Comparing Pipes & Wires

A capital cost analysis of energy transmission via natural gas pipelines and overhead electric wire lines

A Joint Study by the Bonneville Power Administration and the Northwest Gas Association

As energy needs in the Pacific Northwest continue to evolve, it is incumbent upon our region's energy suppliers to examine the most effective and efficient ways to update the region's energy delivery system. To address this task head on, The Bonneville Power Administration (BPA) and the Northwest Gas Association (NWGA) undertook a study to compare the costs of building electrical transmission lines and natural gas pipelines to deliver equivalent energy to population centers (also known as load centers). The results of this study showed two things: 1) The costs of delivering energy to load centers via natural gas pipelines are about half as much as delivering that same energy by electric transmission lines; and 2) Federal cost recovery and pricing policies do not appear to have an inherent bias for one system or the other. This paper summarizes the methodology and results of the BPA-NWGA study.

Why The Study Is Important

More and more electrical generating facilities in the Pacific Northwest are being fueled by natural gas. Once energy is produced in the form of electricity at a generating plant, the resulting energy must be delivered to the location where it is needed and used, usually metropolitan areas. Therefore, if a new generating facility is built far away from the city, new wire lines must be built in order to transmit the electricity to the city. However, if a generating facility is located closer to the city, the infrastructure development happens on the front end. In other words, new pipeline can be built to send fuel (natural gas) to the generating facility. The resulting electricity can then be sent the short distance to the city through much shorter new wire transmission lines. The question therefore arises: when transmitting over a long distance, is it more cost efficient to ship the fuel or the resulting electricity? A related question is: Do regulatory policies encourage the most economically efficient infrastructure outcomes?

Comparing "Apples to Apples"

Both BPA and NWGA recognized that making clear comparisons between electric wire line infrastructure and natural gas pipeline infrastructure is not a simple task. Therefore, BPA and NWGA set out to create two generic examples that could be compared in a more "apples to apples" manner. The study did not attempt to compare specific, individual examples of proposed pipelines or electrical transmission lines. Moreover, it should be noted that, in both cases, end uses of electricity and natural gas remain the same; the only difference is the physical location of the power plant.

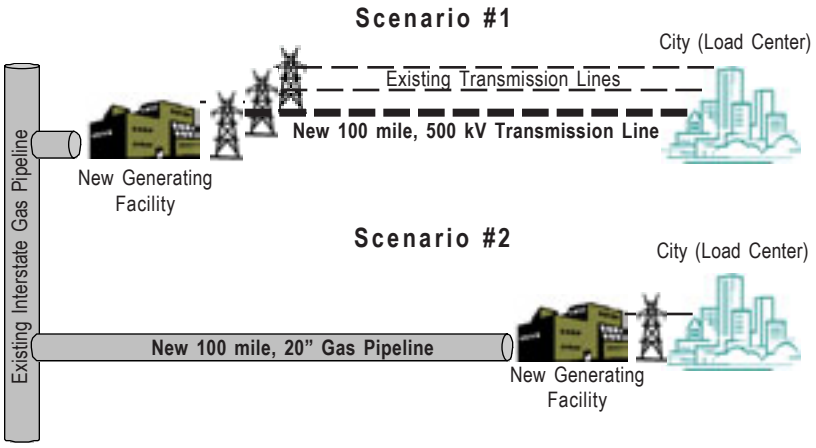
Study Objectives

- Compare the costs of building overhead electrical transmission wires versus natural gas pipelines to deliver energy to load centers.
- Analyze whether the Federal Energy Regulatory Commission's (FERC) pricing policies are achieving their intended outcomes, including the construction of the most economically efficient projects.

Study Methodology

As noted above, this study sought to compare two generic infrastructure scenarios.

- **Scenario #1**
  Build 100 miles of new 500 kV electrical transmission line to deliver the energy from a 1500 MW electrical generation facility located remote from the load center. Energy is then delivered to customers through existing electric wireline distribution systems.
- **Scenario #2**
  Build 100 miles of new 20" gas pipeline to fuel a 1500 MW electrical generation facility located near the load center. Energy is then delivered to customers through existing electric wireline distribution systems.



Capital Cost Breakdown

Scenario #1 (cost per mile):
500 kV Wire Line Addition (1500 MW Generation)

Material, design & construction	$1,300,000
Environmental and land	$338,000
Upgrade at existing substation	$32,500
New substation at generator	$152,750
Communications equipment & fiber	$130,000
Voltage stabilizing equipment (shunt capacitor)	$45,500
TOTAL CAPITAL COSTS	**$1,998,750**

Assumptions:
Typical line segment length 50 miles
Varied terrain and ownership
New substation at generator
Upgrade (2-breaker bay addition) at existing substation
Shunt capacitor addition per 100 miles of wire line
Line loss excluded

Scenario #2 (cost per mile):
20" Pipeline (250 MMcf)

Material, design & construction	$617,500
Environmental and land	$148,500
Road and railroad crossings	$40,000
Mainline valve	$14,000
Internal inspection tool (Pig) launcher and receiver	$5,000
Compression installed	$179,000
TOTAL CAPITAL COSTS	**$1,004,000**

Assumptions:
Average environmental and land conditions
Road and railroad crossings every 5 miles
Mainline valve every 15 miles
Two pig launcher and receiver sets
Two compressor stations totaling 9,400 horsepower installed
Fuel use for compression excluded

Study Conclusions

Conclusion #1

Based on a fundamental, hard-dollar comparison, natural gas pipelines are significantly less costly to build than electric wires. At the most basic level - capital cost per mile of each alternative - natural gas pipelines average between 50 and 60 percent of the cost of electric power transmission per unit of energy (or capacity) delivered.

This implies that, in many circumstances, construction of a gas pipeline would be more economical than construction of electric transmission line. But, because the physics, the associated benefits and the availability of either adjacent pipelines or electrical interconnections are so case- and site-specific, it is not possible to conclude that one system is preferable to the other without studying that specific case. The simple example assumes that the market for the new energy is in one location. If multiple markets exist (such as west-side load areas in winter, California load areas in summer), this comparison becomes much more complex.

One might also note that the annual cost to operate and maintain the generic wire transmission line is nearly half the cost to operate and maintain the generic gas pipeline. However, as indicated in the cost comparison below, this does not change the overall magnitude of cost differences between the two options studied here.

Overall Cost Comparison

	Scenario #1: 1500 MW, 100' Electic Wire	Scenario #2: 100', 20" Gas Pipeline
Capital Cost Per Mile*	$1,998,750	$1,004,000
Capital Cost Per 100 Miles	$199,875,000	$100,400,000
Operation & Maintenance Costs Per Year	$519,000	$1,000,000
Cost of Capital**	12%	12%
Annual Payment (over 30 years)	$24,813,214	$12,464,023
Operation & Maintenance Costs Per Year	$519,000	$1,000,000
Total Costs Per Year	**$25,332,214**	**$13,464,023**
Cost Per kW-Yr* **	**$16.89**	**$8.98**
Cost Per MWh (65% load factor**)**	**$2.97**	**$1.58**

*See previous page for breakdown of capital costs per mile.

**A 12% interest rate was used for this study as being generally representative of private sector borrowing. In fact, BPA's actual cost of borrowing is approximately 7% and the pipeline industry's cost of borrowing is approximately 8.75%. However, a comparison at any of these rates does not change the magnitude of cost differences uncovered in this study.

***Figures cited do not reflect actual rate figures.

**** 65% load factor approximates the typical electric transmission scenario in the Northwest.

Conclusion #2

FERC's pricing policy currently seems consistent with one of its main objectives: protecting existing customers from the costs of capacity expansions if they, themselves, do not benefit (i.e. only the beneficiary of such expansions pays for the infrastructure development). One key difference between the two systems is that most electrical transmission expansions benefit both existing and new customers. Gas pipeline expansions, on the other hand, are typically driven by specific customers willing to finance the enhancements by contracting for the additional capacity.

Although FERC's cost recovery and pricing policies for pipelines and transmission lines do not appear to have an inherent bias for one system over another, electric transmission rules are in a state of flux. FERC has proposed a Standard Market Design for all regions, and although it subsequently recognized that regional differences could not be avoided, it is not possible to predict with certainty what changes might occur. Adding to the uncertainty are possible national energy legislation and the development of a regional transmission organization.

Questions for the Region

? How can the region capture the economics of gas transmission?

? How might the region benefit from better integration between electric and gas planning and development?

? What policies might be considered that would facilitate better integration of the Northwest energy system?

? What transmission pricing policy changes might occur in the future and what changes would benefit the region?

Why Now?

The issues addressed in this study are particularly timely for the Pacific Northwest region and its power suppliers. Several current circumstances make this discussion more relevant now than ever before:

> More natural gas is being used in the region to fuel electric generating facilities.

> The demand on the energy transmission system continues to grow, causing growing stress on the current infrastructure.

> Bonneville Power Administration has launched a new initiative to ensure it is providing the most cost-effective solutions for the region's transmission needs. BPA's Transmission Business Line (TBL) is investigating how to fully and effectively integrate non-wires solutions (NWS) - i.e. ways to meet transmission needs without building new wires - into its transmission planning process. For more information about BPA's Non-Wires Solutions initiative, visit the Planning & Projects section at www.transmission.bpa.gov.

Study Participants

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About the Bonneville Power Administration

The Bonneville Power Administration (BPA) is a federal agency, under the U.S. Department of Energy, which makes wholesale electrical power, and operates and markets transmission services in the Pacific Northwest. The power comes from 31 federal hydro projects, one nonfederal nuclear plant and several other nonfederal power plants. About 45 percent of the electric power used in the Northwest comes from BPA. BPA's transmission system accounts for about three-quarters of the region's high-voltage grid, and includes major transmission links with other regions.

About the Northwest Gas Association

The Northwest Gas Association (NWGA) is a trade organization of the Pacific Northwest natural gas industry. Its members are located in Washington, Oregon, Idaho, and British Columbia, and include gas utilities, combined gas-electric utilities and interstate pipeline companies. Member companies are: Avista Utilities; Cascade Natural Gas Corporation; Intermountain Gas Company; NW Natural; Puget Sound Energy, Inc.; Duke Energy Gas Transmission; Gas Transmission Northwest Corporation; and Williams Northwest Pipeline. The Northwest Gas Association's mission is to advance the interests of the Pacific Northwest natural gas industry through education and advocacy.

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