

# Impact of Hydrogen Production on U.S. Energy Markets

E. Harry Vidas

Energy & Environmental Analysis, Inc.

May 26, 2005

This presentation does not contain any proprietary or confidential information

Project ID #  
**ANP3**

# Overview

## Timeline

- Project to start May 2005
- Project end date is September 2008

## Budget

- Total project funding is \$1.3 million
- Funding for FY05 TBD

## Partners

- EEA Inc.
- Brookhaven National Lab
- Power & Energy Analytic Resources

## Barriers

- Lack of Consistent Data, Assumptions, and Guidelines
- Lack of Macro-Systems Model
- Lack of Understanding of Transition of a Hydrocarbon-Based Economy to a Hydrogen-Based Economy

# Objectives

- Develop a consistent, integrated framework for evaluation of impacts of hydrogen production within U.S. energy markets.
- Evaluate costs and timeliness of various scenarios of a developing hydrogen supply infrastructure.
- Evaluate impacts on U.S. energy markets including price and consumption changes for coal, natural gas, renewables and electricity.
- Identify most economic routes and financial risks of hydrogen production.

# Approach

- Primary modeling framework will be the MARKAL model.
- MARKAL will be modified to incorporate latest and most consistent cost and performance data for alternative hydrogen production technologies.
- Additional analyses on natural gas markets will be performed using models from EEA. Key relationships will be incorporated/calibrated into MARKAL

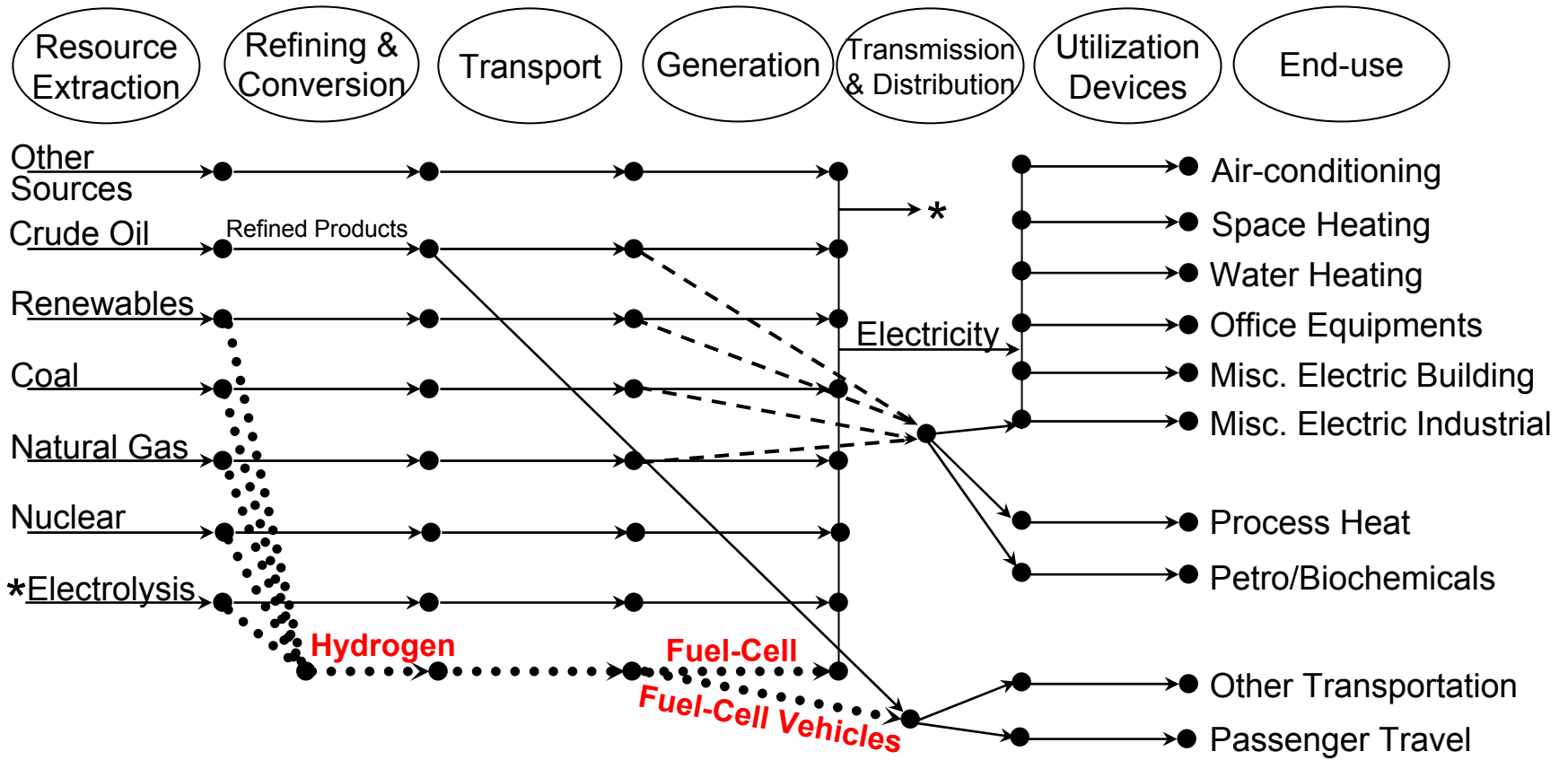
# Approach (cont.)

- Additional analyses on coal and electricity markets will be performed using models from PEAR. Key relationships will be incorporated/calibrated into MARKAL.
- Scenario analyses and sensitivity analyses to be performed with MARKAL.
- Results to be presented in series of briefings and reports.

# Milestones

Milestone #	Task #	Date Completed	Description of Completed Analysis	Deliverable Milestone
1	1	Nov-05	Development of consistent set of technical and economic assumptions to be used in the analysis	Appendix for Final Report
2	2	Apr-06	Hydrogen Market Assessment	Briefing
3	3	Apr-06	Completion of Scenario Development	Briefing
4	4	Sep-06	Completion of Initial Feedstock Market Impact Analysis	Draft Report on each feedstock
5	5	Feb-07	Completion of Power Generation and Other Market Analysis	Draft Report
6	6	Feb-07	Completion of Draft Integrated Analysis	Briefing
7	6	Jul-07	Completion of Final Integrated Analysis	Briefing
8	4&5	Oct-07	Complete Final Market Impact Analysis	Final Draft Report
9	7	Dec-07	Complete Draft of Final Report	Draft Report and Briefing
10	8	May-08	Complete Optional Analysis	Report and Briefing
11	7	Sep-08	Final Report available for publication	Final Report

# MARKAL for Integrated Market Analysis

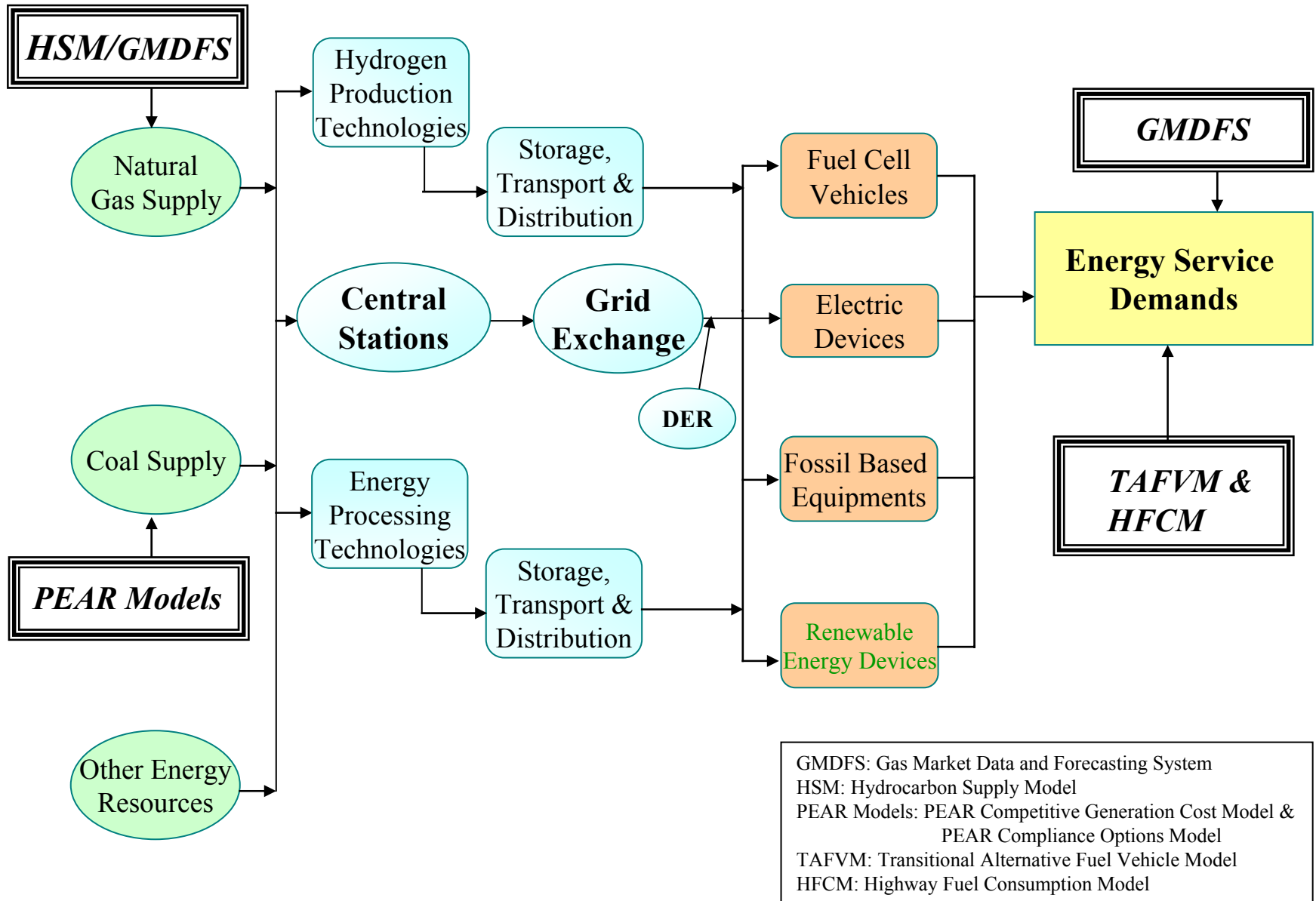


# MARKAL for Integrated Market Analysis

- Generates ***least-cost*** energy path based on ***life-cycle costs*** of technologies
- Utilizes a ***bottom-up*** approach to identify an ***optimal technology/resource mix*** to meet demands in a balanced energy market
- Consists of a ***dynamic integrated framework*** to assess ***market competition, technology diffusion*** and ***emission accounting***
- Produces outputs that facilitate the analysis of ***economic tradeoffs*** among alternative energy infrastructure systems



# Model Interactions in Hydrogen Market Analysis



# Model Interactions in Hydrogen Market Analysis

- ***TAFVM*** & ***HFCM*** generates demands (e.g. fuel cell vehicles) used in ***MARKAL***
- ***HSM*** & ***GMDFS*** provide natural gas supply and power demand used in ***MARKAL***
- ***PEAR Models*** determine coal production and use
- ***MARKAL*** incorporates disparate elements from individual models to perform integrated analysis

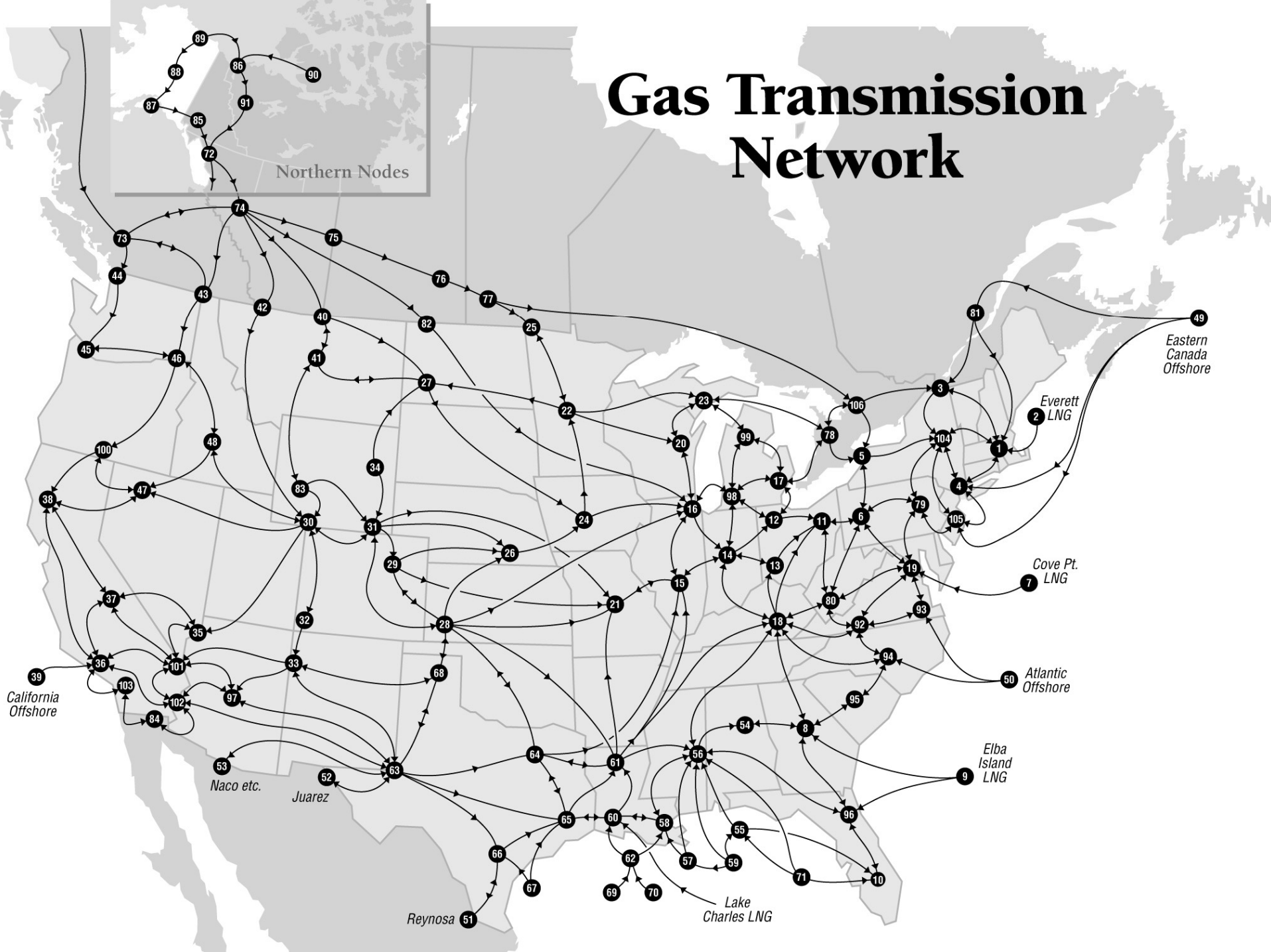
# Unique Features of Project

- Integrates supply/demand and various fuel markets
- Inter-temporal approach that looks at technology evolution and stranded investments
- Evaluates energy markets over the long-term (2005 - 2050)
- Examines alternative scenarios and sensitivities
- Focuses of on the competition among production technologies
- Considers hydrogen demand levels, technology costs, regional cost variations, and feedstock prices
- Estimates impact of hydrogen production on hydrogen feedstock prices and consumption changes in other energy markets

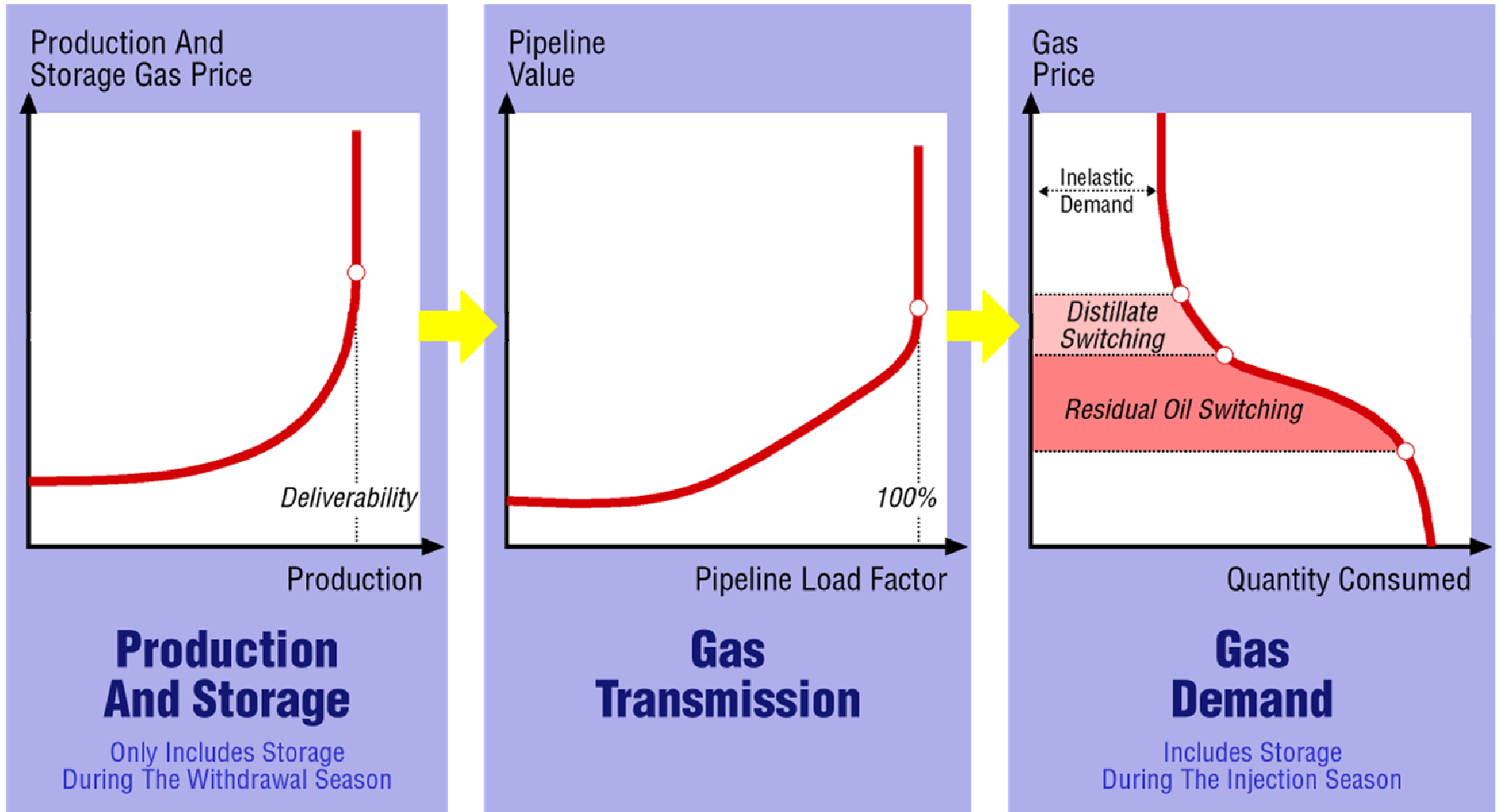
# EEA Gas Market Model

- EEA's model is a general equilibrium representation of gas markets throughout North America.
- The model simulates North American gas markets on a monthly basis, solving for gas demand, production, storage activity and prices within many regions and nodes.
- Creates a monthly balance of gas supply and demand at over 120 market locations integrated by an extensive pipeline network.
  - Balance includes pipeline flows and storage injections and withdrawals at each location.

# Gas Transmission Network



# Monthly Gas Quantity And Price Equilibrium



# Uses of the EEA Gas Model

- Facility investment decisions
  - Own investment
  - Competitor's investment
- Gas supply planning
- Gas and oil resource economics
- Evaluate weather risk
- Gas infrastructure requirements
- Due diligence for M&A activity
- Certification and rate case proceedings
- Policy studies

# Scenarios and Sensitivities with EEA Gas Model

- Most forecasts have been created for planning purposes for the next 5 or more years.
  - Scenarios can be run through 2035.
- Many levers for scenario analysis. The most commonly changed variables include:
  - Gas supply drivers
  - Power plant additions and availability
  - Pipeline/storage expansions
  - Economic growth
  - Weather
  - Oil and coal prices