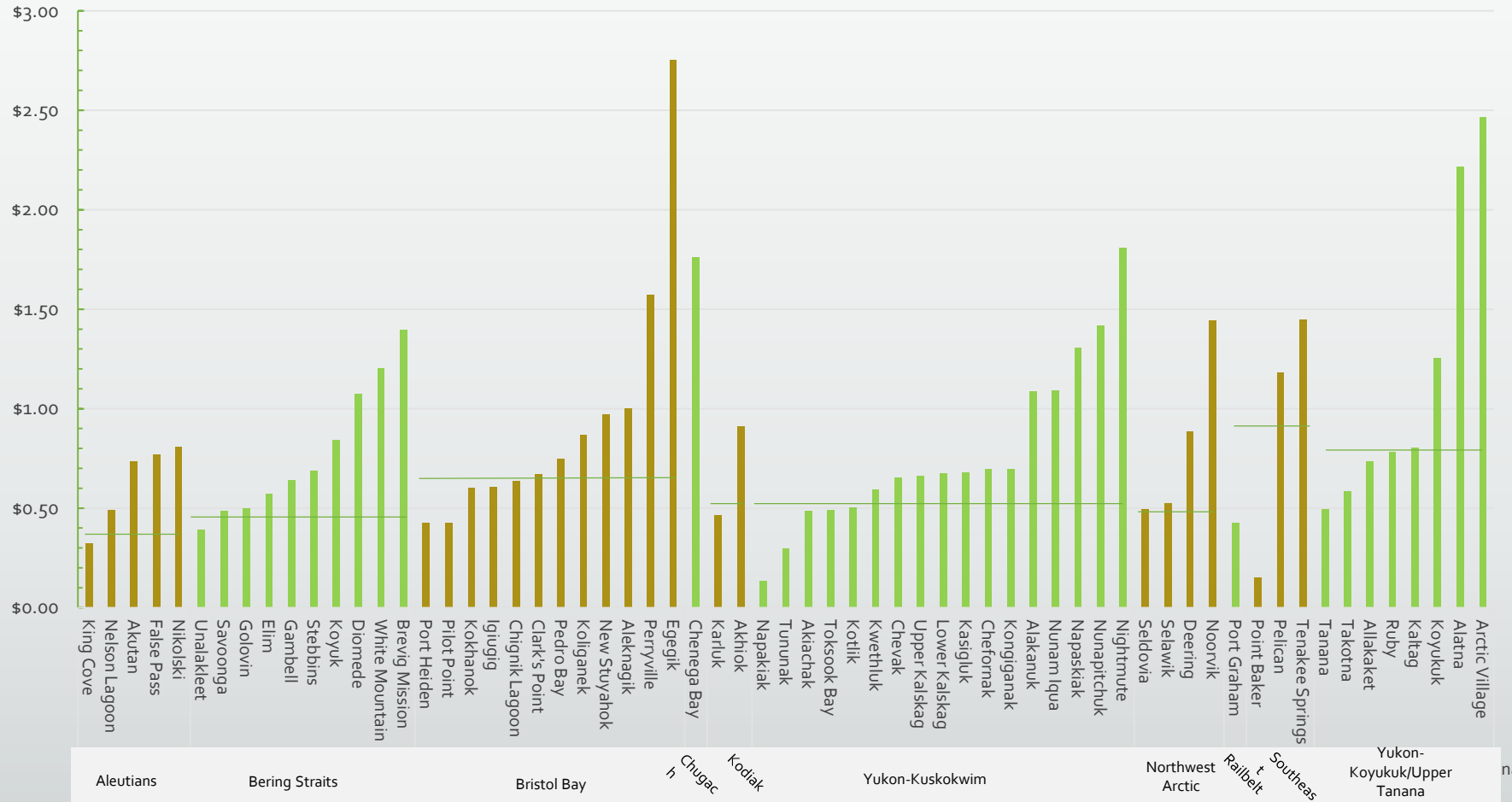
Non-fuel costs do not increase significantly with increased crude prices

Components of Utility Diesel Cost in Remote High Cost Community



# Unbooked Capital Expenses: Fuel Storage

Value of Bulk Fuel Upgrades as Equivalent \$/gal  
(Assumes 40-year life, one inventory turnover per year, 5% financing)

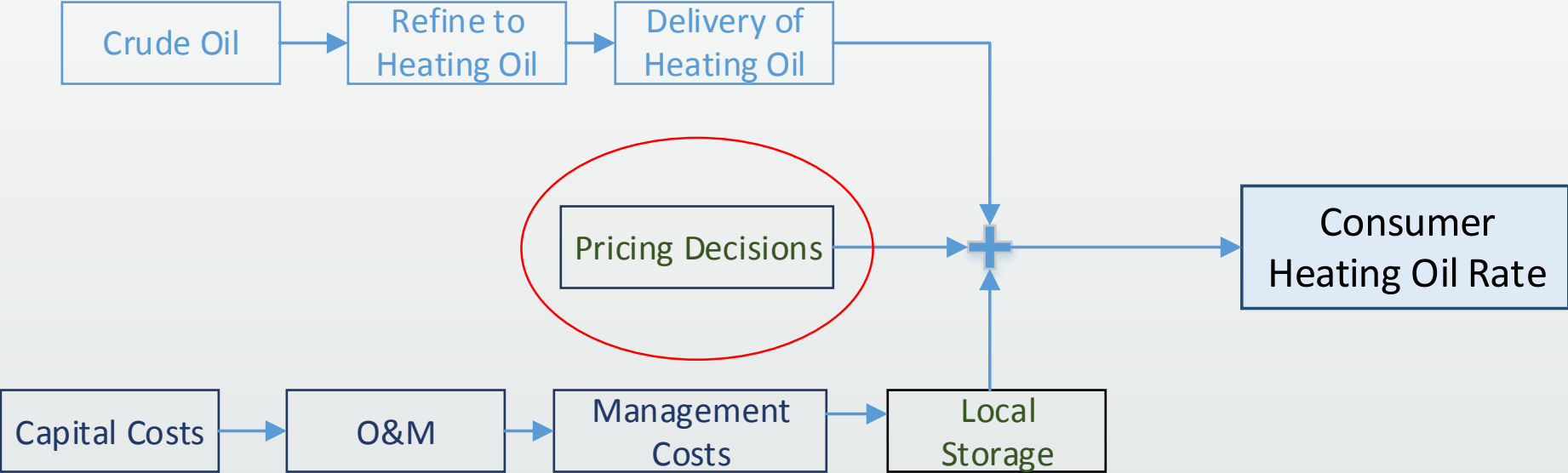


- Graph overstate additional costs in some communities with multiple fuel deliveries per year
  - (Arctic Village, Akutan, Tenakee Springs, for instance)
  - More turnover = lower per unit costs
- The projects for these communities were not just for the heating oil

# Retail Heating Oil

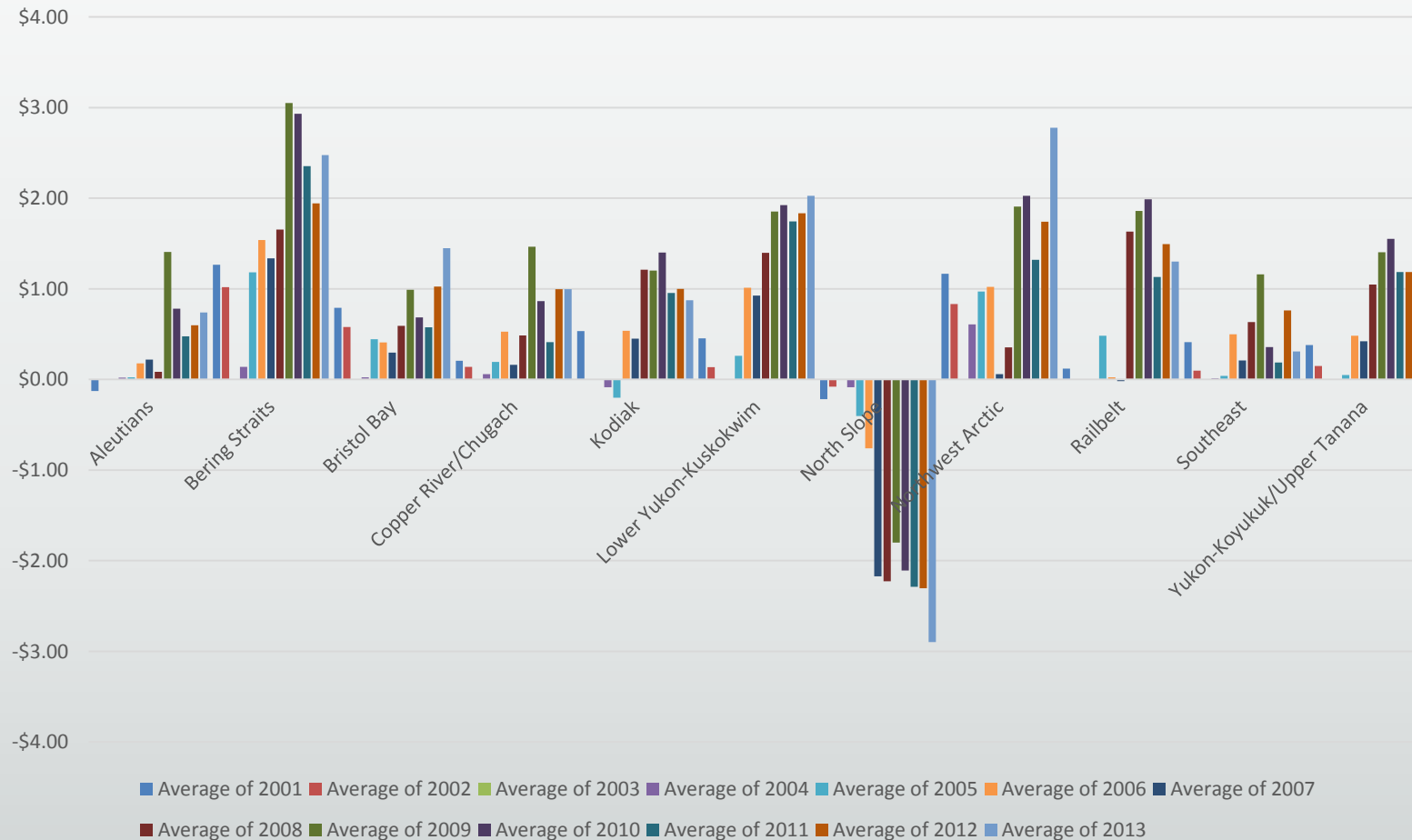
- Markups not known—not correlated with diesel, crude oil
  - ISER (2008, 2009, 2010)
    - Components of Fuel Price studies. “Other” component of retail price was unknown and unknowable
      - <http://www.iser.uaa.alaska.edu/Publications/Finalfuelpricedelivered.pdf>
      - <http://www.iser.uaa.alaska.edu/Publications/fuelpricedeliveredupdate.pdf>
      - <http://www.iser.uaa.alaska.edu/Publications/componentsoffuel3.pdf>
  - Attorney General (2009)
    - No indication that fuel deliverers were earning outsized profits
    - Local markups were not consistent
      - 2009 Rural Fuel Price Investigation (<http://www.law.state.ak.us/pdf/civil/021810RuralFuelPricinginAlaska.pdf>)
  - AEA (2015-16)
    - Unsuccessfully attempted to find correlation between utility diesel and retail heating oil
  - Anecdotes for differences in retail markups
    - A de facto tax for community services
    - Profit to owner

# Factors that lead to consumer Heating Oil Rate



# Heating Oil vs. Utility Diesel Costs

Cost Difference Between Average Retail HF#1 and Diesel  
(from AHFC fuel survey and PCE by fiscal year--2014\$)

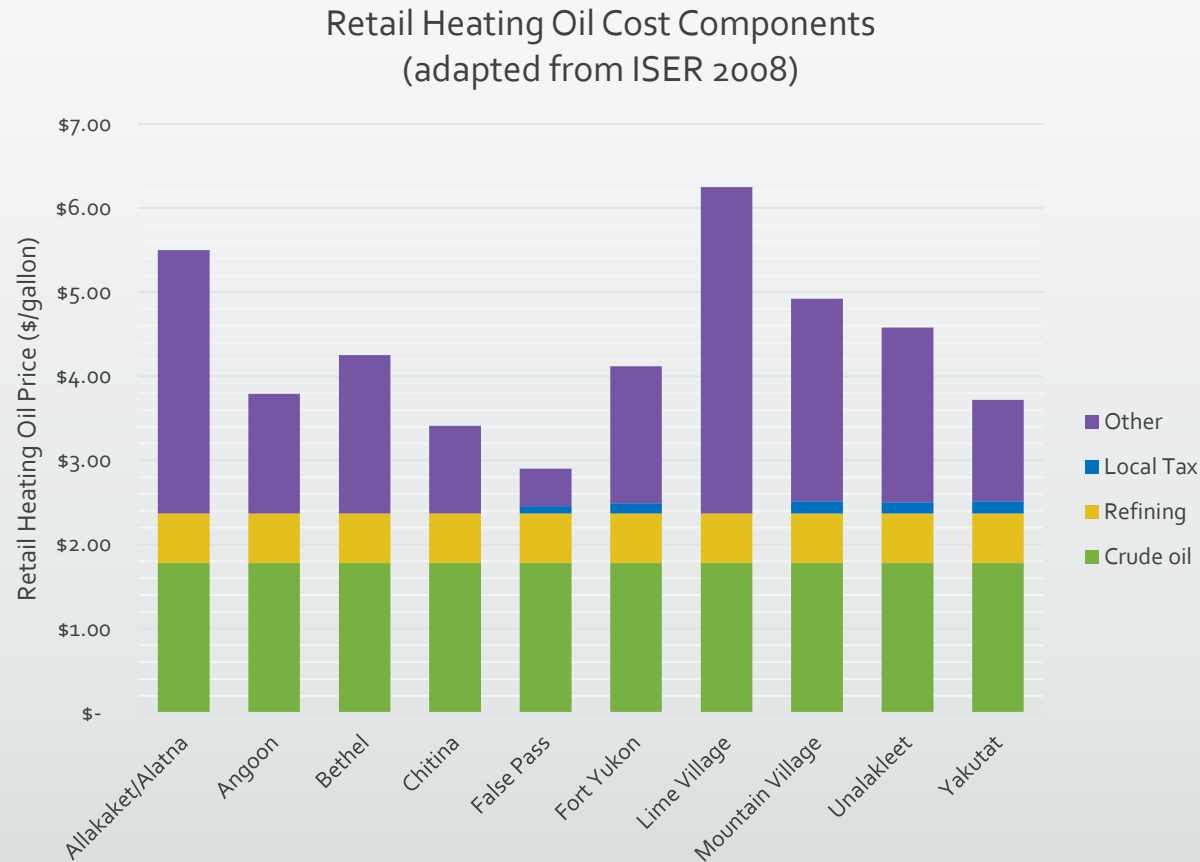


- Assume utility diesel & heating oil similar price & price to deliver
- Actual retail markups unknowns
- Large Regional differences
- Year to year differences

Data Sources:  
Heating oil: AHFC/DCRA surveys in Alaska Energy Data Gateway  
Utility Diesel: PCE filings



# Cost Components for Retail Heating Oil



- Assumed \$71/bbl
  - Refining seems high
- Local taxes
- Other—  
transportation,  
retail markup

Data Sources:  
ISER 2008

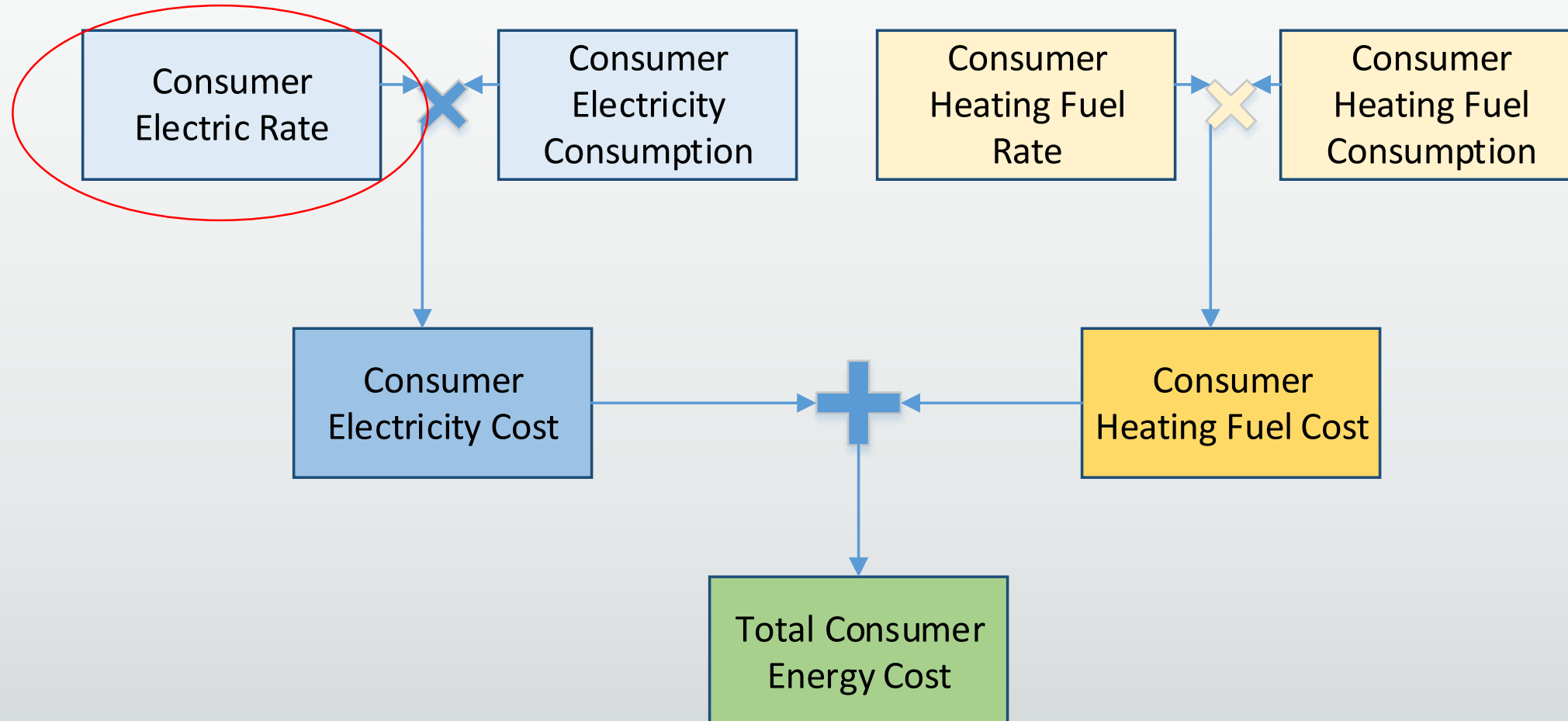
<http://www.iser.uaa.alaska.edu/Publications/Finalfuelpricedelivered.pdf>



# Electricity

The Drivers for Unit Cost and Consumption

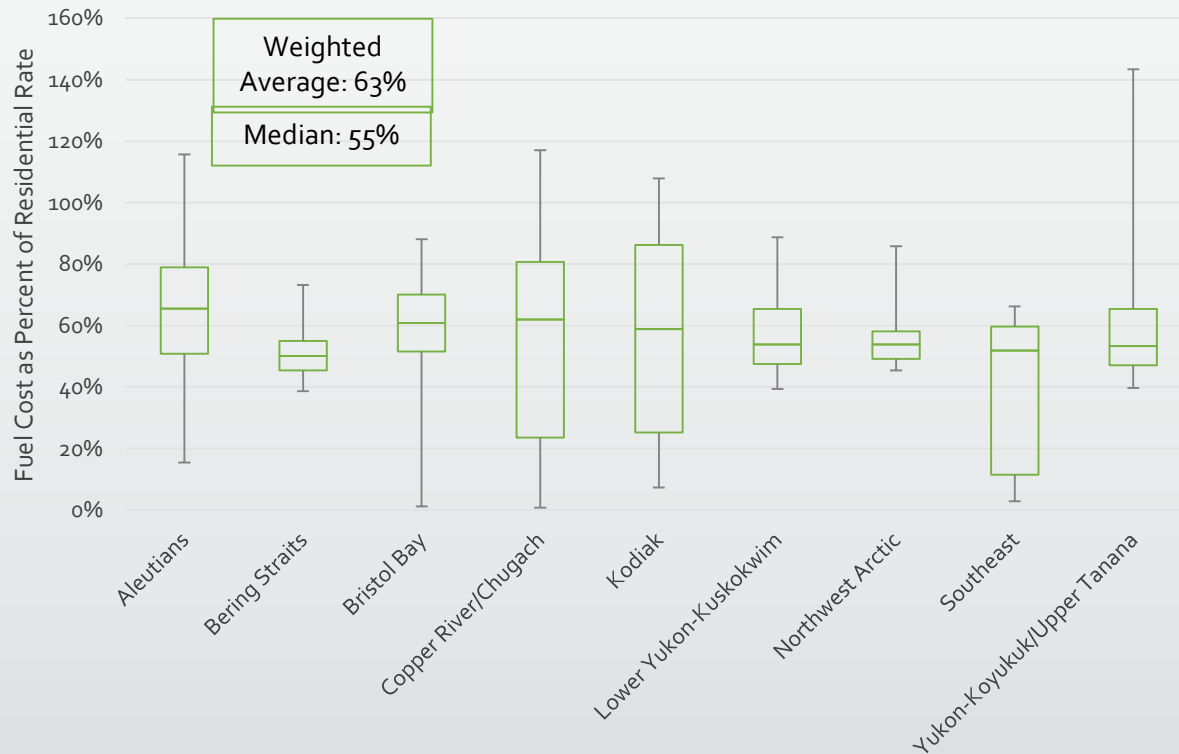
# Factors That Lead to Consumer Energy Costs





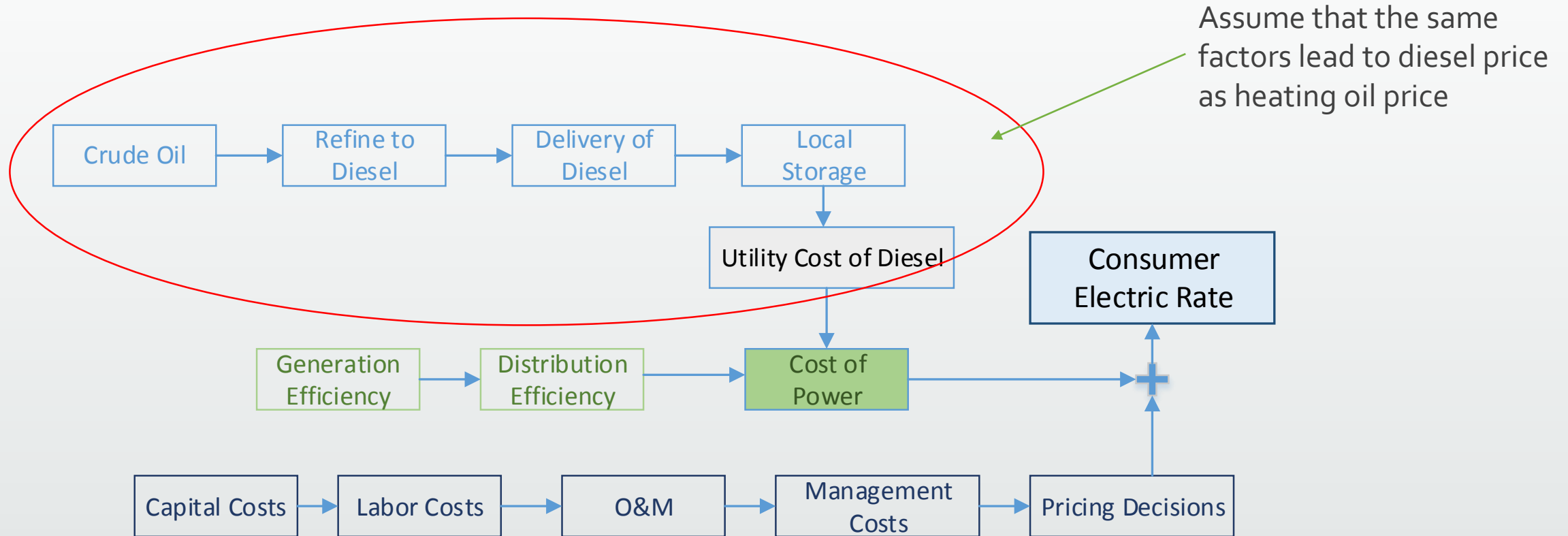
# Fuel Cost as a Percent of Rate

Cost of Fuel as a Percent of Residential Rate  
(2013 PCE data)

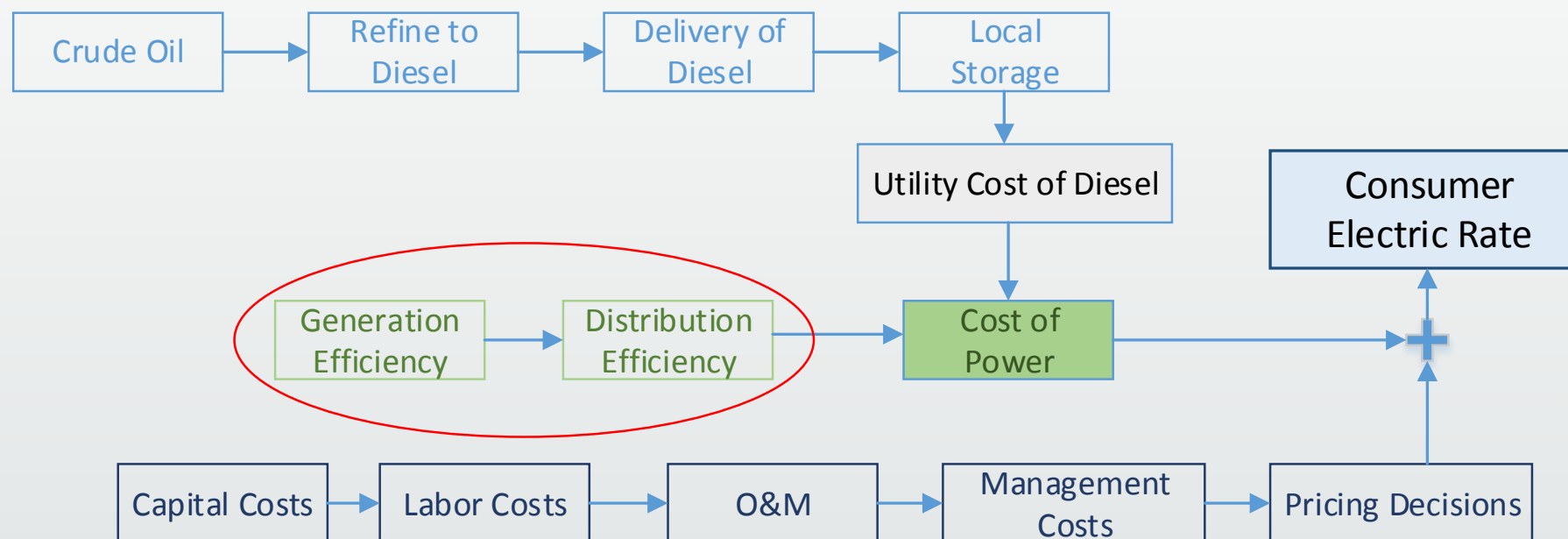


- North Slope removed—large subsidy distorted graph
- Wide range of fuel cost within & between regions
- Hydro in some communities lead to low or no fuel cost.
- Some rates don't cover cost of fuel

# Factors That Lead to Consumer Electricity Rate

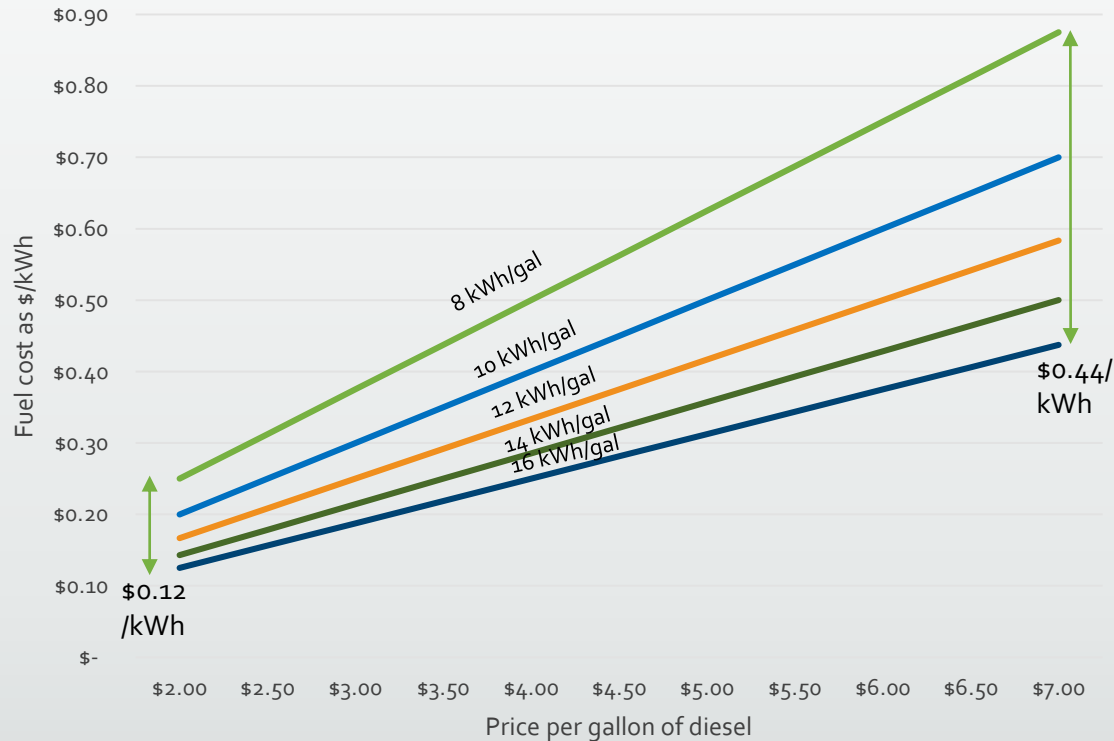


# Factors That Lead to Consumer Electric Rate



# Generation Efficiency

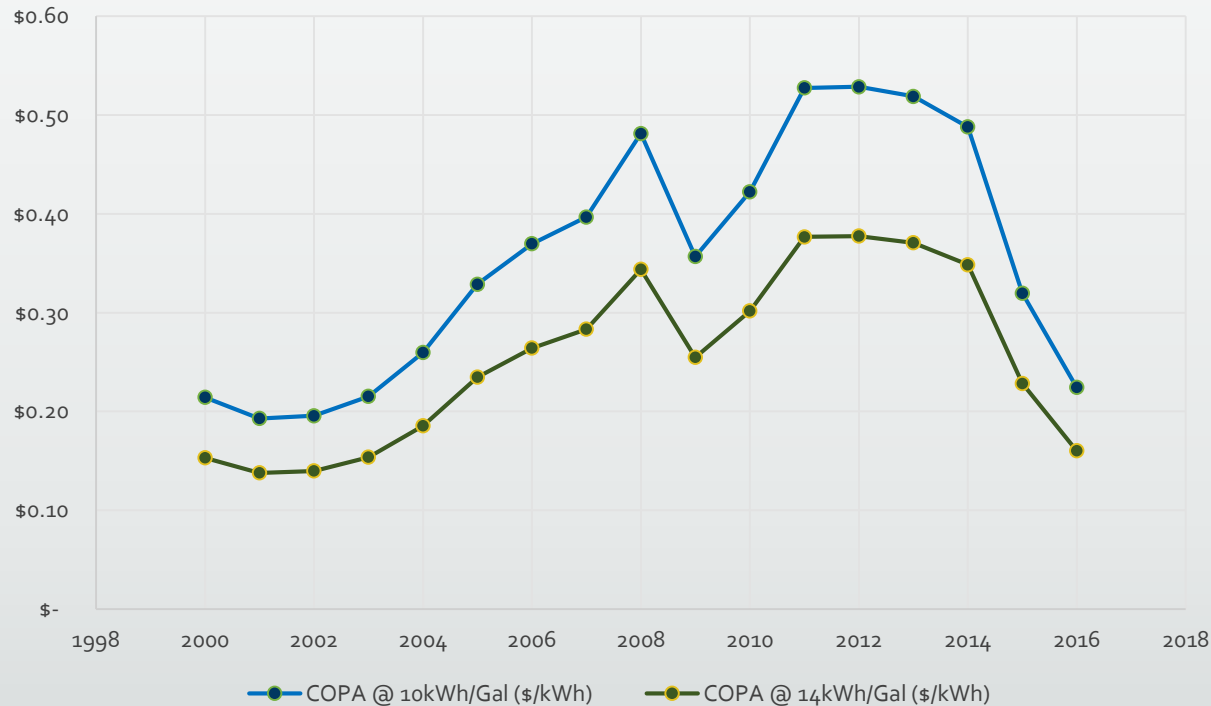
Change in Fuel Cost (\$/kWh) based on Efficiency (in kWh/gal) and Delivered Fuel Cost (\$/gal)



- Ratio of costs between efficiencies stays the same, spread increases with higher fuel prices

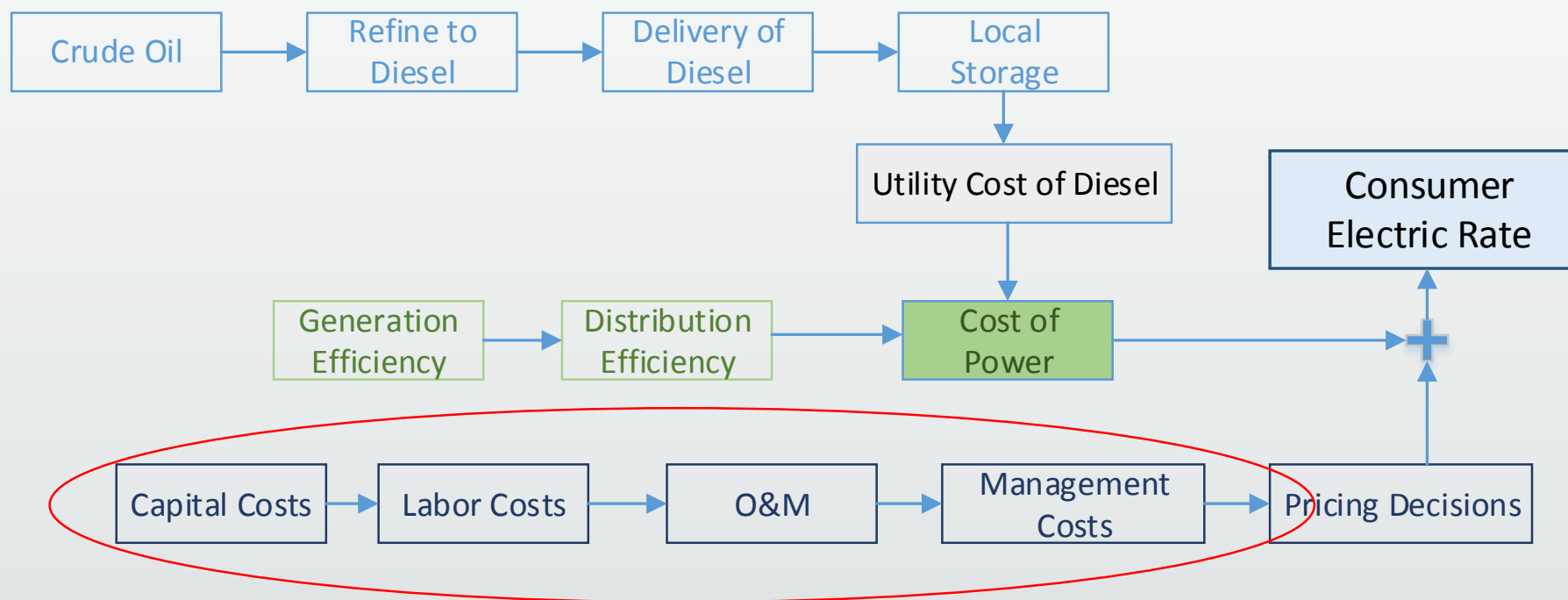
# Generation Efficiency & Historical Crude Oil Prices

Cost of Power Difference between Generation Efficiency of 10 and 14 kWh/gallon  
(Using Average Brent 2000-16 and Bethel model cost)



- Volatility greater with lower efficiency
- Does not include costs for improving or maintaining efficiency

# Factors That Lead to Consumer Electric Rate



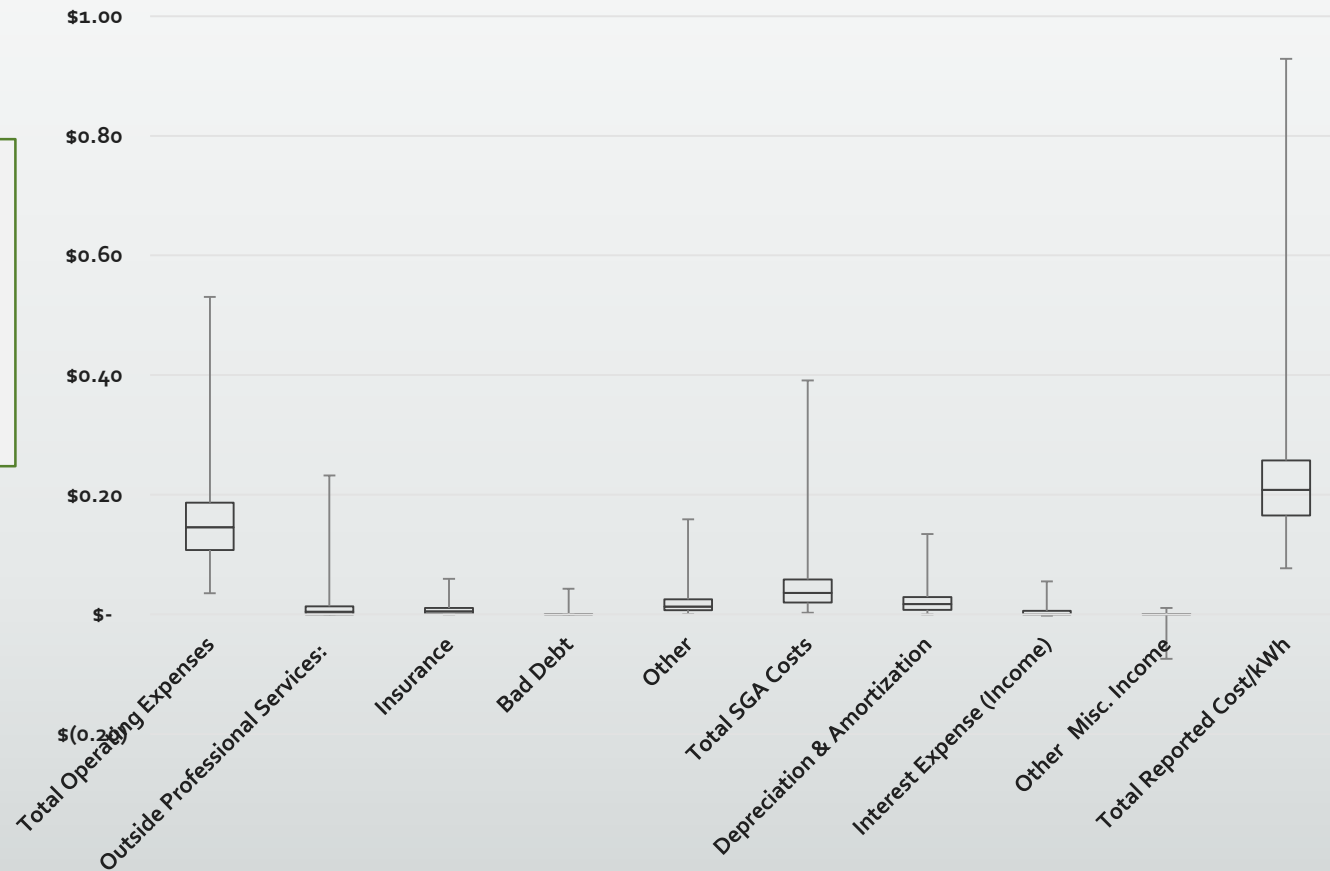
# Utility Non-Fuel Costs

## Cost Categories:

- Personnel—operations & management
- O&M, R&R
- Capital
- Outside professional services
  
- Outside the range of this presentation:
  - Management decisions that impact operations

# Reported, Allowable Costs

Range of Average Cost/kWh for Reported, Allowable RCA Cost Categories from Non-Regulated PCE Filings (2007-2014)

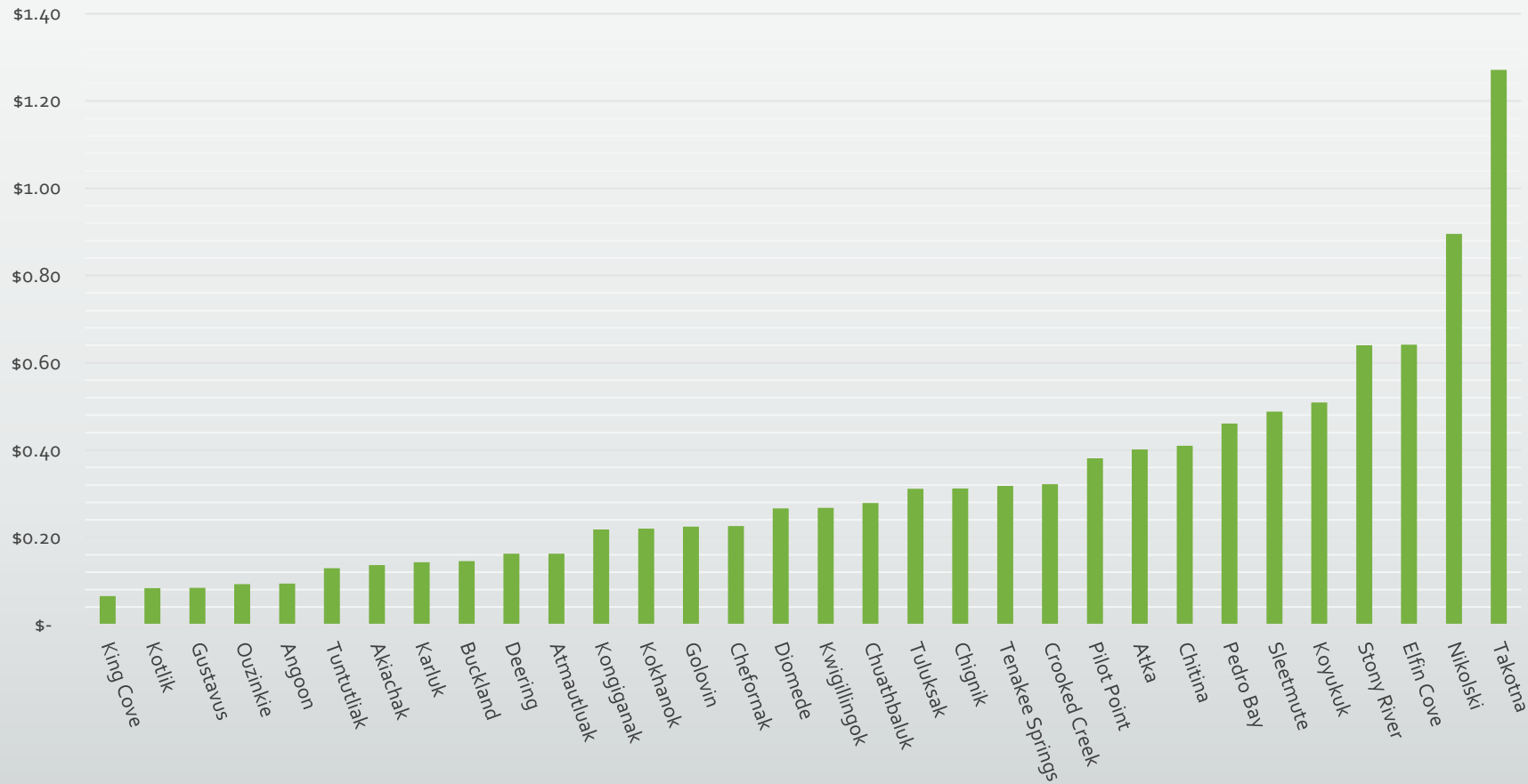


- Operating
  - Personnel
  - O&M, R&R
- Outside professional
- Bad debt
- G&A
- Depreciation
- Income



# Unbooked Capital Expenses—Power House

Increase in Rate if RPSU Project was Booked  
(\$/kWh)



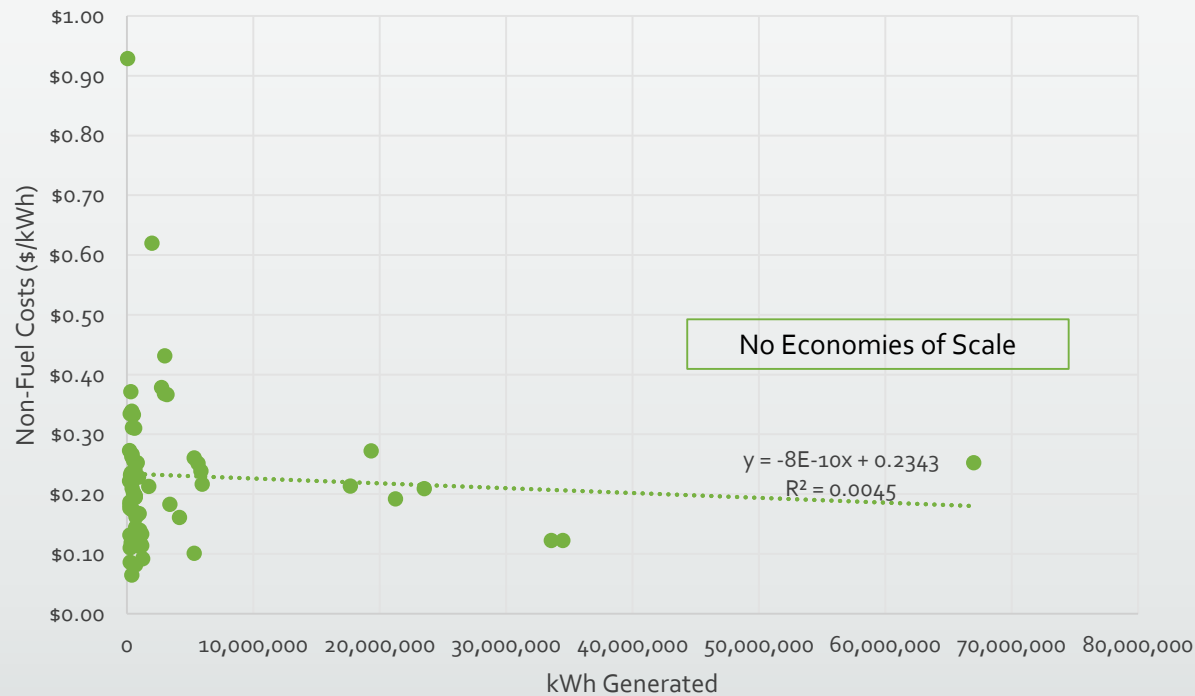
Wide range of \$/kWh costs for power houses—primarily as a factor of economy of scale

# Unbooked Capital Expenses: Fuel Storage

- At 12 kwh/gallon, each \$0.50 of CAPEX translate to an increase of \$0.04/kWh in the cost of power
- More turnover leads to lower per unit cost

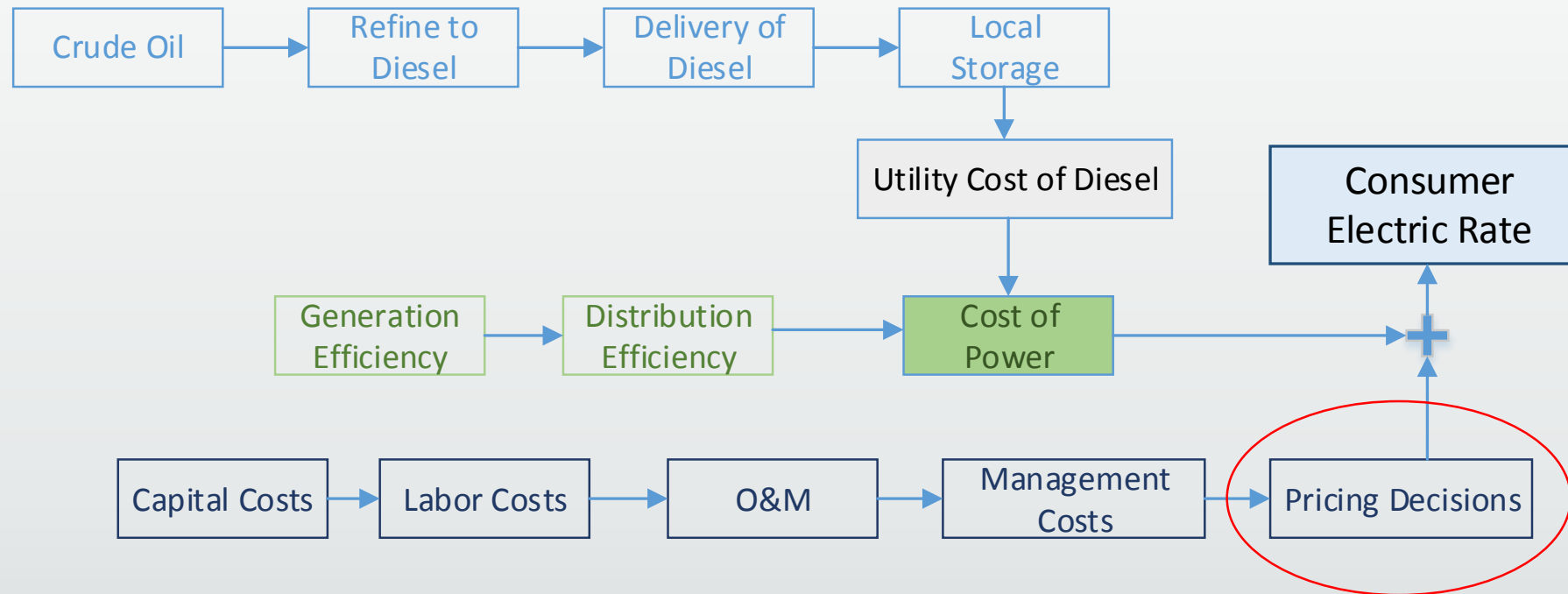
# Economies of Scale

Economies of Scale in Utility Non-Fuel Costs  
Reported, Allowable Non-fuel Costs per KWh vs. kWh  
Generated

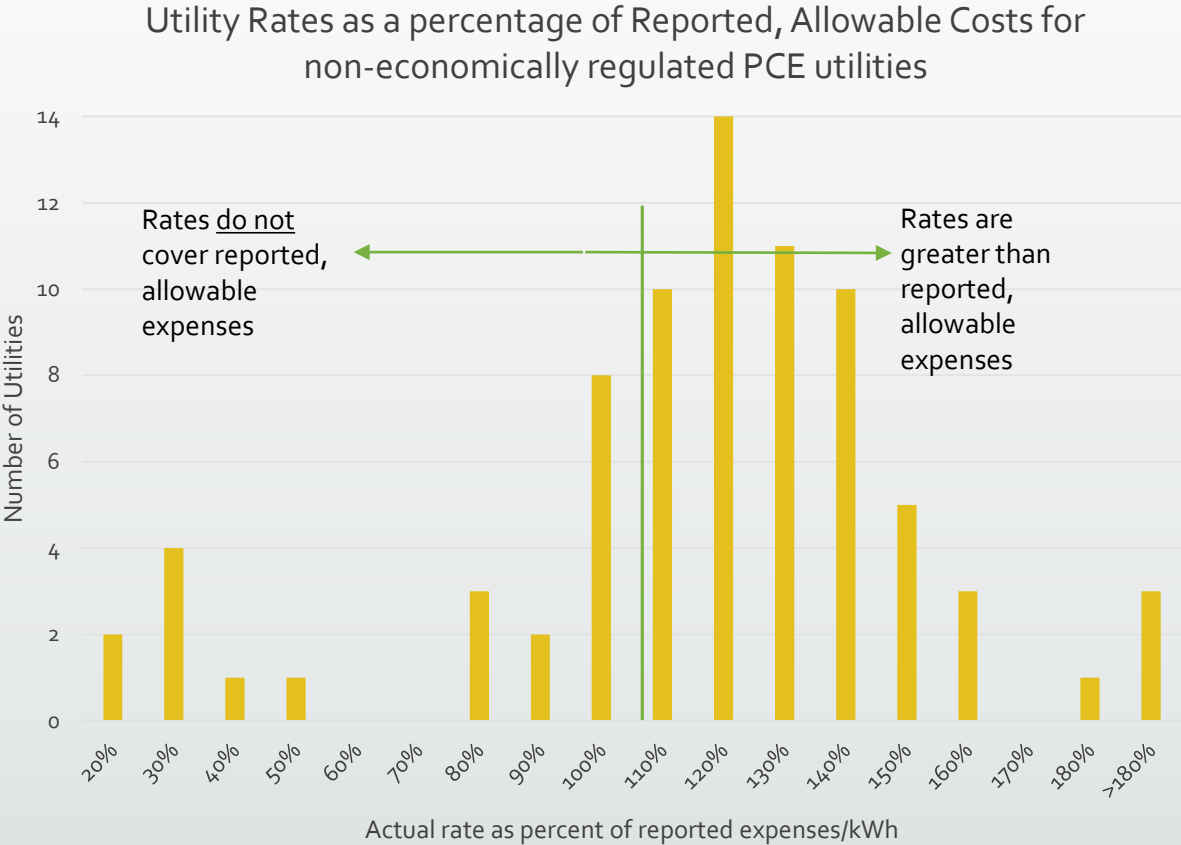


- \$/kWh not correlated with sales
- Low \$/kWh may not reporting everything, doing insufficient maintenance, etc.

# Factors That Lead to Consumer Electric Rate

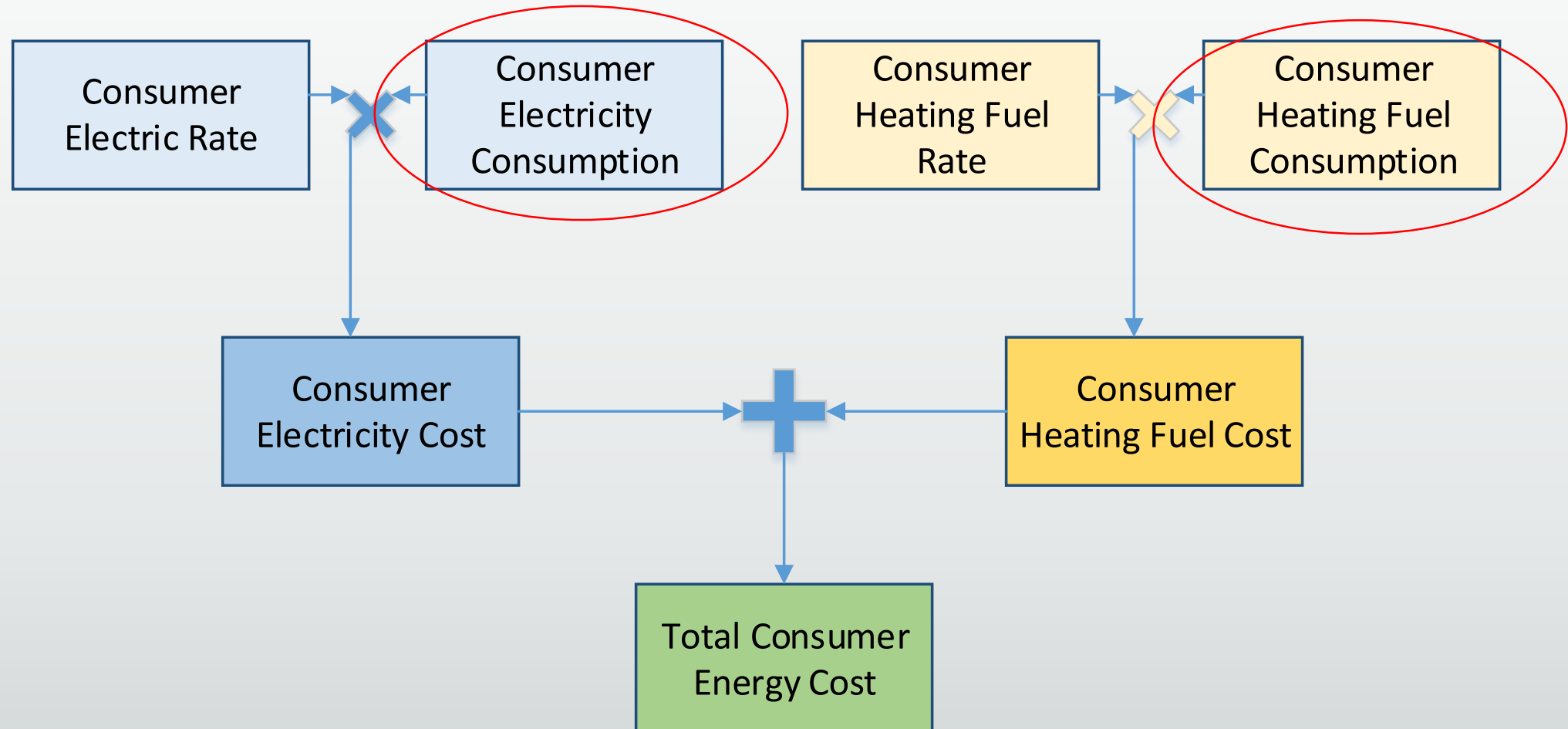


# Rates vs. Reported, Allowable Expenses

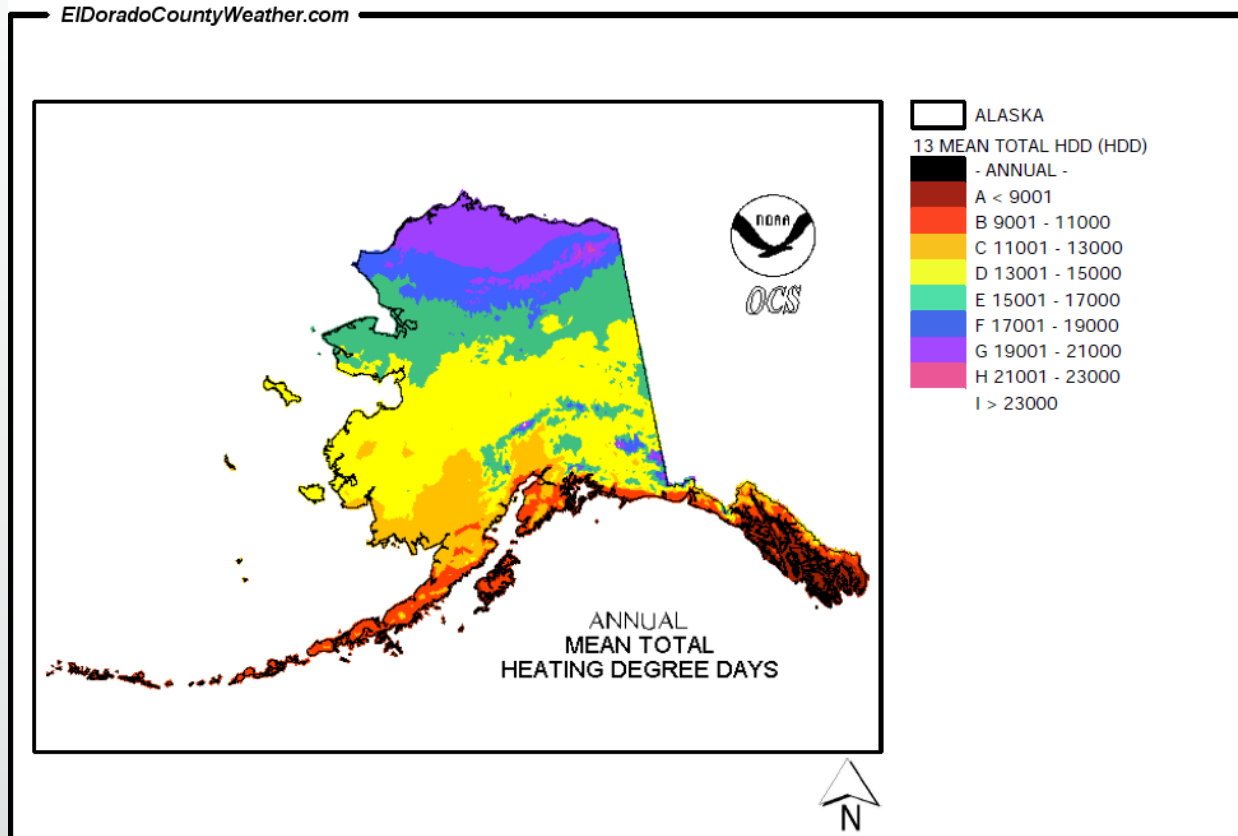


- Rates are generally above needed to recover costs for reported, allowable expenses

# Factors That Lead to Consumer Energy Costs



# Factors that Lead to Consumption



- Climate
- Building Size
- Building Use
- Building Energy Efficiency

# Average Non-Residential Building Sizes

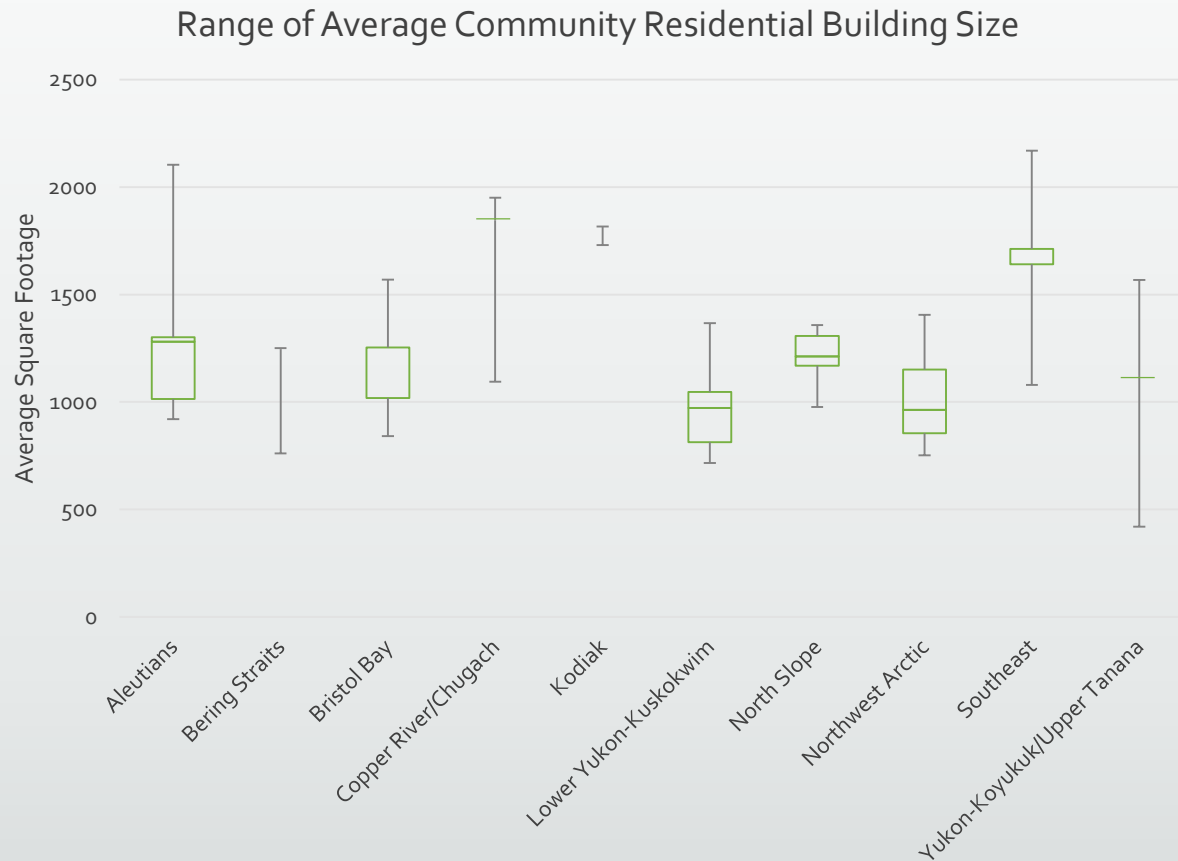
Average square feet per building type			
	Population less than 300	Population between 300 and 1200	Population greater than 1200
Accommodation Services	4,718	6,476	6,476
Education - K - 12	10,921	20,463	62,095
Education - University	N/A	N/A	19,106
Food Service and Drinking Places	2,304	3,649	7,706
Health Care - Hospitals	2,157	3,802	6,779
Health Care - Nursing/Residential Care	3,882	15,071	15,071
Office	2,023	2,665	10,199
Other	2,072	4,036	5,566
Public Assembly	2,842	3,296	9,257
Public Safety	2,463	2,302	12,602
Residential - Multi-Family	2,403	5,857	5,857
Retail - Other	1,971	6,090	5,217
Warehousing	1,883	2,869	3,950
Average (removing education buildings)	2304	3649	7706

- Based on data from approximately 3,000 buildings
- Statistically significant results
- On average, larger communities have larger buildings

Data Sources:  
ARIS, 2012 End Use Study, Regional Plans, Municipal Property Tax Records



# Residential Building Sizes



- Reported square footages from ~17,000 records in ARIS database
- Significant differences in average house size within and across regions

Data Source:  
ARIS

# Non-Residential Consumption by Building Types

	Average Gallons Heating Oil per Square foot			Average kWh per Square Foot		
	Population less than 300	Population between 300 and 1200	Population greater than 1200	Population less than 300	Population between 300 and 1200	Population greater than 1200
Accommodation Services	0.7	0.8	0.8	8	10	12
Education - K - 12	0.9	0.8	0.9	6	7	9
Education - University			1.1			12
Food Service and Drinking Places	0.6	0.6	0.6	8	10	12
Health Care - Hospitals	0.7	0.8	0.7	8	10	12
Health Care - Nursing/Residential Care	0.5	0.5	0.5	12	12	14
Office	1.0	0.9	0.6	9	6	9
Other	0.9	1.1	1.1	6	8	15
Public Assembly	0.6	0.8	0.5	4	5	20
Public Safety	0.9	0.8	0.6	10	8	12
Residential - Multi-Family	0.9	0.6	0.3	5	5	4
Retail - Other	1.4	1.4	1.4	21	24	22
Warehousing	1.2	1.2	1.2	8	10	12
Average	0.93	0.94	0.93	7.7	9.6	11.9

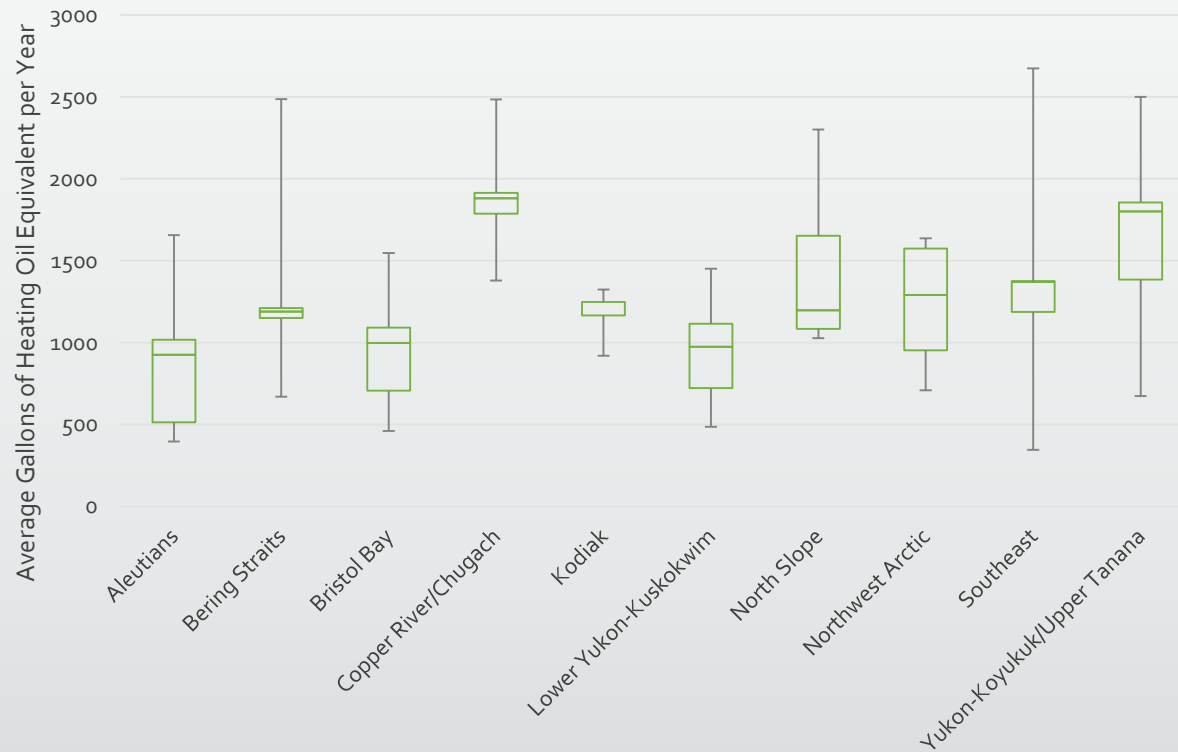
- Some difference in heating oil consumption across building types
- Average heating oil average not different across community sizes
- Electricity consumption increases with community size
- Large differences in average electricity consumption across building types

Data Sources:  
ARIS, 2012 End Use Study, Regional Plans



# Residential Heating Demand

Range of Yearly Thermal Demand in AEA Regions  
(in gallons of heating oil)



- Wide range of averages
- Climate, sizes, quality of housing
- Modeled consumption data

Data Source:  
ARIS

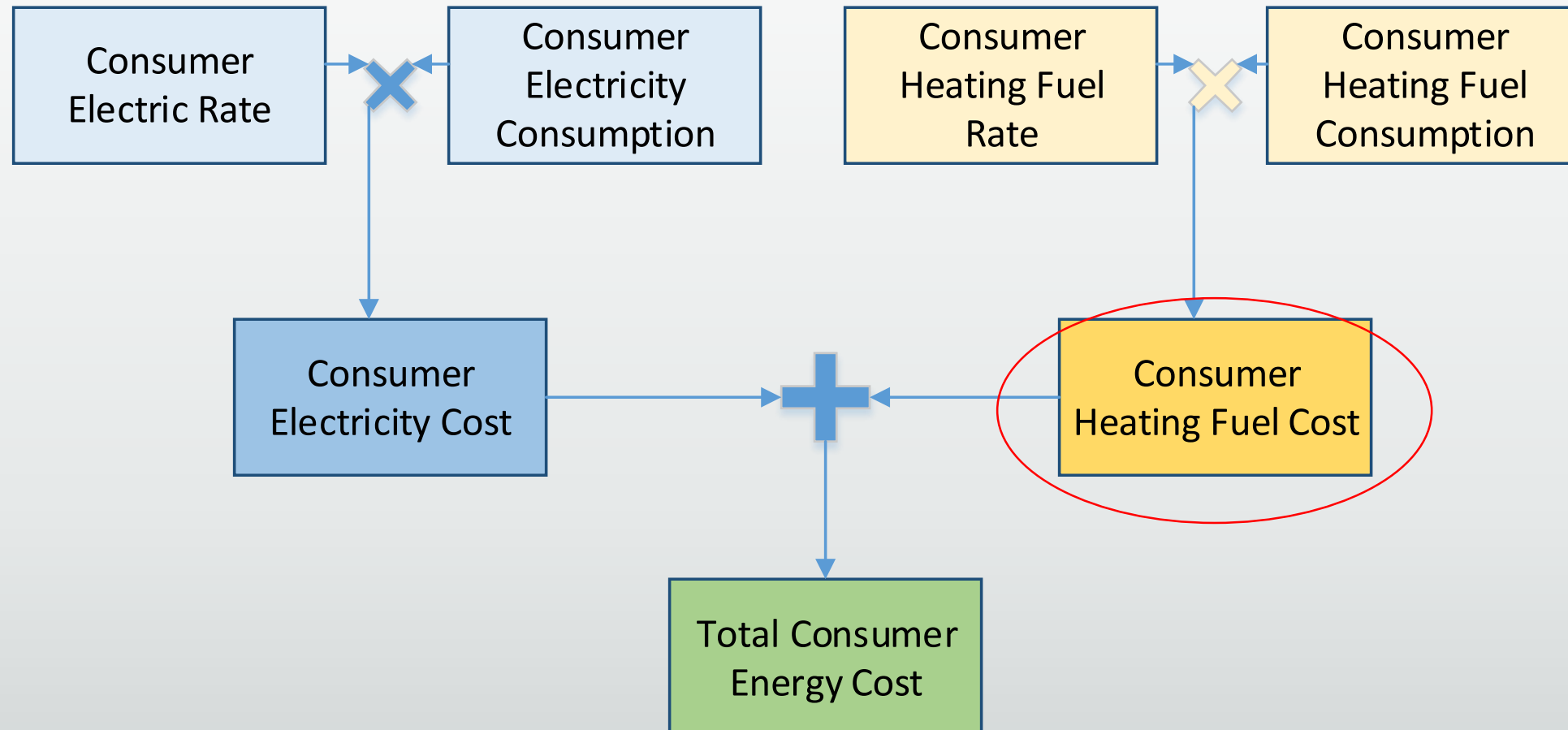
# Type of Heating Fuel

AEA Region	Fuel oil, kerosene, etc.	Wood	Electricity	Bottled, tank, or LP gas	Utility Gas
Aleutians	90%	2%	3%	1%	2%
Bering Straits	91%	4%	3%	0%	1%
Bristol Bay	87%	10%	1%	0%	1%
Copper River/Chugach	68%	21%	2%	3%	5%
Kodiak	81%	5%	8%	0%	3%
Lower Yukon-Kuskokwim	83%	14%	2%	0%	1%
North Slope	58%	6%	2%	0%	34%
Northwest Arctic	85%	6%	3%	0%	2%
Southeast	56%	27%	13%	2%	2%
Yukon-Koyukuk/Upper Tanana	52%	44%	2%	0%	1%

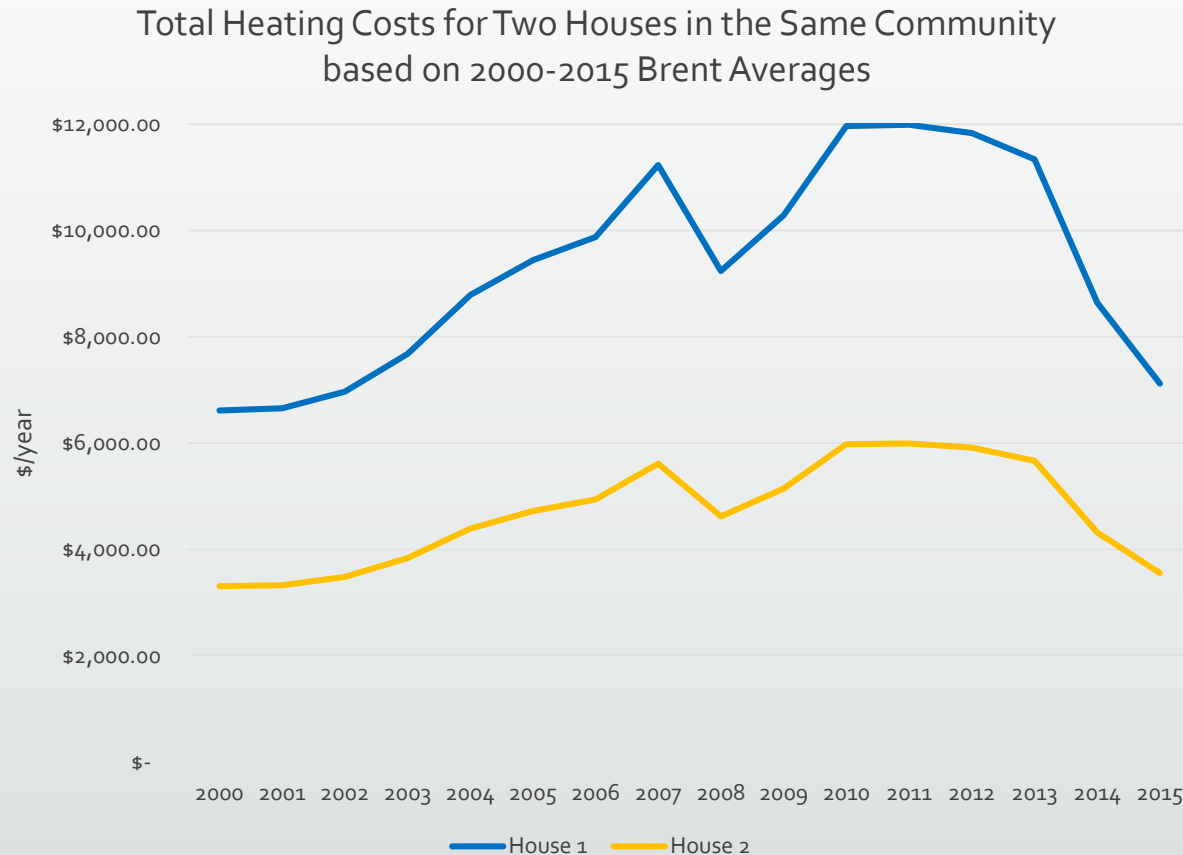
- Utility gas a statistical aberration except for North Slope (Barrow, Nuiqsut)
- Wood is very common in some regions
- Electricity is common in Southeast and Kodiak

Data Source:  
2014 5-year American Community  
Survey (by US Census)

# Factors That Lead to Consumer Energy Costs



# Residential Cost Impact of Total Consumption & Crude Oil Prices



- House 1 & 2:
  - Same square footage
  - Different levels of heating oil consumption/sf
    - Common “Poor” & “Good” houses
- Large difference in consumption
- Volatility is greater in House 1 (blue line)

Data Source:  
Historical Average Yearly Brent Prices  
(EIA)

# Recommendations

- To be developed in Strategies, but may include....
  - Target areas with highest opportunity and likelihood of reducing the costs to consumers
  - Target areas where the state can have the most beneficial impact on consumers
  - Be cognizant of potential interactions between strategies

[AKEnergyAuthority.org](http://AKEnergyAuthority.org)

