

# Understanding World Natural Gas Markets and Investments

Presented to



Presented by



Dr. Dale M. Nesbitt

November 13, 2021

[dale.nesbitt@arrowheadeconomics.com](mailto:dale.nesbitt@arrowheadeconomics.com)

(650) 218-3069

**Assisted by:**  
**Dr. Antoine Calvez**  
**Alan Clark**  
**Randy Begotka**

# Dr. Dale M. Nesbitt

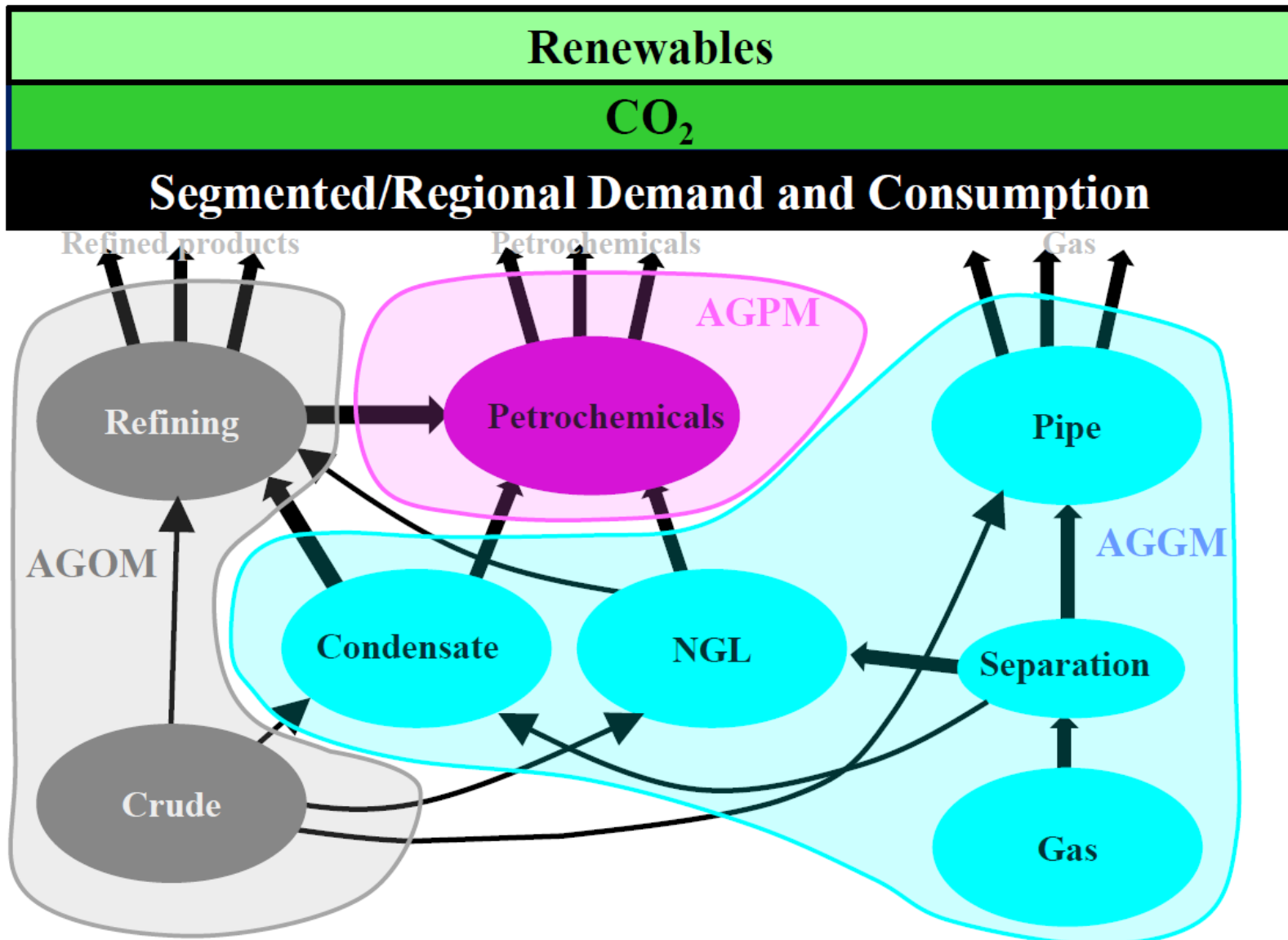
- Ph.D., Engineering Economic Systems, Stanford University, 1975, dissertation defense with honors, “Policy Ordering in semi-Markovian Decision Processes.”
- Employment History
  - Employee #70 at legendary Xerox PARC (1972-4).
  - Stanford Research Institute, Decision Analysis Group (1974-7).
  - Co-founded and built Decision Focus Inc. (DFI) into \$25 million (sales) company (1977-95).
  - Co-founded four new companies (1996-09)
    - Altos Management Partners (management consulting)
    - MarketPoint Inc. (enterprise software)
    - Reticle Inc. (high surface area carbon, water deionization/desalination)
    - Ferritech Inc. (biotechnology/ferric oxidation)
  - Sold Altos and MarketPoint (2011)
  - Founded ArrowHead Economics LLC, software and consulting (2013)
- Stanford (<https://msande.stanford.edu/person/dale-nesbitt>)

# EIA: Thank You for This Topic

- There are so many issues at play today that you need an economic model to keep track of them.
  - There is no hope without it
  - The human brain (and spreadsheets and LPs) are incapable



# ArrowHead Offers an Integrated, Interconnected World Hydrocarbon Model

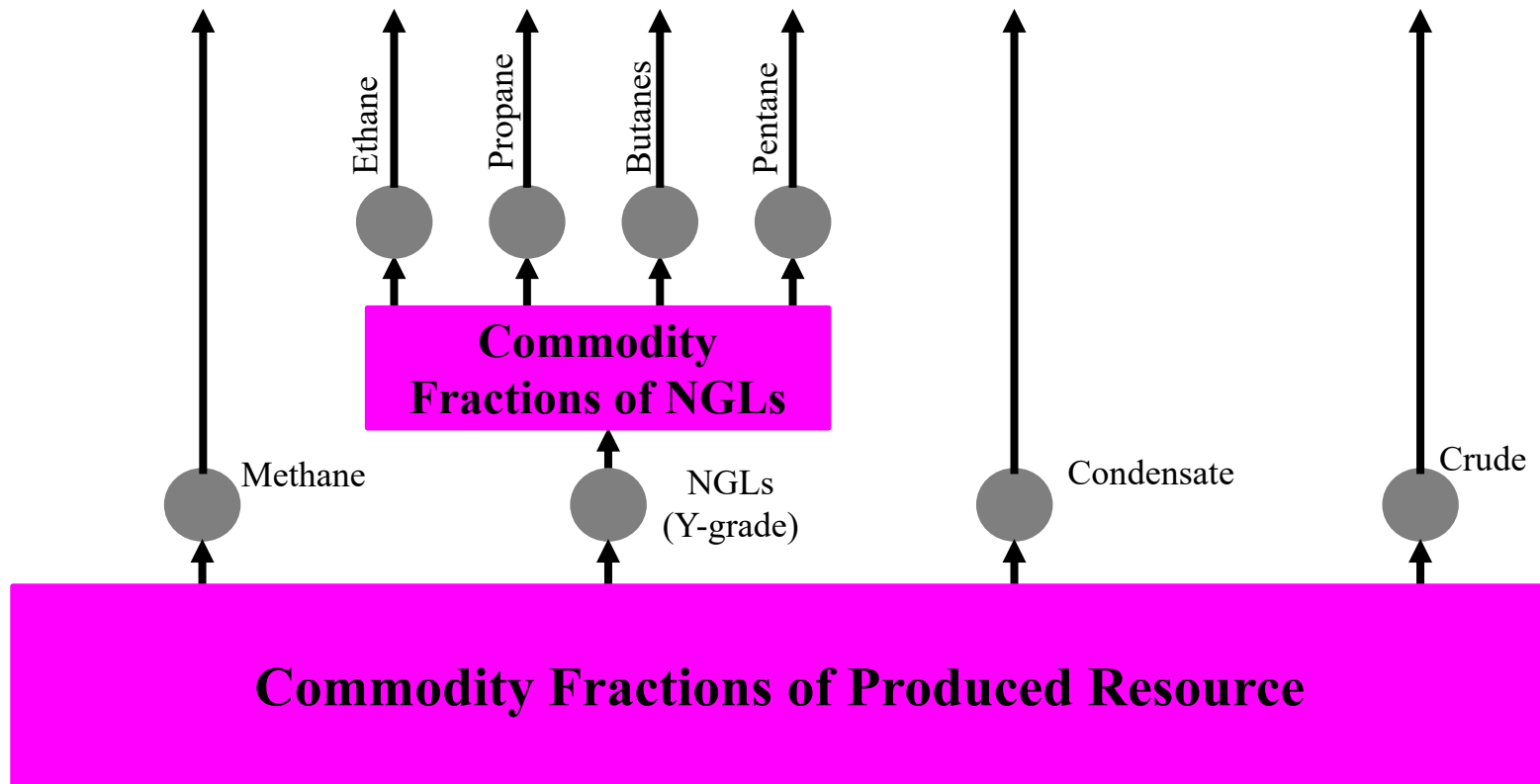


# **Global, Integrated Model Is Required To Answer Questions**

---

- Oil, condensate, NGL (Y-grade), and gas are produced jointly, meaning interdependent prices, investment, and demand.
- Oil on gas competition has re-emerged, exacerbating this.
- CO2 tax and policy connects them all together
- Renewables and policy connect them all together

# The Resource Spans All Fuels Everywhere in the World

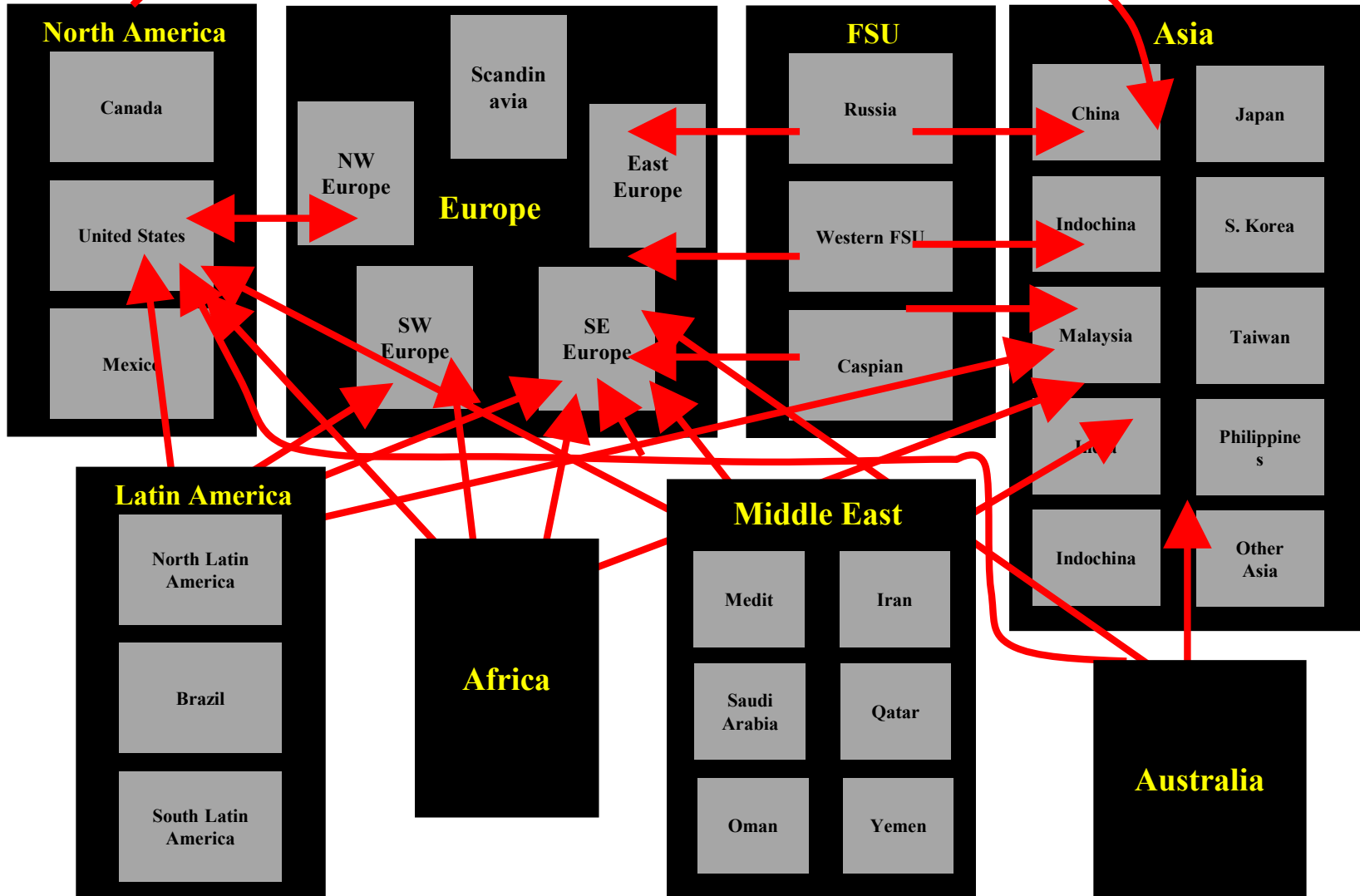


**The economist Ramsey told us how to model this—we do it!**



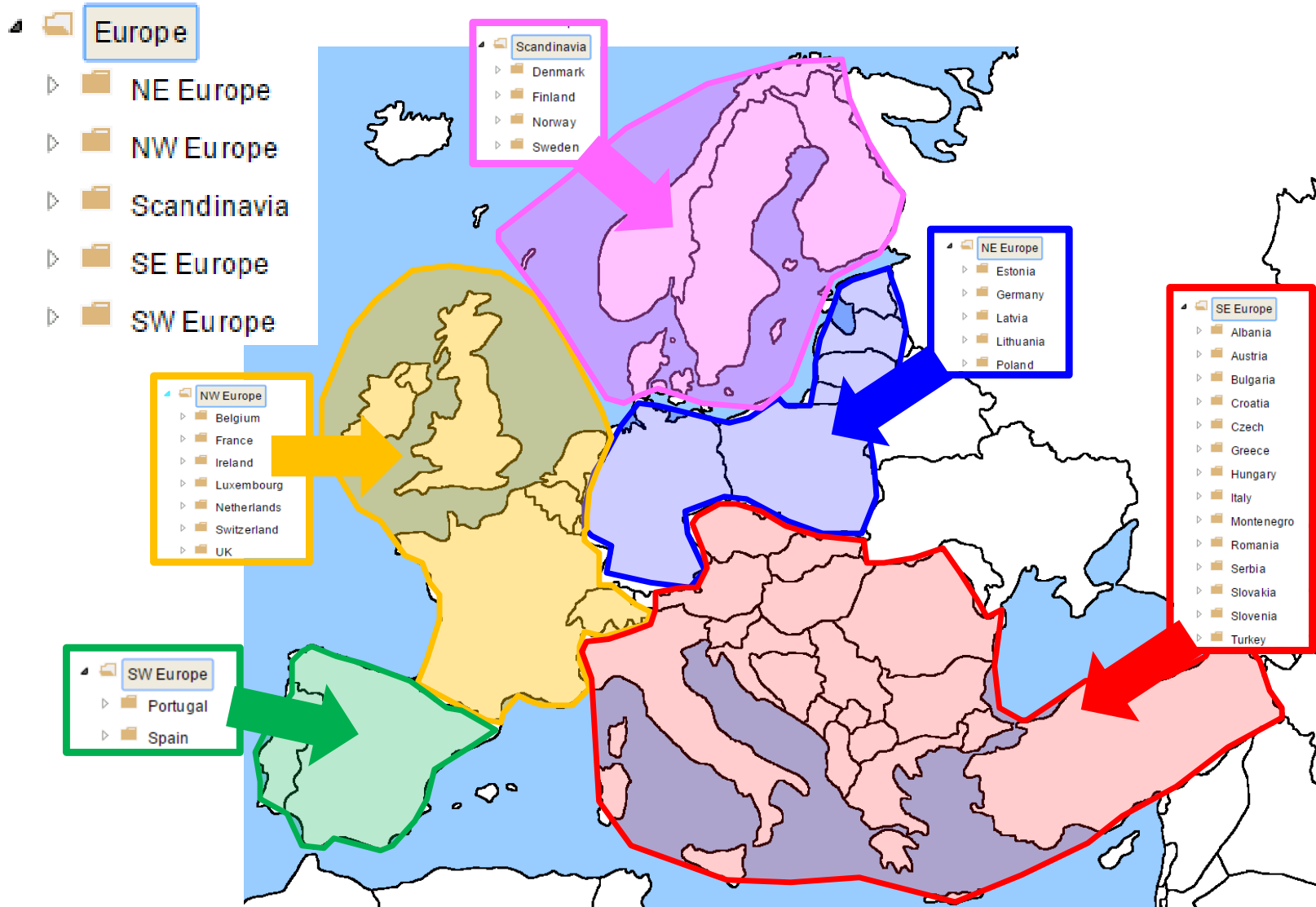
# Each Constituent Model Has Full World Regionality

ArrowHead Economics



# Supply-Transport-Demand-Inflow-Outflow

## Detailed in Every Region/Subregion





# You Can't Understand CO2 Without It



Oil and gas companies need to show that they reduce Scope 3

EIA needs to calculate Scope 1, 2, plus 3 throughout the world. That's the externality

# Pounds of CO2 Emitted per MMBtu of Fuel (EIA Has Done the Hard Work!)

Coal (anthracite)	228.6
-------------------	-------

Coal (bituminous)	205.7
-------------------	-------

Coal (lignite)	215.4
----------------	-------

Coal (subbituminous)	214.3
----------------------	-------

Diesel fuel and heating oil	161.3
-----------------------------	-------

Gasoline (without ethanol)	157.2
----------------------------	-------

Propane	139.0
---------	-------

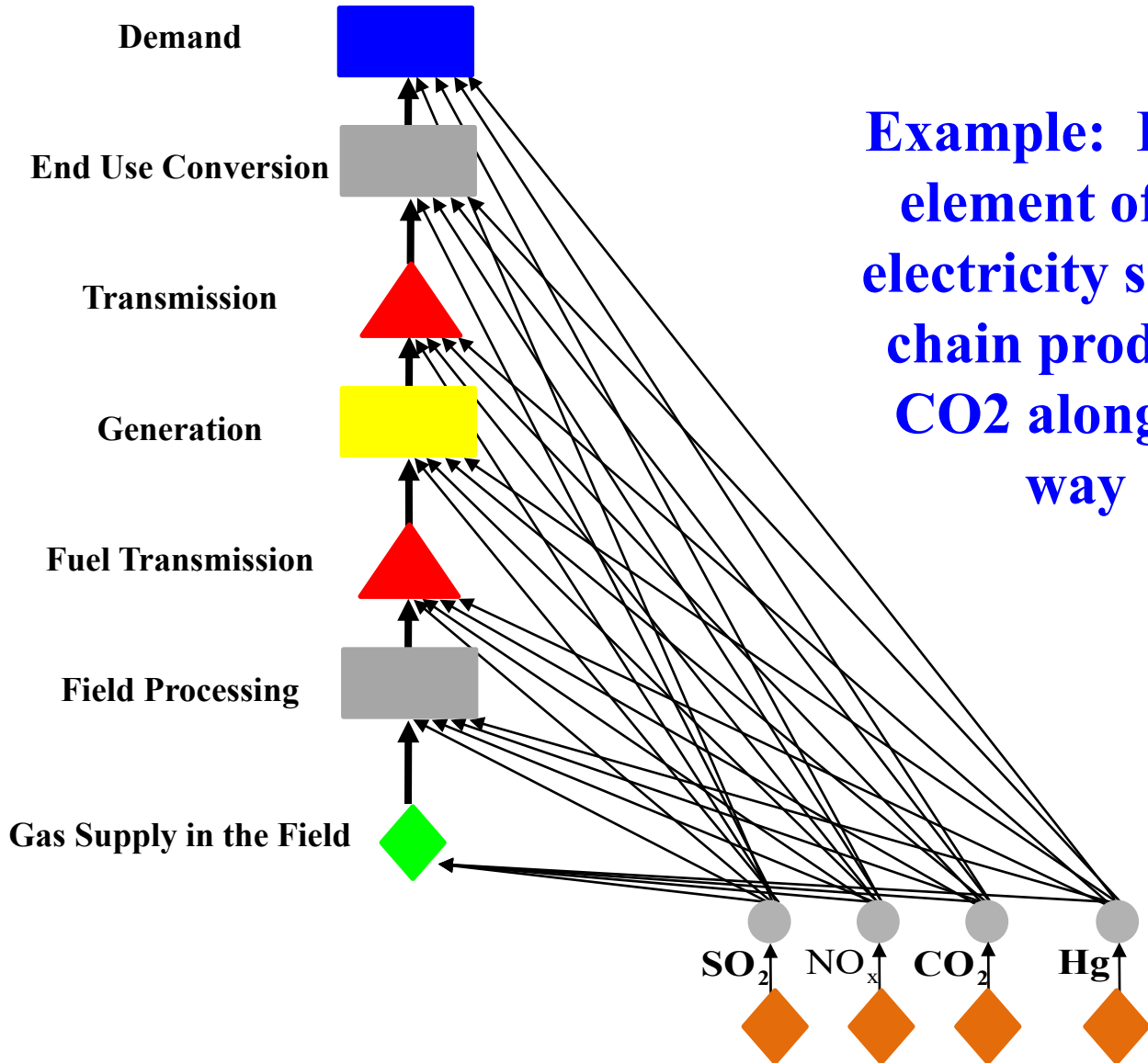
Natural gas	117.0
-------------	-------

<b>Hydrogen</b>	<b>0</b>
-----------------	----------

**You have to  
know how to use  
this! Here's  
how.**

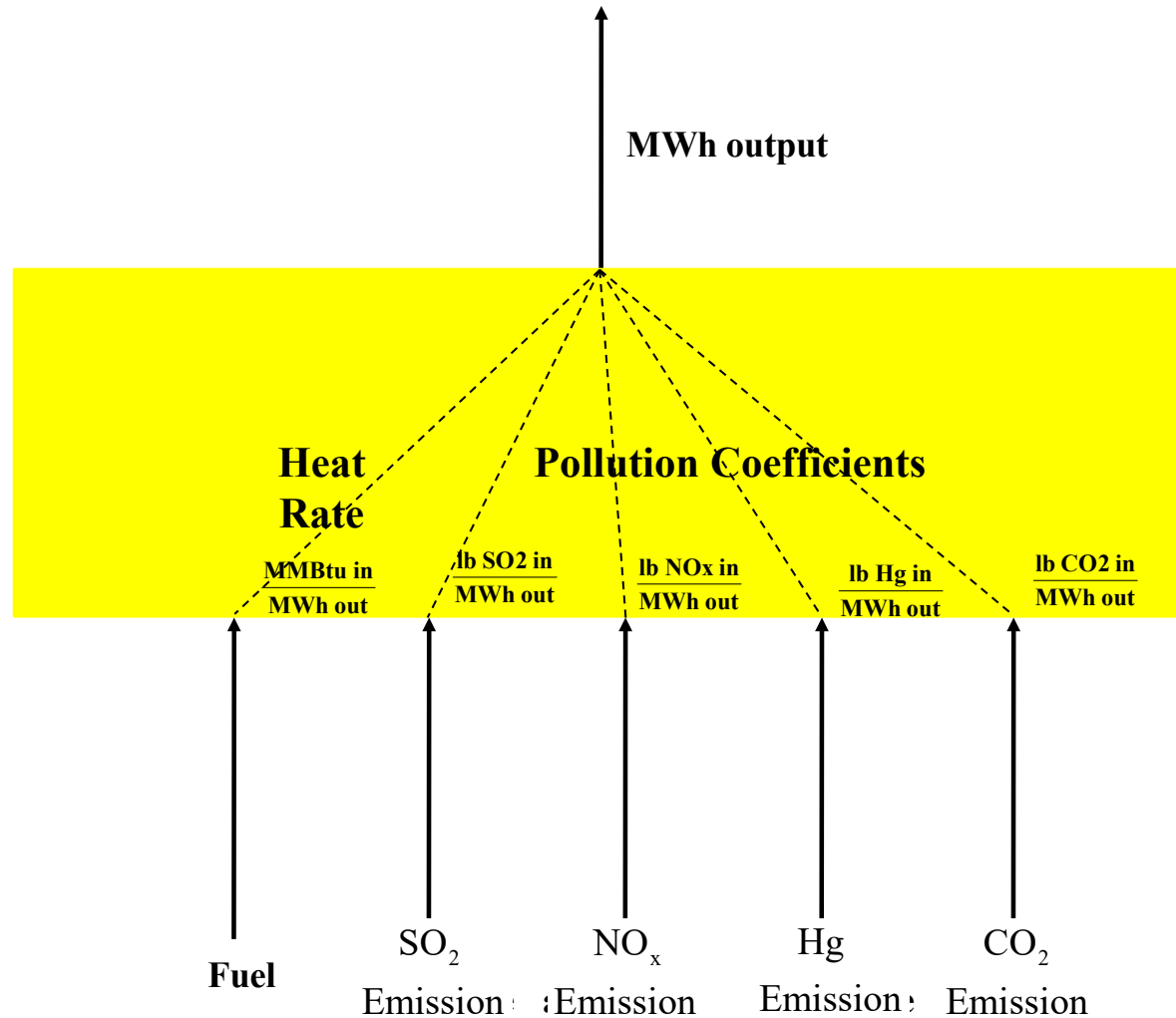


# How Do You Use EIA Information to Do It?

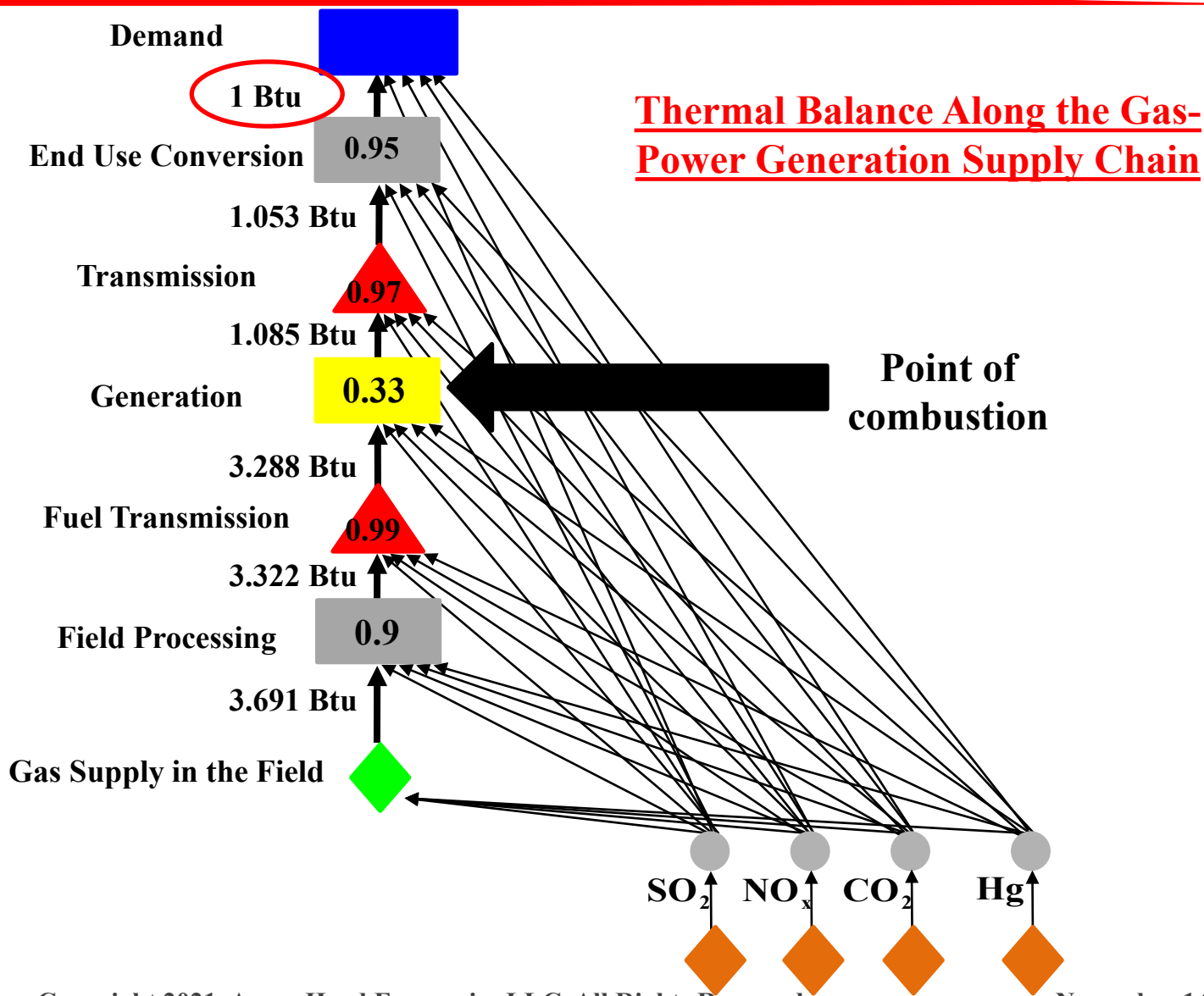


**Example: Every element of the electricity supply chain produces CO<sub>2</sub> along the way**

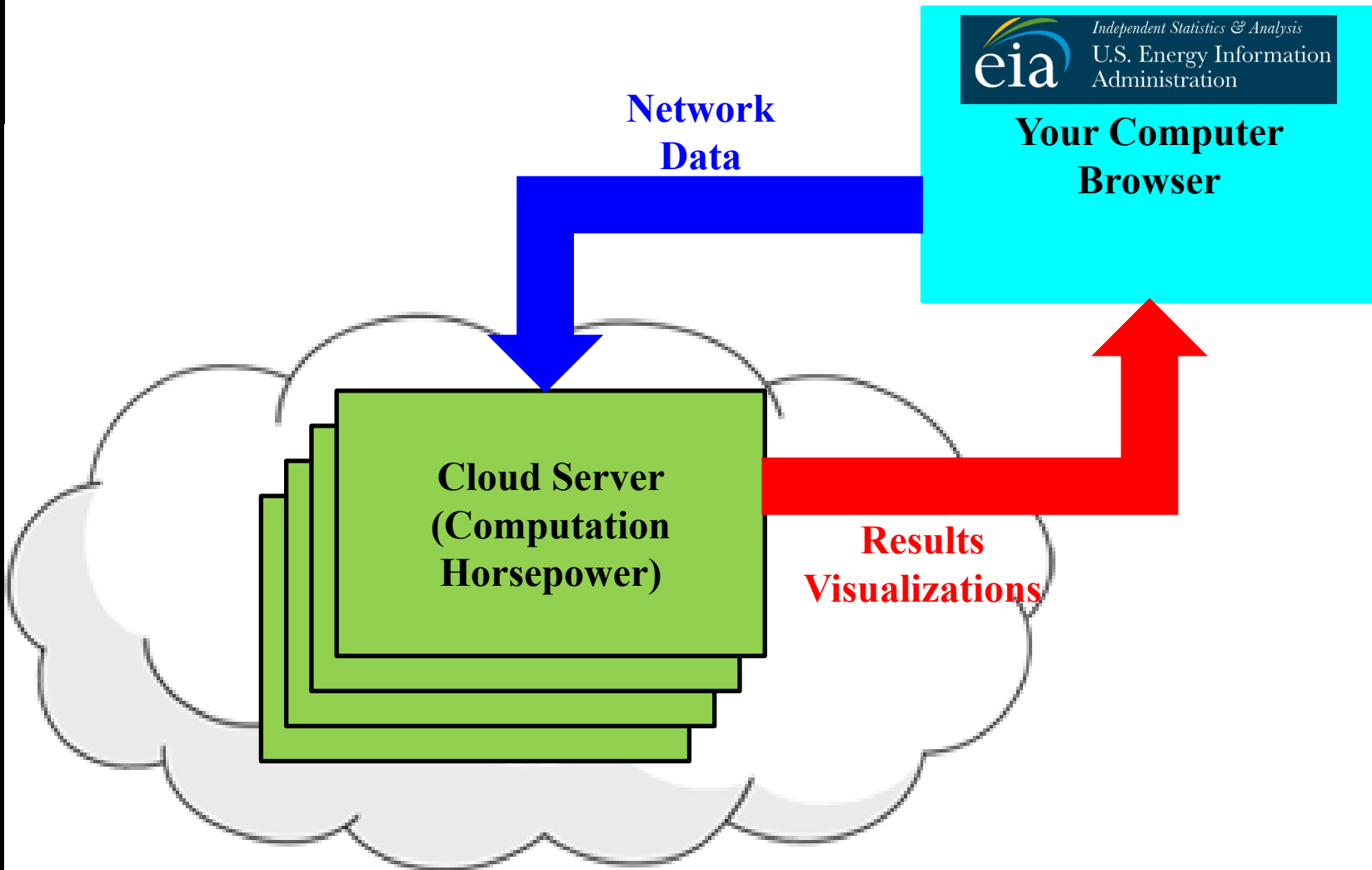
# Get the Thermal and Emissions Accounting for Every Node



# We Do the Thermo and Stoichiometry on Every Element of Every Supply Chain



# Operates Worldwide Over the Cloud (AWS)



# Open Access Source Code

- Open access source code for economic logic.
  - Customers can write (and share) economic source code, putting theirs into a library for any or all to see and use or develop.
  - Code must be compilable and should be fast.
- ArrowHead also offers proprietary economic logic.
  - No one is compelled to use non-accessible logic
  - Users can switch

# What Are We Learning?

Summary rather than detailed model  
results

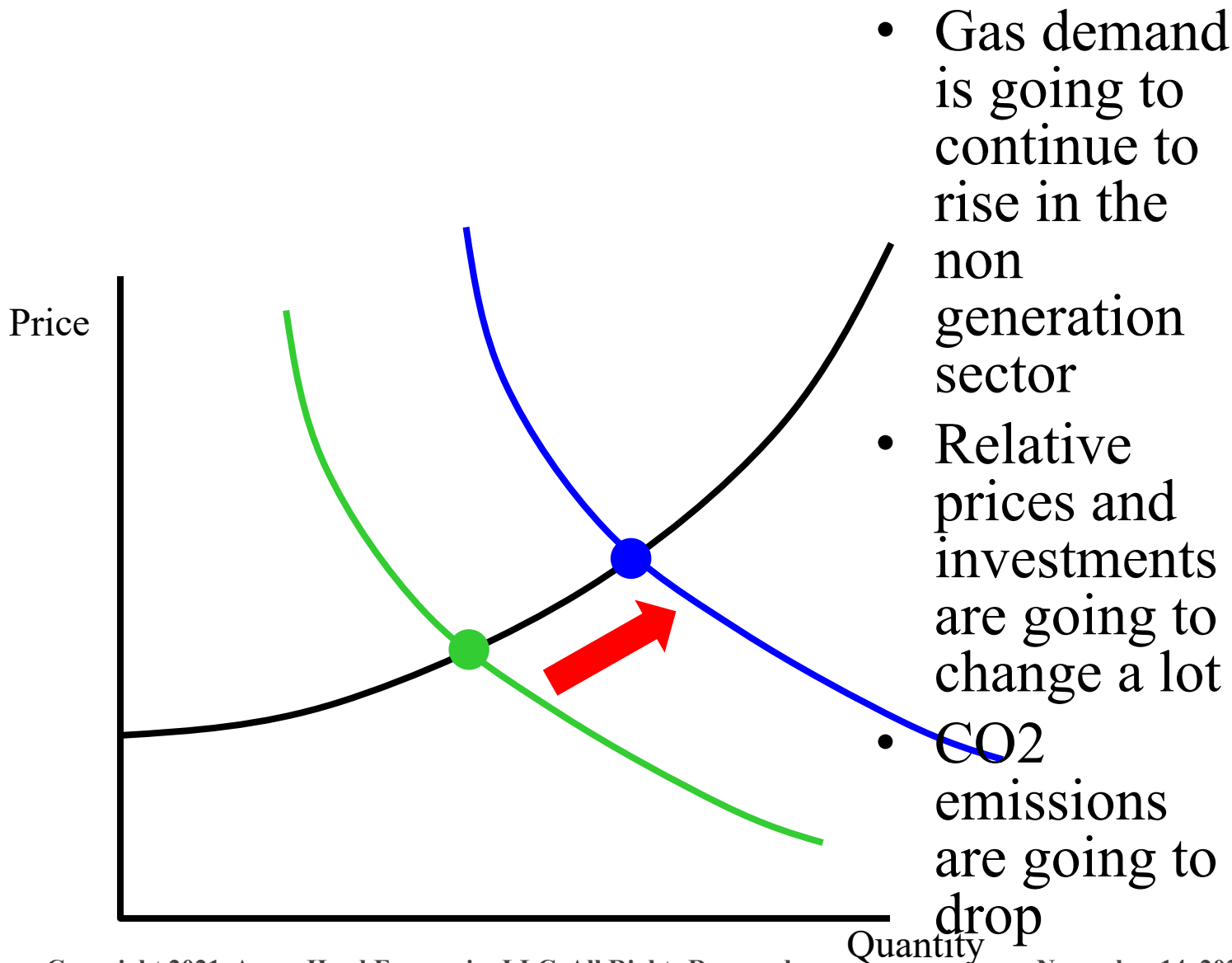
Seventeen points I will choose from



# 1. Gas and Liquids Have Become Substitutes Again

- Rail (LNG versus diesel)
- Off-road heavy-duty vehicles (dump trucks in mines)
- On-road heavy duty vehicles (e.g., long distance haulage on TransCanada Highway, Interstate-80)
- Intra-continental shipping (LNG versus diesel)
- Inter-continental shipping (LNG versus HS bunker versus LS bunker versus diesel versus refinery hydrogenation)
- CNG in buses and light duty vehicles
- Electric vehicles, which can come from gas
- Hydrogen generation (which used to come from methane or from the “water gas reaction” but now promises to come from electrolytic decomposition of water)
- Industrial substitution in other regions around the world that actually do have an industrial sector

# Gas Is Going to Win a Lot of These Battles



- Gas demand is going to continue to rise in the non generation sector
- Relative prices and investments are going to change a lot
- CO2 emissions are going to drop

# **17 More Prospective Substantive Points Being Finalized and Prioritized Today**

I will select only a subset of the most  
important points

# Thank You

Dr. Dale M. Nesbitt



221 Main Street, Suite 1856

Los Altos, CA 94022

November 13, 2021

[dale.nesbitt@arrowheadeconomics.com](mailto:dale.nesbitt@arrowheadeconomics.com)

(650) 218-3069