An Evaluation of Regulatory Frameworks for the Development of Interstate Hydrogen Transmission Infrastructure in the United States

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Introduction

Markets for natural gas, electric power, and oil, and associated regulatory frameworks for the development of infrastructure to move said commodities in the United States, are mature – having developed over the last century and a half. Hydrogen is a fundamentally different energy commodity than those currently under the purview of Federal regulators in the United States. To this end, this study provides an assessment of potential regulatory frameworks for the development of interstate hydrogen transmission infrastructure. One conducts a historical analysis of commodity market, and infrastructure, development in the United States for the oil, natural gas, and electric power sectors. In order to justify an investigation into regulatory frameworks for the development of interstate hydrogen network development, one develops a linear program to evaluate the hydrogen transmission network which serves to minimize total expenditures on hydrogen. The study concludes with an evaluation of regulatory frameworks for the development of hydrogen transmission infrastructure.

Historical Analysis

Oil:
- Reject the notion of common carriage as it breeds market consolidation through moving favored shippers' quantities ahead of other customers
- Implement commodities clause to ensure the separation of pipeline owners and resource owners

Natural Gas:
- Separate end-use shippers from owning interstate hydrogen pipelines
- Give FERC authority to issue CPCNs for hydrogen transmission infrastructure
- Order hydrogen pipeline owners to follow structured regulatory accounting practices

Electric Power:
- Ensure siting authority of bulk interstate transmission projects lies with federal governments rather than states.

Network Modeling

In order to determine whether the development of an interstate hydrogen transmission network, one develops a linear program to determine total expenditure on hydrogen in 2050 with and without such a network.

Production Cost Modeling:

$$PC_{r_i} = \frac{OCapEx_{r_i} * CRF + O\&M_{Elyzr_{r_i}} + C_{Power_{r_i}} + C_{Water_{r_i}}}{S_{H2_{r_i}}}$$

The above yields a unit cost of hydrogen production from an electrolyzer asset.

Demand Scenarios:

$$Q_{H2_{r_i}} = \alpha_{r_i} * Q_{H2}$$

Where Q_{H2} is the total hydrogen demand in 2050 and α_{r_i} is the share of total hydrogen demand by each region.

Transmission Model:

$$T_{(r_i,r_j)} = \frac{\beta * \left(OCapEx_{r_i} - D\right) + O\&M_{Pipe} + PP_{r_i} * Q_{Power_{r_i}}}{Q_{Moved(r_i,r_j)}}$$

Where β is equal to the allowed rate of return for the asset owner.

Optimization:

$$minimize \sum_{(r_i,r_j)} P_{(r_i,r_j)} * Q_{H2_{r_j}}$$
$$subject\ to \sum_{r_i} S_{H2} = \sum_{r_i} Q_{H2}, \forall\ i,j$$

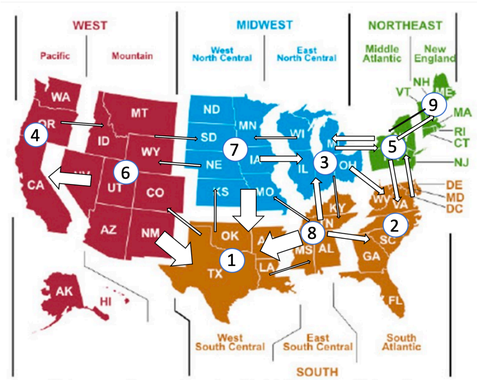
Where:

$$P_{(r_i,r_j)} = PC_{r_i} + T_{(r_i,r_j)}$$

This model minimizes total expenditure on hydrogen across all regions in the United States and yields an optimal hydrogen transmission network between regions of the United States.

Key Modeling Results

- Case:
  - H2 Demand: 5 Quads
  - Power Price: $50/MWh in (3)
- Results from the model show the network which serves to minimize total expenditure on hydrogen.



- Results vary by case – the optimality of an inter-regional network versus a serving demand within each region with local supply depends on a couple key metrics:
  - Power price differential between regions – greater price differences will drive arbitrage opportunities for hydrogen
  - Total cost of pipeline infrastructure – the greater the CapEx of the infrastructure, the higher the cost of transmission

Regulatory Frameworks

While the safety of hydrogen pipelines is regulated by the PHMSA under the DOT, no regulation exists to regulate the development of hydrogen infrastructure. Three different regulatory frameworks are assessed below – congressional action will likely be required in each scenario:

- **No Regulation:** Without proactive Federal regulation of the midstream hydrogen sector, the Federal government might end up fighting antitrust cases as the hydrogen market matures
- **Roll into Natural Gas Act:** Hydrogen could potentially fall under purview of FERC today, even without changing any codes, but this has yet to be tested in court.
- **Fully Integrate Energy Systems:** Optimal solution might be to develop of Energy System Operator (ESO) to jointly plan and operate both electron and molecule-based energy systems