



# Natural Gas Conversion Technologies ARPA-E Workshop

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Houston, TX  
January 13, 2012

[www.arpa-e.energy.gov](http://www.arpa-e.energy.gov)

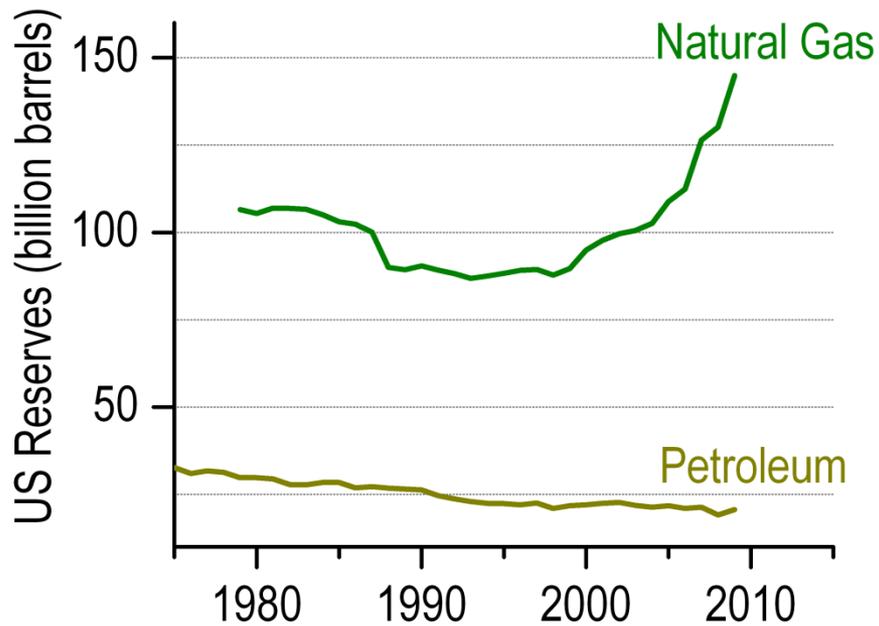


**Why natural gas? Why now?**

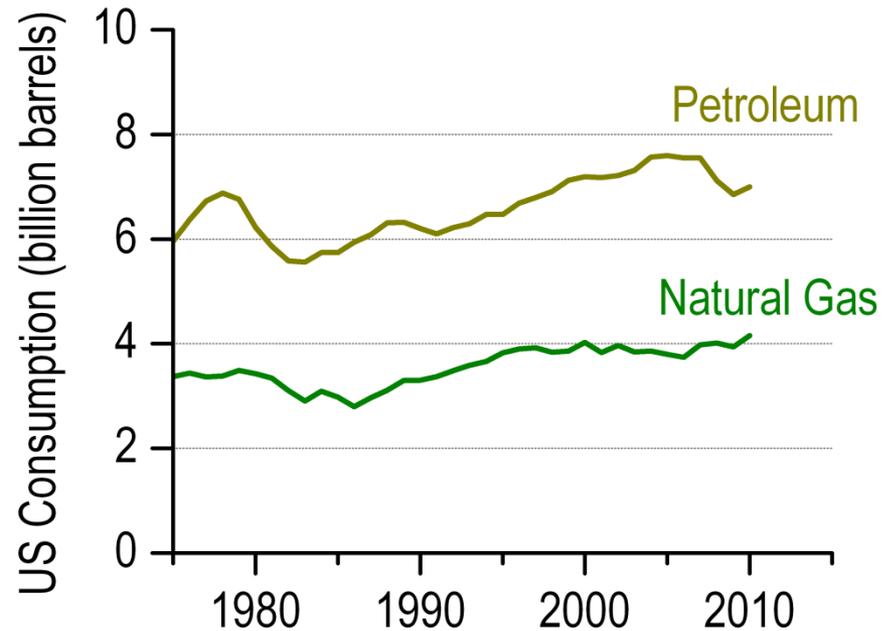
# U.S. SUPPLY AND DEMAND



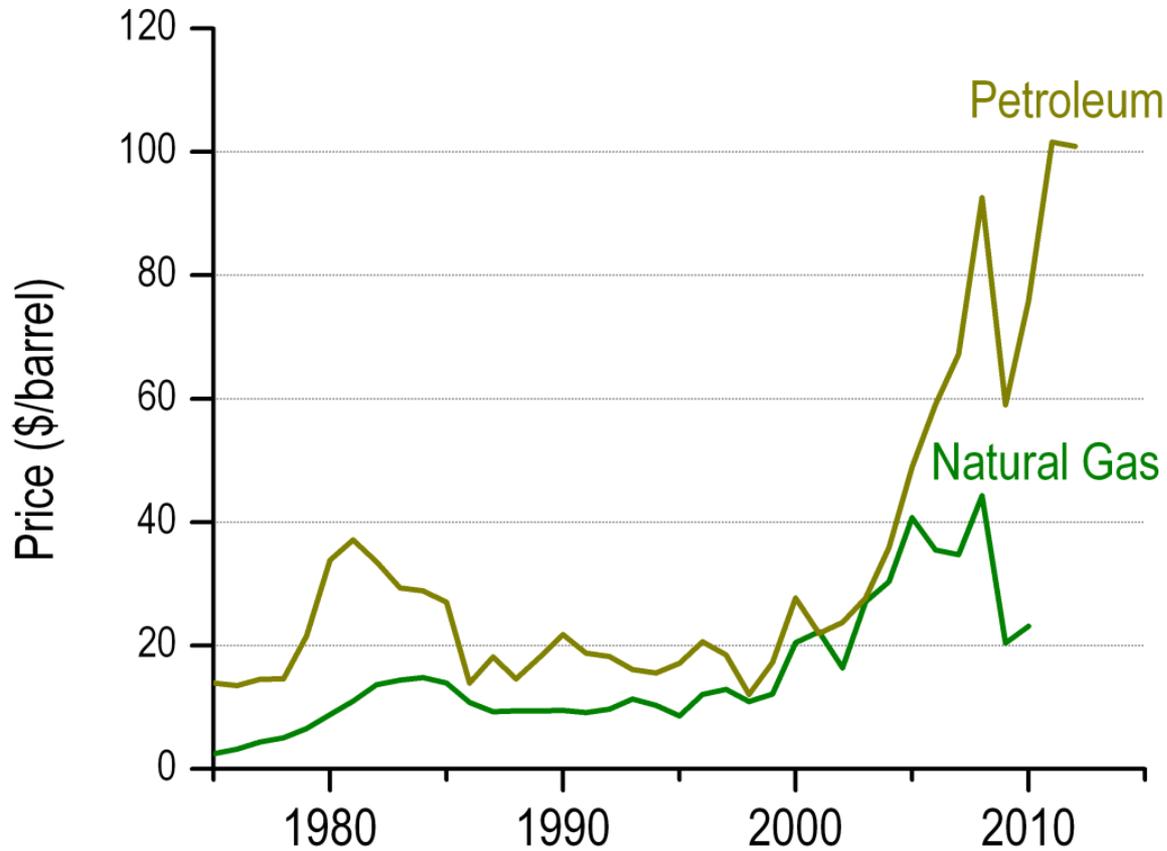
## U.S. Proven Reserves



## U.S. Annual Consumption



# U.S. ANNUAL NATURAL GAS & PETROLEUM PRICES



# NATURAL GAS – PETROLEUM ARBITRAGE OPPORTUNITY?

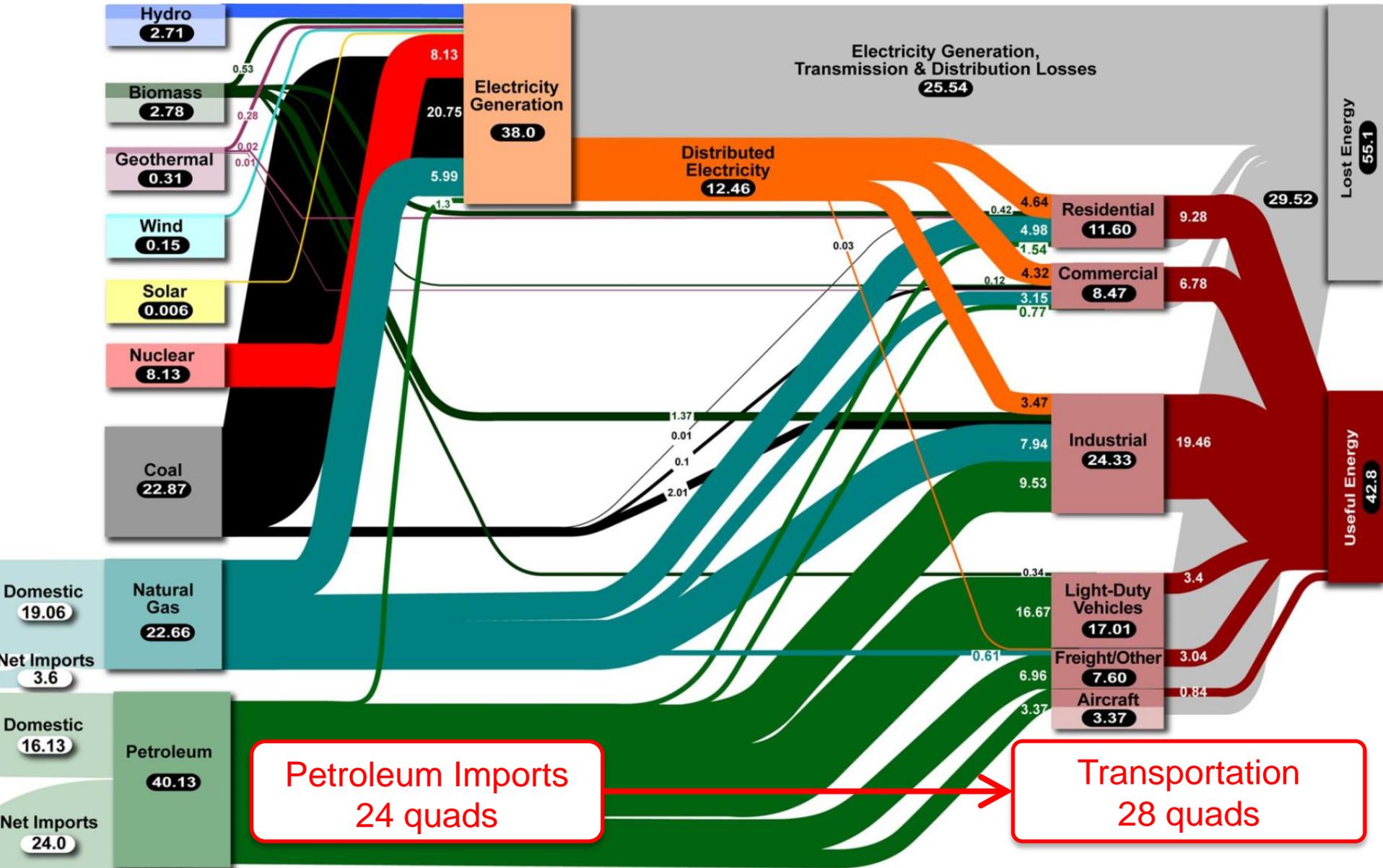


- Natural gas prices are nearly **5x less** than petroleum prices
- Is this a **short-term** arbitrage opportunity or **long-term** market trend?

**How can we use this domestic resource  
with the maximum benefit for our Nation?**



# 2008 US ENERGY FLOWS (98 QUADS)



1 Quad = 1.06 EJ

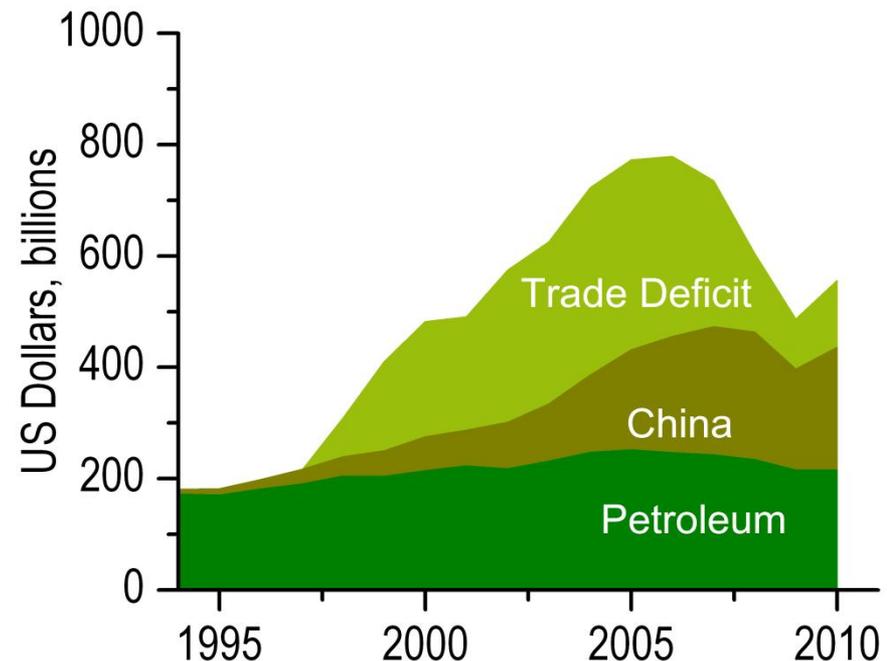
Source: LLNL, US DOE 2009

# ECONOMIC IMPACT



- Petroleum imports
  - energy dependence
  - 24 quads
- Transportation sector
  - petroleum demand
  - 28 quads
- Petroleum impact
  - 35% deficit
  - \$200BN/yr

Annual U.S. Trade Deficit



Source: US Census Bureau, 2011



**How do we get natural gas into the transportation sector?**

# NATURAL GAS FOR TRANSPORTATION



- Is increasing use of natural gas in the transportation sector the right direction?
- Using natural gas directly more efficient than converting to liquid fuels
- Why develop natural gas conversion technologies?

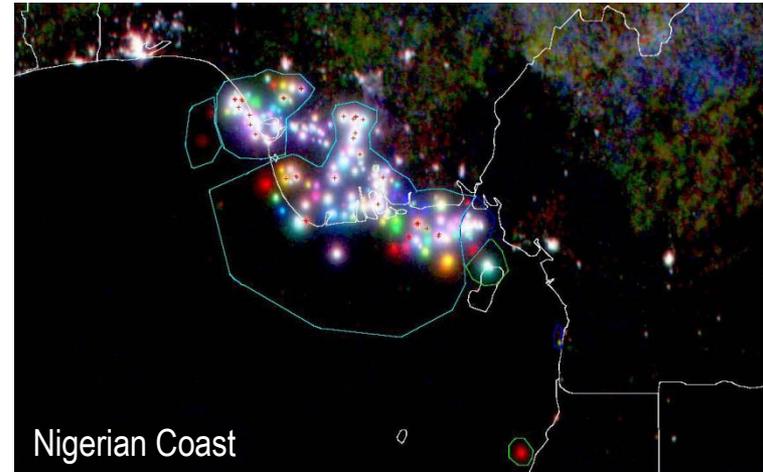


**The global problem of flared/vented associated natural gas presents the clearest near term opportunity for natural gas conversion technologies**

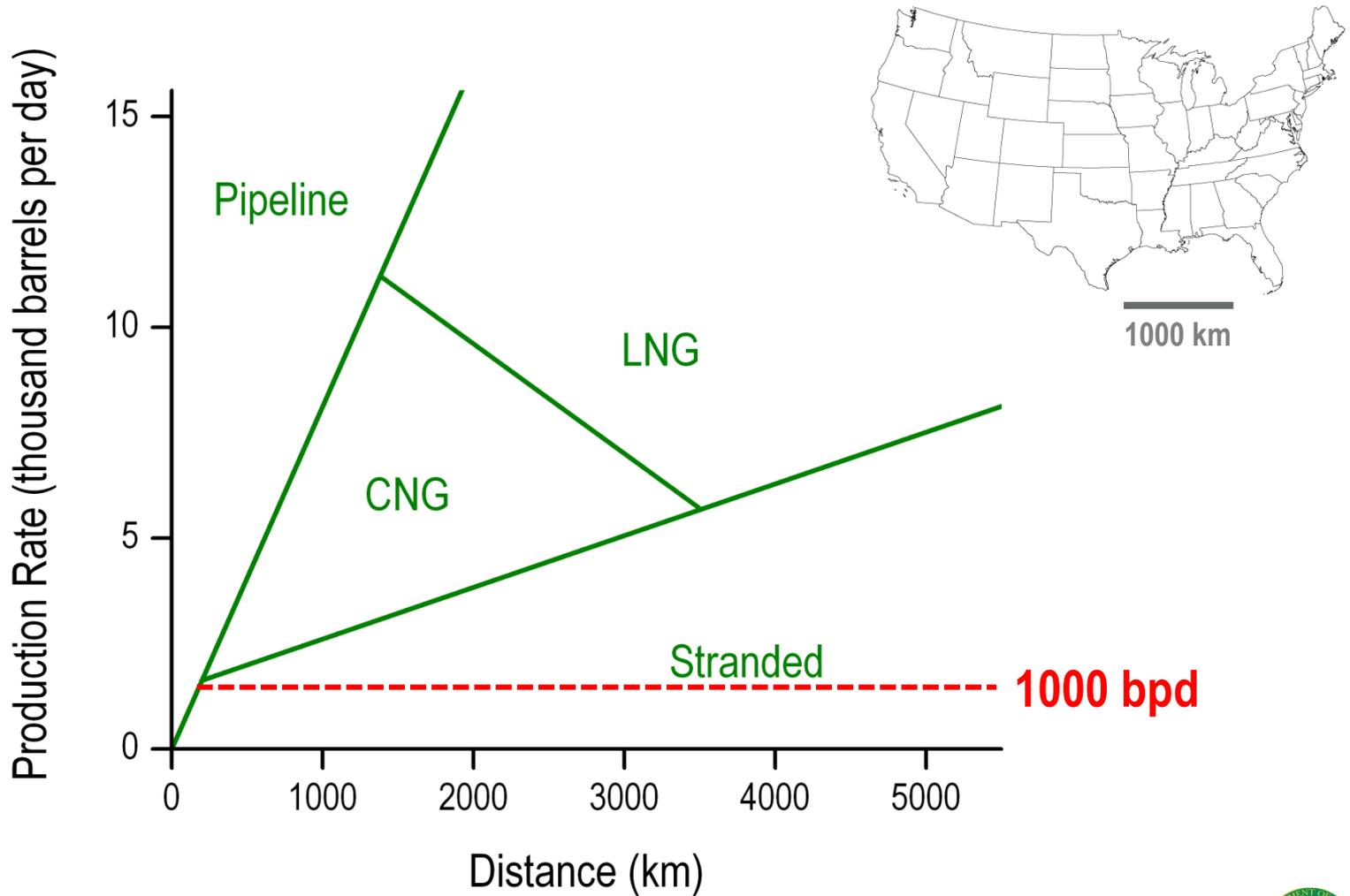
# STRANDED NATURAL GAS FLARING/VENTING



- 5.3 trillion cubic feet of natural gas flared annually
  - 5 quadrillion BTUs
  - 25% US electricity production
  
- 50% of flared/vented fields produce less than 1000 barrels per day oil equivalent



# ECONOMICS OF TRANSPORTING NATURAL GAS





**What are we shooting for?**

# WORKSHOP OBJECTIVES



Identify technological whitespace, new research directions, and opportunities that could enable natural gas conversion to liquid hydrocarbons with the following characteristics:

1. Small scale (< 1000 boe/day)
2. High carbon efficiency (> 60%)
3. Low cost (simple/few unit operations)

# NOT PART OF THE DISCUSSION



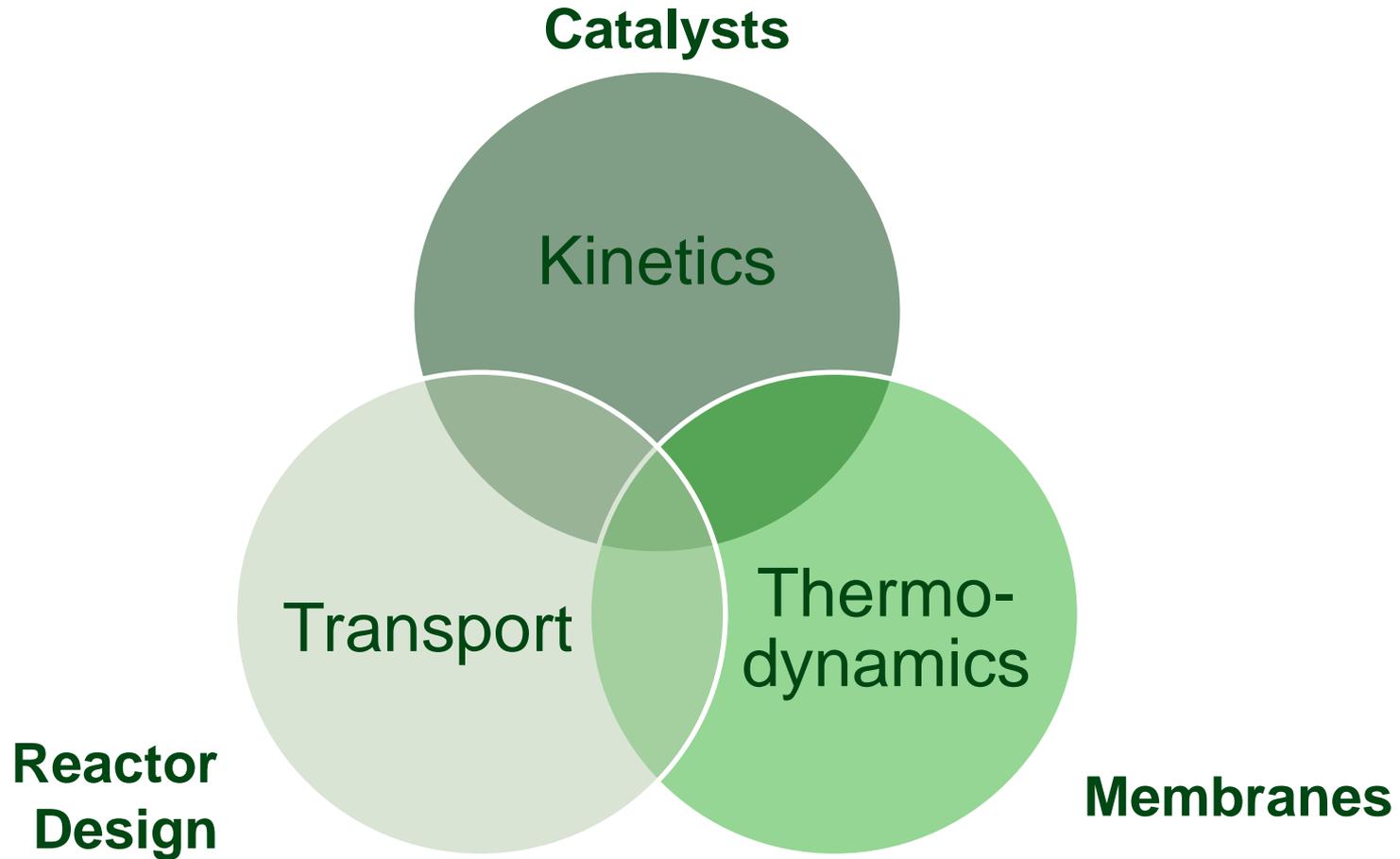
In the interest of time, the following topics will not be discussed:

1. Regulation and policy
2. Coal, biogas, carbon dioxide feedstocks (XTL)
3. Ethane, propane, butane (LPG) separation and conversion



**What is the grand challenge in methane conversion to liquids and where are the opportunities?**

# CHALLENGES FOR METHANE CONVERSION TO LIQUID FUELS



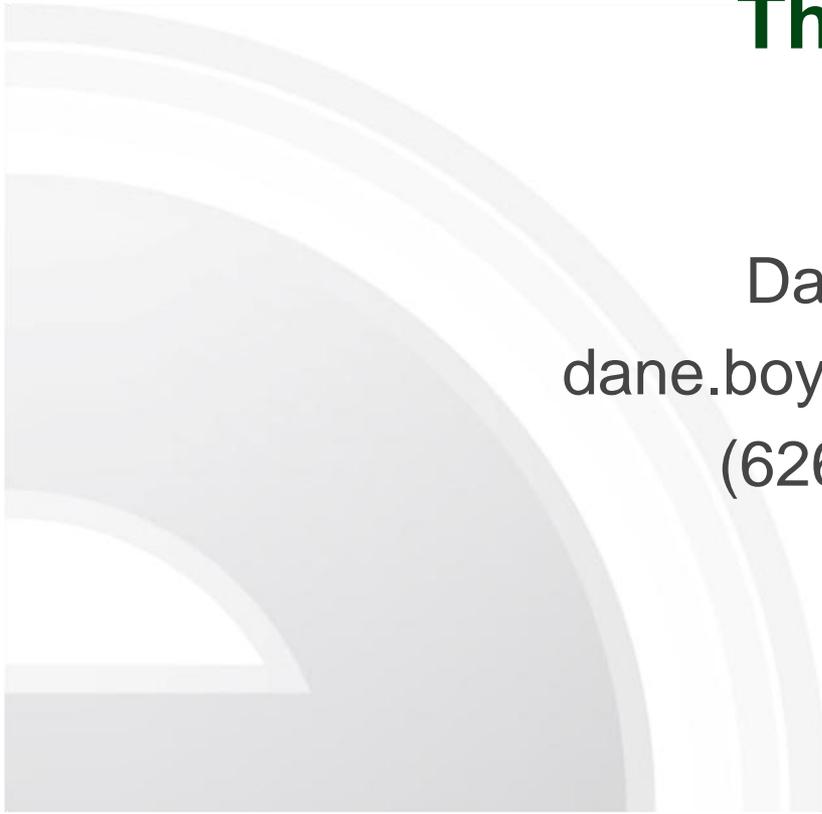


# Today's Event

# AGENDA



08:15	Welcome and Opening Remarks	Eric Toone, Deputy Director, ARPA-E
08:30	Workshop Overview and Objectives	Dane Boysen, Program Director, ARPA-E
08:45	Gas to Liquids Overview	Arno de Klerk, U. Alberta (formerly Sasol)
<b>10:00</b>	<b>Morning Breakout Sessions</b>	
12:15	Lunch – review morning session results	
01:00	Commercialization Considerations for Gas Conversion Technology Development	Rob Motal, Chevron
	Center for Catalytic Hydrocarbon Functionalization (DOE Energy Frontier Research Center)	Roy Periana, The Scripps Research Institute
<b>02:20</b>	<b>Afternoon Breakout Session</b>	
04:30	Review afternoon break session results	
05:30	Group Photo	



**Thank you**

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