

Impact of Hydrogen Production on U.S. Energy Markets

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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

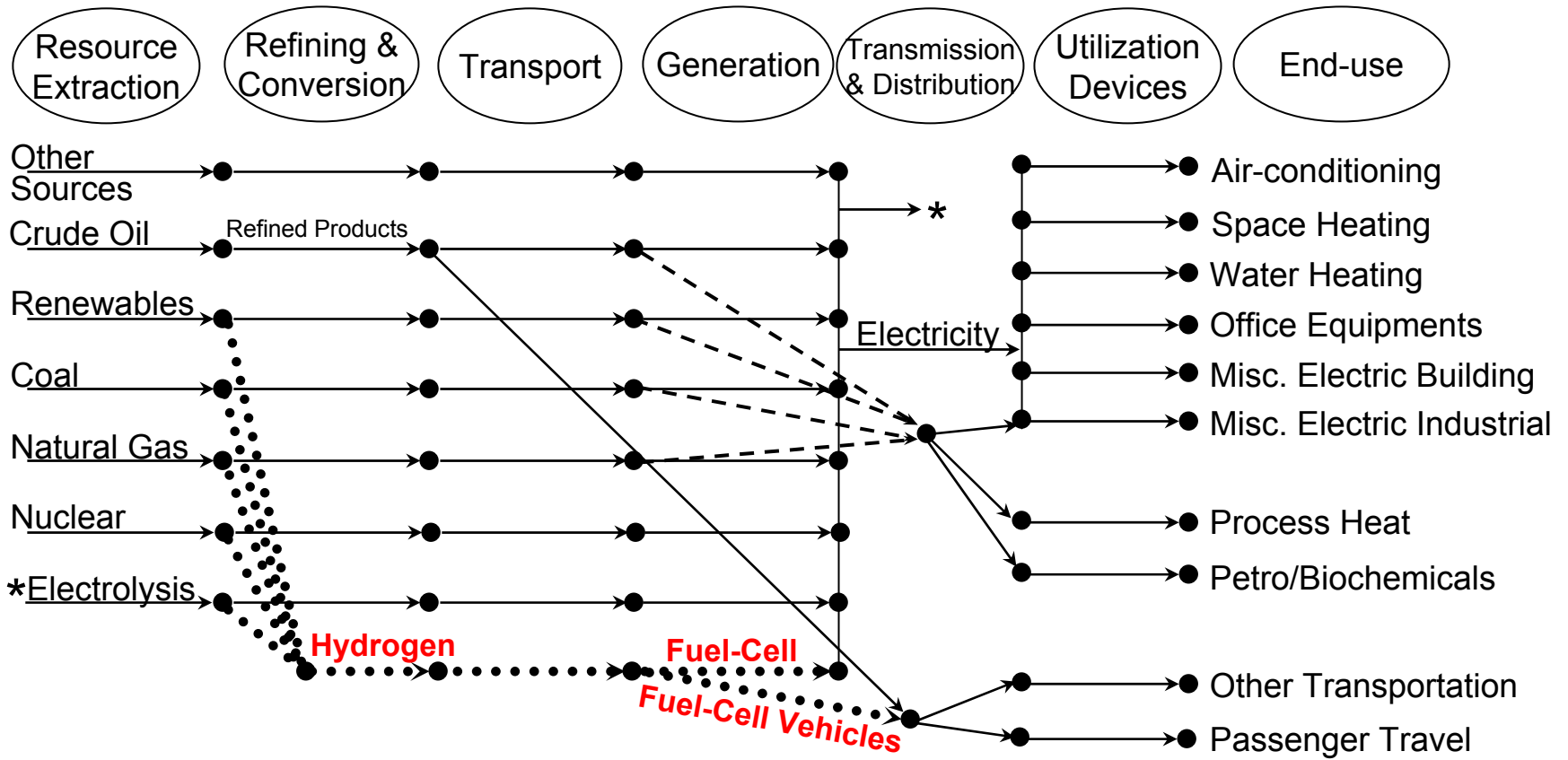
Approach (cont.)

- 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

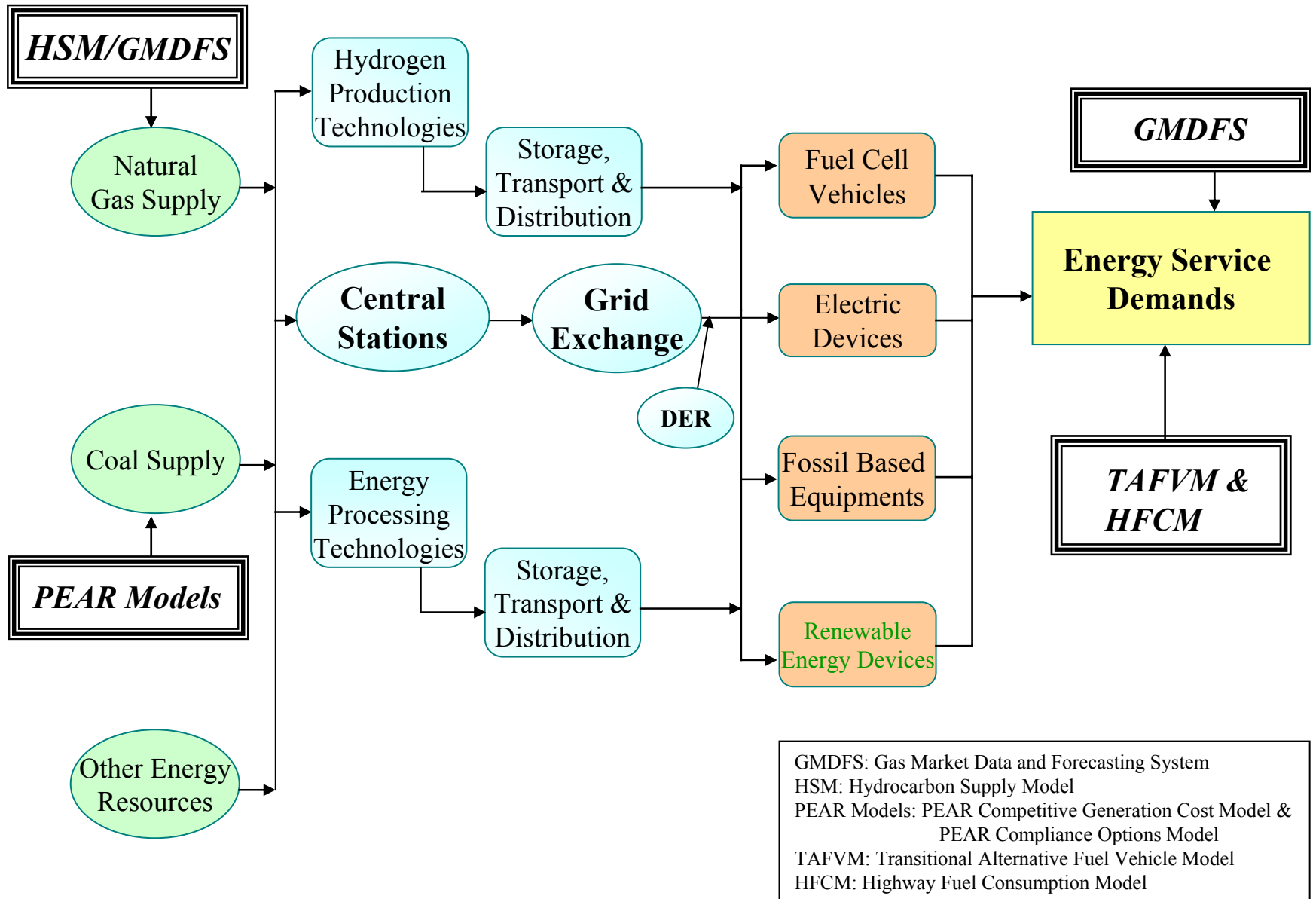
MARKAL for Integrated Market Analysis



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

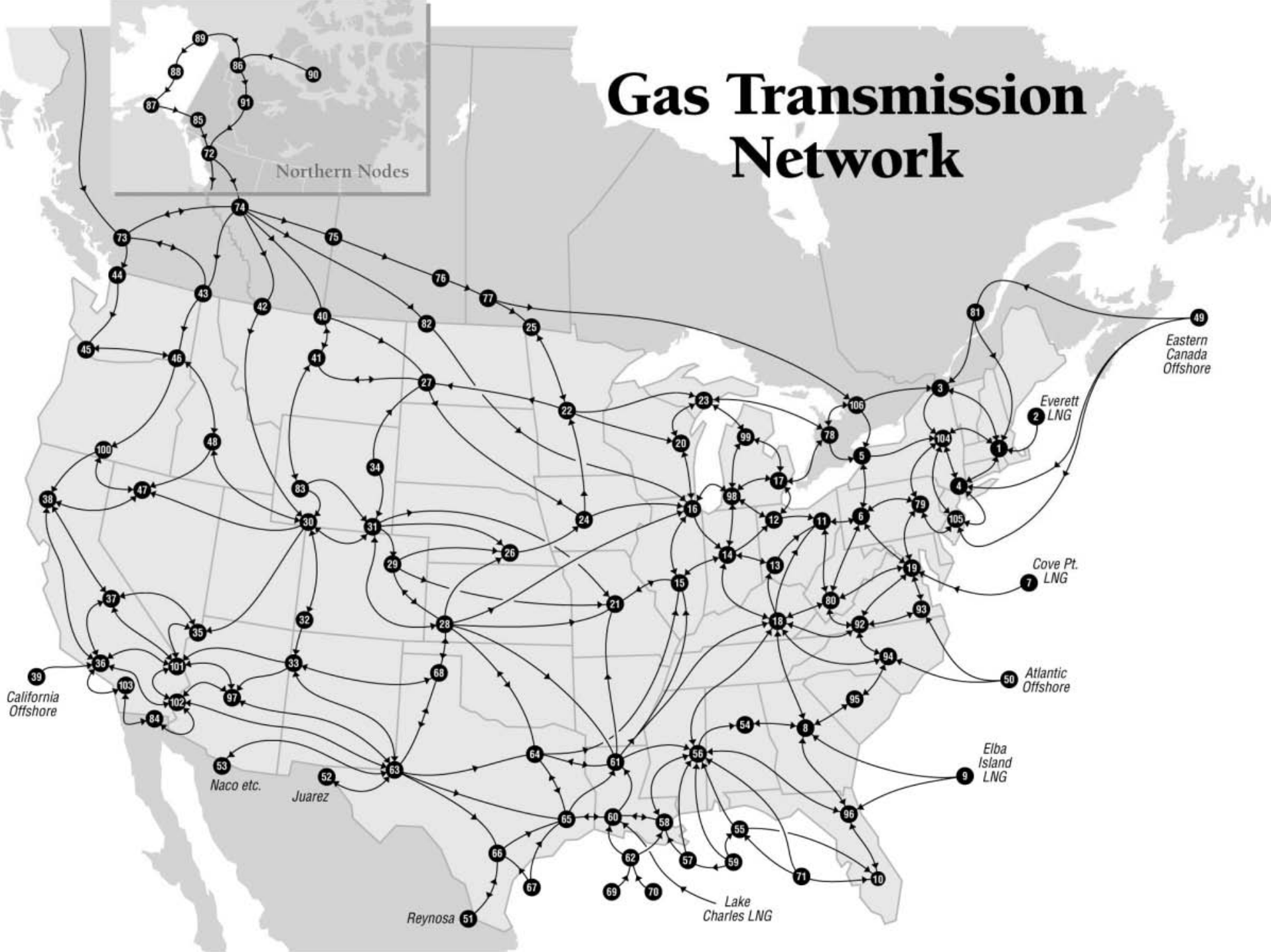
Unique Features of Project

- 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

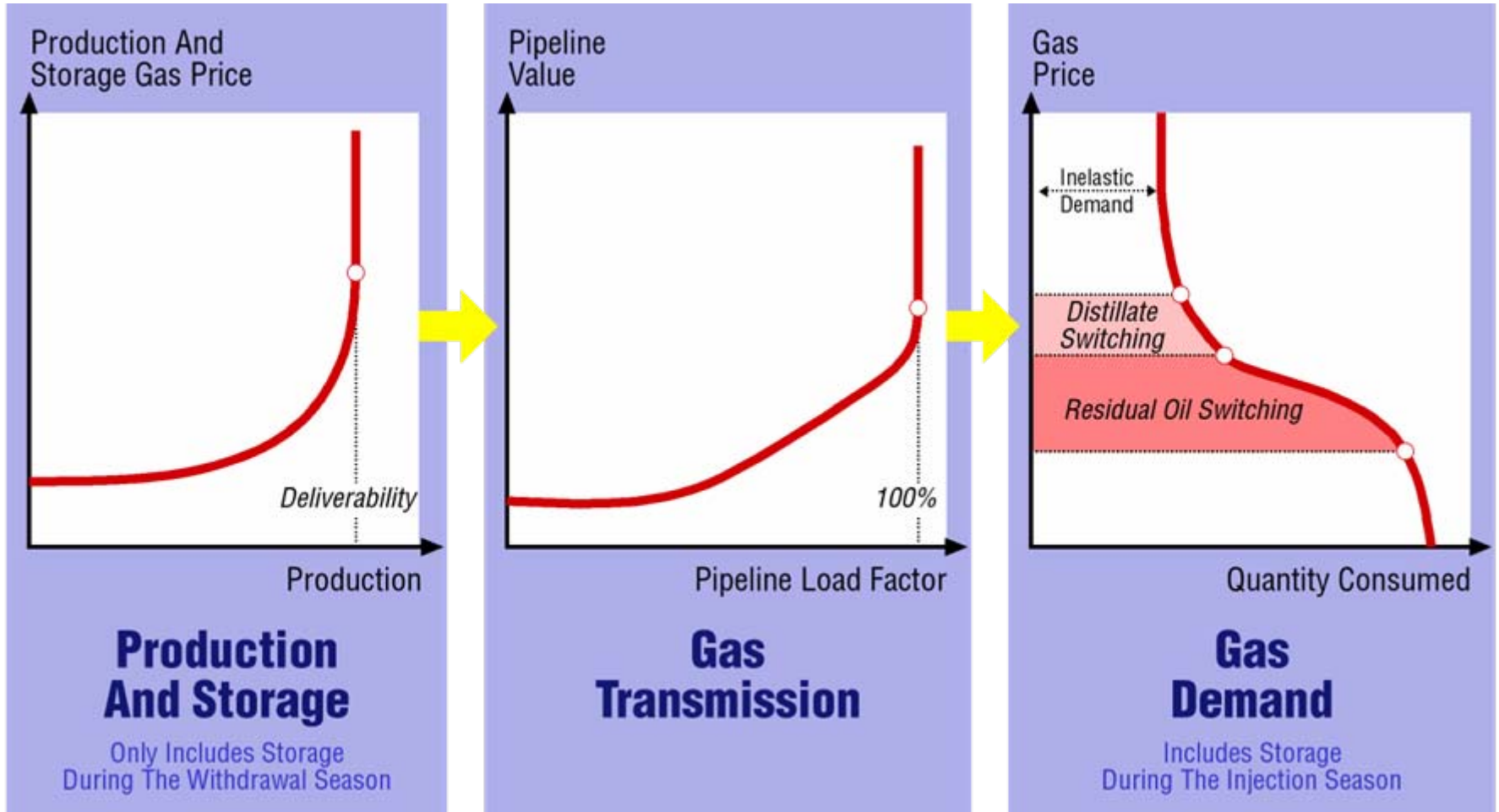
EEA Gas Market Model

- 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