

# Overview of NEMS-H2, Version 1.0

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# Today's Presentation

- Overview of NEMS-H2 Structure
- Current Status
- New Hydrogen Market Module (HMM)
- Transportation Module Modifications
- Preliminary Test Runs
- Looking Ahead to Next Phase



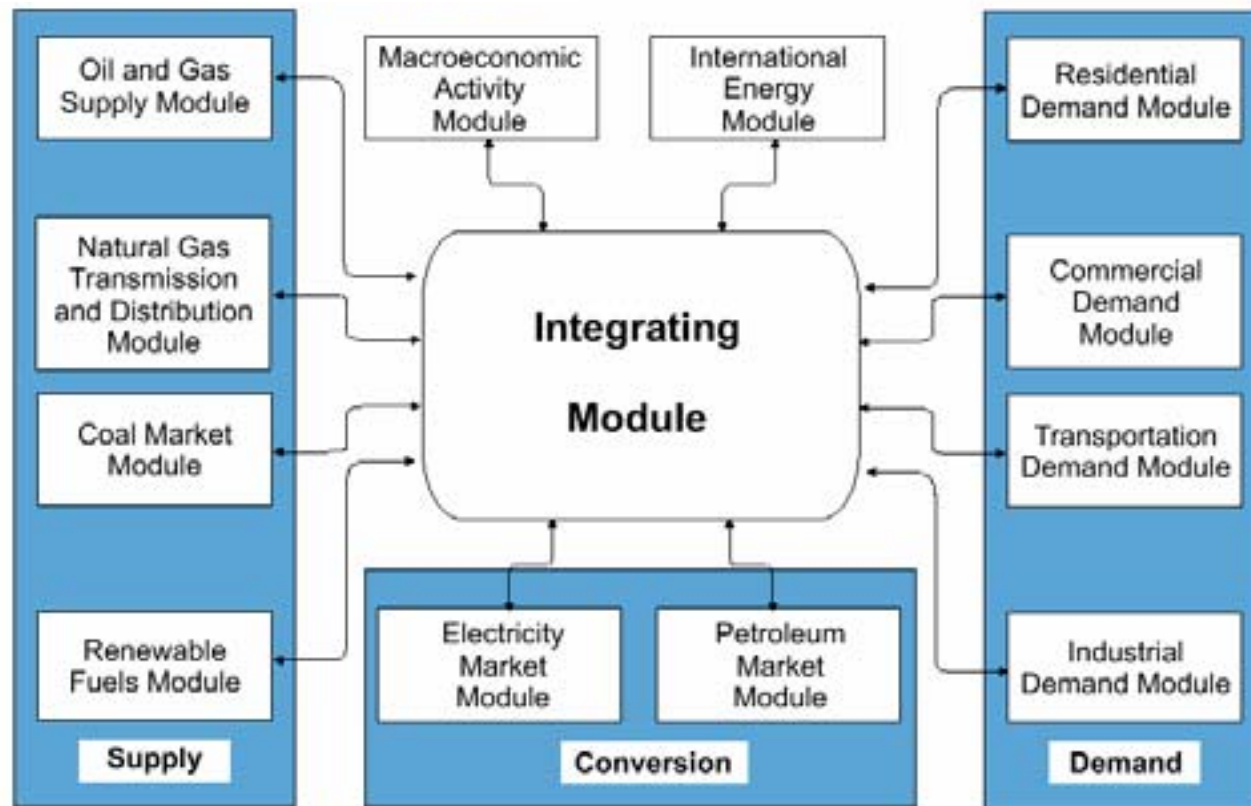
# NEMS Overview

- The National Energy Modeling System (NEMS) was developed and is maintained by EIA
  - Annual Energy Outlook projections
  - Congressional as well as agency requests
- NEMS has also been used extensively outside of EIA
  - Various National Laboratories studies
  - National Commission on Energy Policy
  - Program offices within DOE for R&D benefits estimation
- Modular structure allows each sector to be represented by methodology and data that fit it best
  - Optimization techniques used for electricity capacity expansion and dispatch and petroleum refining
  - Extensive technology representation for many sectors
  - Econometric approach for others
- Lacks hydrogen market representation



# NEMS Overview

- NEMS is a simulation model organized by energy producing, consuming, and conversion sectors.

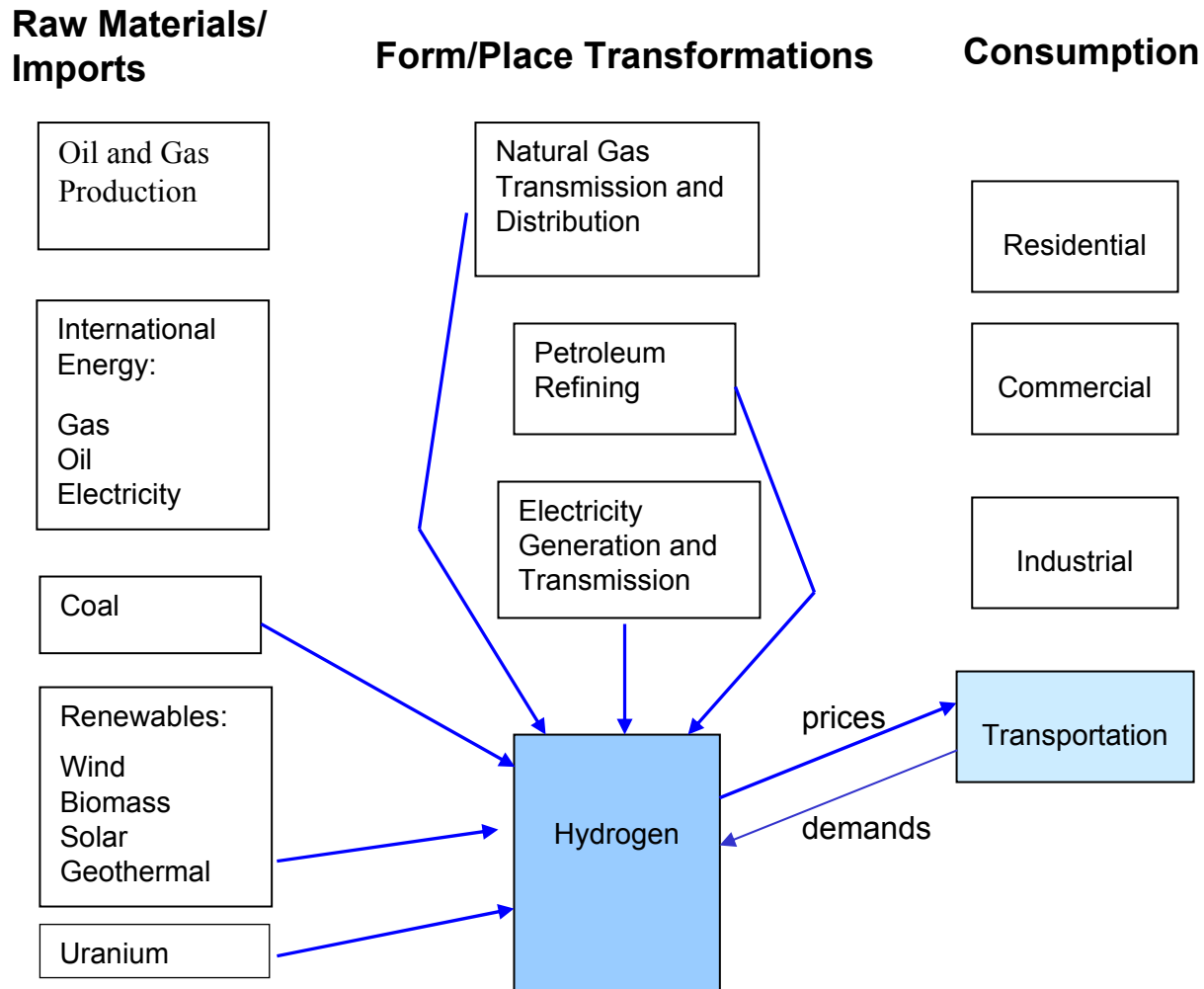


# Key Attributes of NEMS-H2 Version 1.0

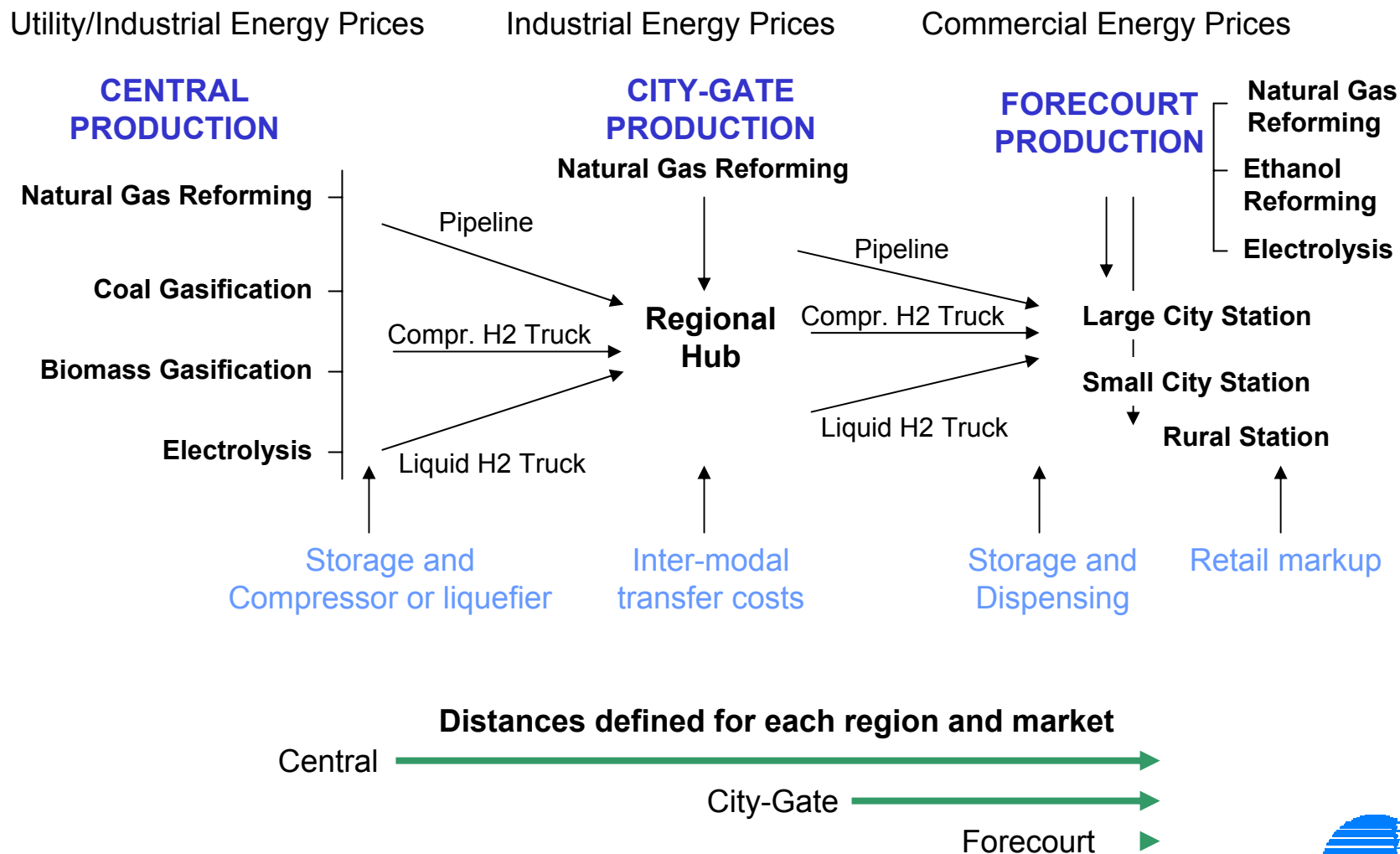
- Designed to analyze interactions of hydrogen markets with other energy markets
  - Focus is on economic, not engineering, aspects of hydrogen production, delivery, and consumption
- Hydrogen represented for 3 market segments within 9 Census Divisions
- New Hydrogen Market Module (HMM) where hydrogen supply options compete based on delivered cost in each market
  - Multiple production and delivery pathways
  - Integration of NEMS fuel and electricity supply inputs
- Light duty vehicle choice within NEMS modified into three market segments
- Hydrogen stationary fuel cells not yet included



# Interconnections of New Hydrogen Module



# H2 Production and Delivery Pathway Representation



# Hydrogen Production Technologies Currently in the HMM

- Production is defined by three type of facilities
  - Central Production
    - Natural Gas Reforming (with and without sequestration)
    - Coal Gasification (with and without sequestration)
    - Biomass Gasification
    - Electrolysis (grid-based electricity)
  - City-Gate
    - Natural Gas Reforming
  - Forecourt Production
    - Natural Gas Reforming
    - Electrolysis (grid-based electricity)
- Each is represented by capital cost, non-fuel O&M costs, and energy conversion efficiencies.
- Additional technologies may be added in the next Phase.





# Regions and Markets

- NEMS demand models currently use Census Divisions for regional detail. Hydrogen market module was designed around this same regional breakdown.
- Census Divisions are employed to capture the potential impact of variations in fuel input prices throughout the country.
- Market segments are used to capture relative demand density and associated delivery costs within the regions.
  - Currently, for testing purposes, three market segments have been defined based on population
  - Market segment definitions constructed from county level data and Core Base Statistical Areas (CBSA's)
    - Large City (> 250,000 population)
    - Small City (>25,000 and <= 250,000 population)
    - Rural (remaining counties)
- Goal is sensible hydrogen production costs and delivered hydrogen costs, *not* projection of actual plant locations



# Current NEMS Transportation Model

- The NEMS light duty vehicle module is comprised of many submodules that
  - Select vehicle attributes for each vehicle type
  - Determine market shares among vehicle types (gasoline, diesel, hybrids, etc.)
  - Vintage stocks and add new sales
  - Determine vehicle miles traveled (VMT)
- Market shares among alternative technology vehicles (ATVs) are based on a multi-attribute logit model with consumer preferences for attributes such as capital cost, cost of driving, acceleration, luggage space, make and model availability and fuel availability
- Each ATV has a unique set of these attributes
- This competition is performed within each region and for 12 size classes of cars and trucks



# Enhancements in NEMS-H2 for Hydrogen Fuel Cell Vehicles

- Hydrogen fuel cell vehicles are among the ATVs within the standard NEMS
- NEMS-H2 modifies the ATV sales choice section of the transportation model to accommodate the three markets (large city, small city, and rural)
  - Hydrogen prices for the three markets are determined by the HMM
  - Hydrogen fuel availability is based on the stock of hydrogen vehicles (stations increase as stocks increase) or by user assumption
  - Make and model availability is internally computed based on existing NEMS algorithm or by user assumption
- Stock of hydrogen FC vehicles for each market is tracked through the age vintaging model in order to compute hydrogen fuel consumption in each market
- Hydrogen consumption by Census Division and market is passed back to the HMM



# **Test Results**

## **(Not Real Scenarios)**



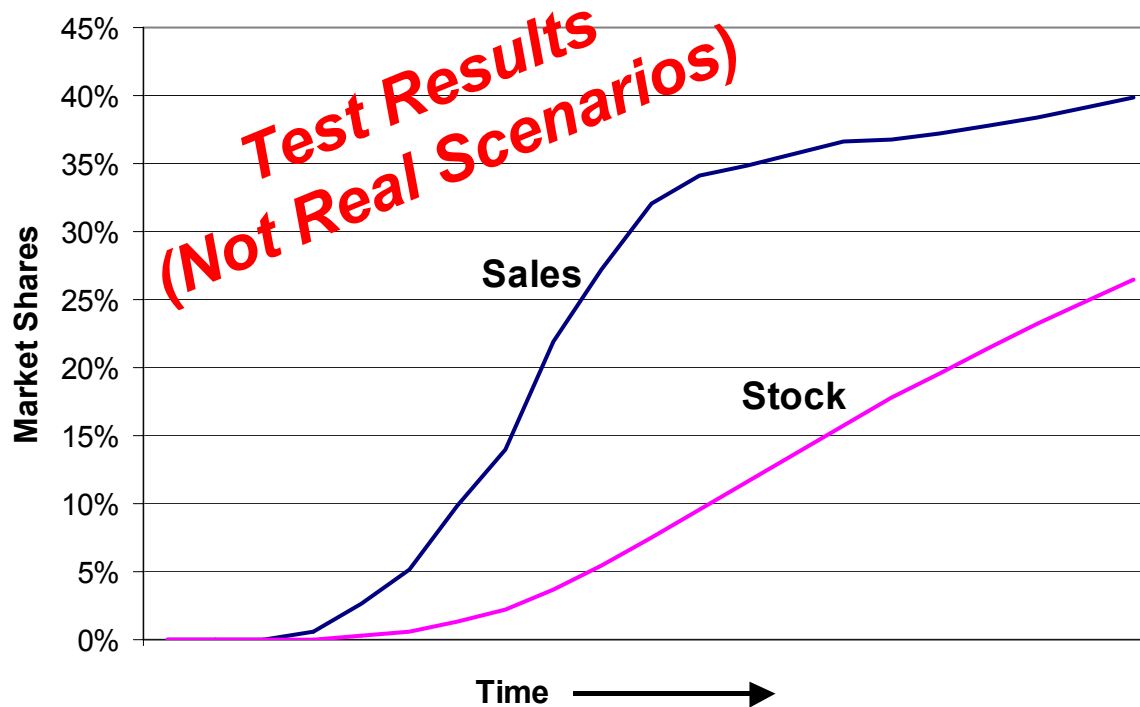
# Model Testing

- We have run the model with a variety of assumptions designed to test the reasonableness of its results.
- These are not real scenarios and do not represent any forecast of the future.
- Because the current model timeframe ends in 2025, we have “sped up the clock” with our inputs assumptions.



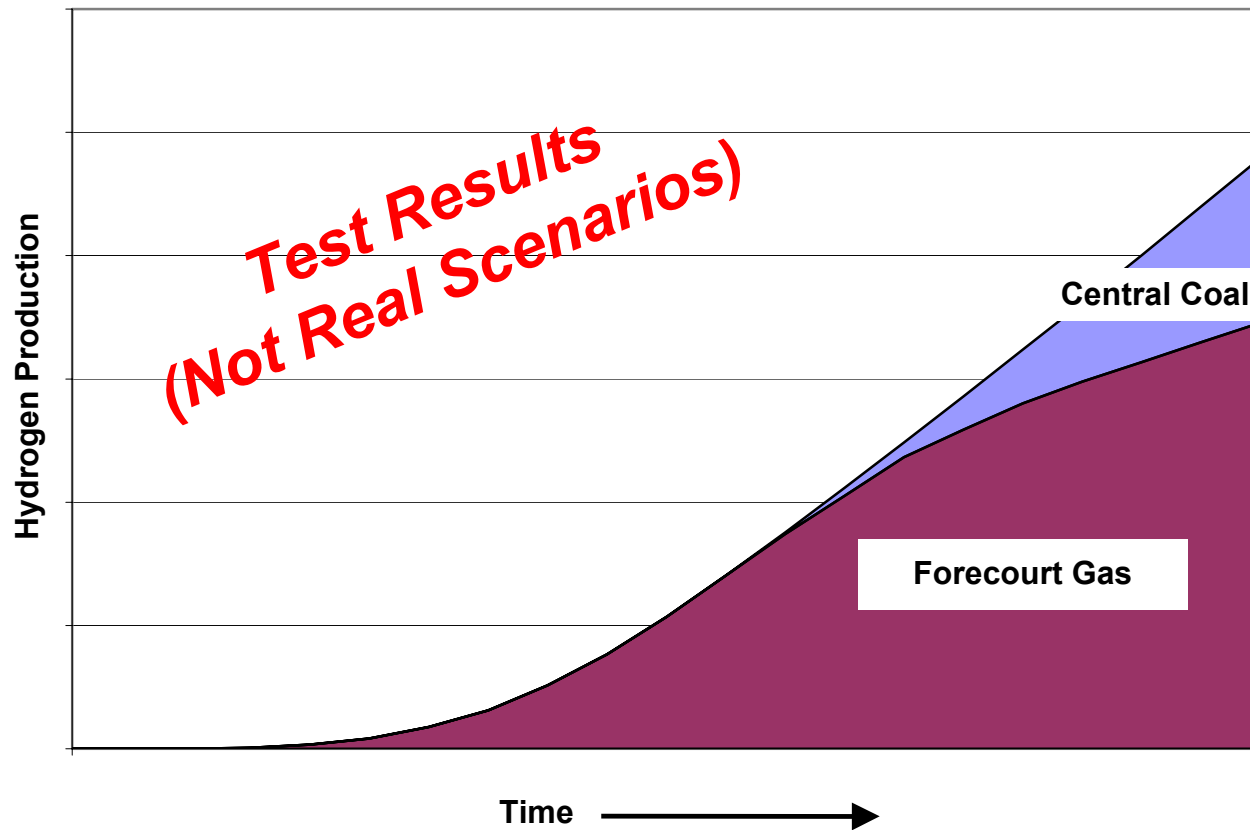
# Vehicle Sales and Stocks

- In our test case with HFCIT vehicle goals and a subsidy, hydrogen fuel cell vehicles gain market share over time
  - Vehicle costs and efficiencies improve over time and then plateau (by assumption)
  - Make and model and fuel availabilities increase as more are sold



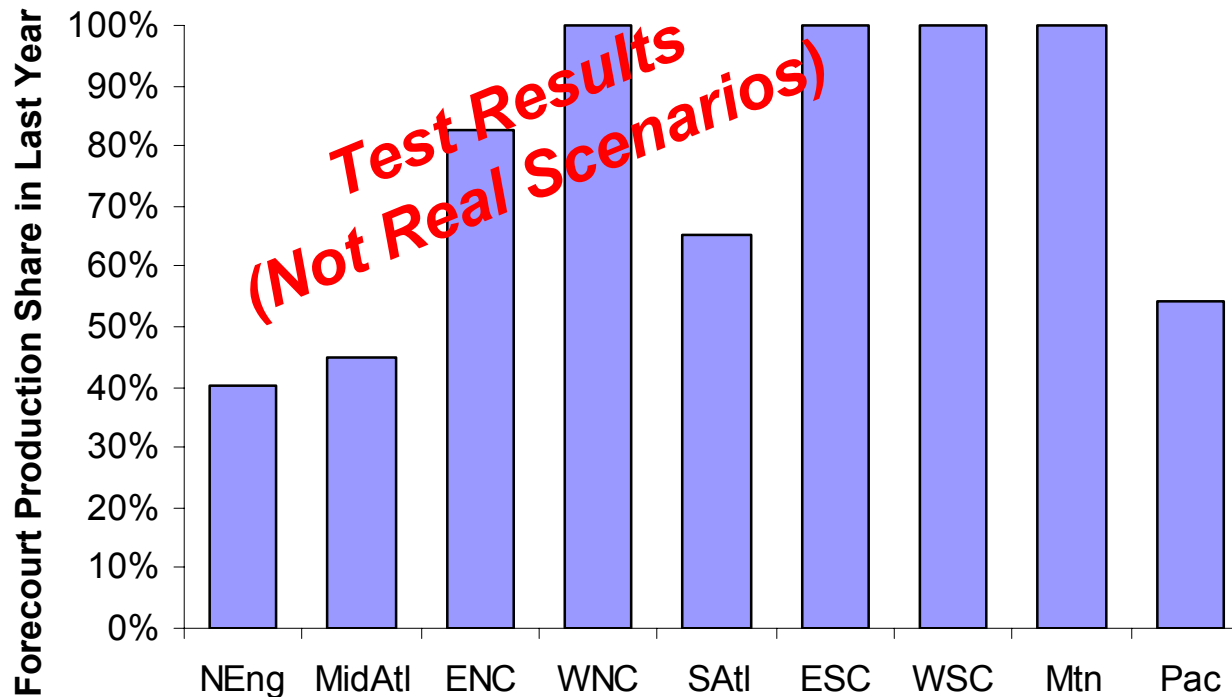
# Hydrogen Production

- Forecourt appears to be the entry technology with central production following as demand increases



# Regional Variations

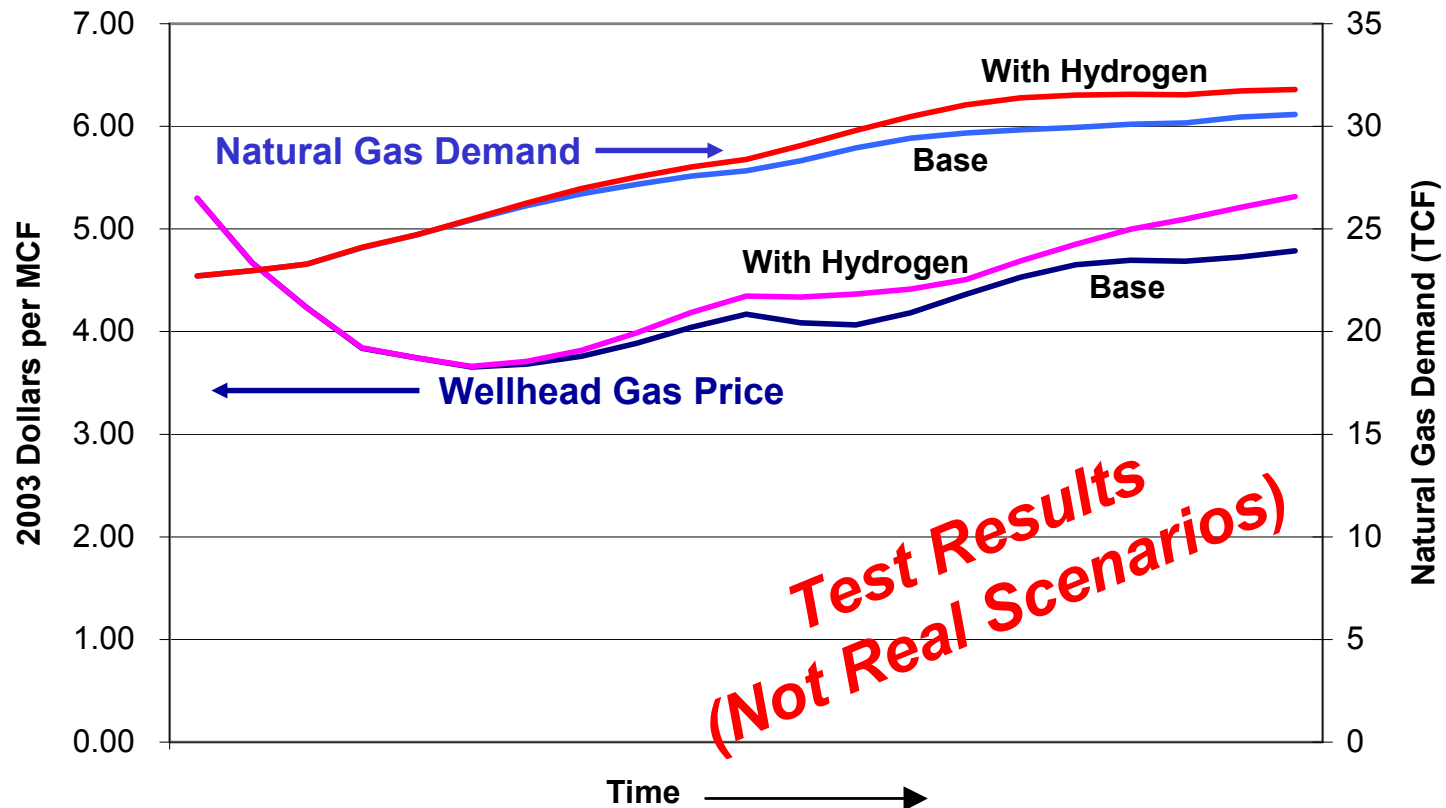
- In regions with large areas and low demands, forecourt production dominates through the forecast
  - Unclear how this might change over longer time period or with updated delivery costs





# Natural Gas Markets

- Additional natural gas demand for hydrogen production puts upward pressure on the wellhead gas price



## Planned Phase 3 Activities

- Integration with AEO2006 version of NEMS
- Internal model review
- Extension of NEMS-H2 to 2050
- Hydrogen specific enhancements
- Scenario runs
- External review

