LNG Exports from North America: Economics and Market Impacts

United States Energy Association
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- North American Natural Gas Resource Base Adequacy
- Price and Pipeline Flow Impacts of LNG Exports
- Outlook for World Natural Gas Prices and Possible Export Volumes from US and Canada
- General Economic Impacts (GDP, jobs, balance of trade)

Interventions in DOE Proceedings have been Limited

- Only the long term export license applications have attracted opposing interventions
- Major objections have come from some industrial consumer groups and the American Public Gas Association.
  - Increased exports will raise the price of natural gas by increasing demand for the stated level of gas supply
  - While any one export project will have a minimal impact on prices, the cumulative effect will be far greater
  - Higher gas prices affect industry's ability to compete and may cost jobs
  - The controversy over shale production suggests the supply of gas will not be what DOE and exporters expect, where exports will further strain gas supply
  - Domestic gas should be used in this country to support energy independence
  - Exports would potentially link U.S. gas prices to much higher, oil-based LNG prices in Europe and Japan

Congressional Interest

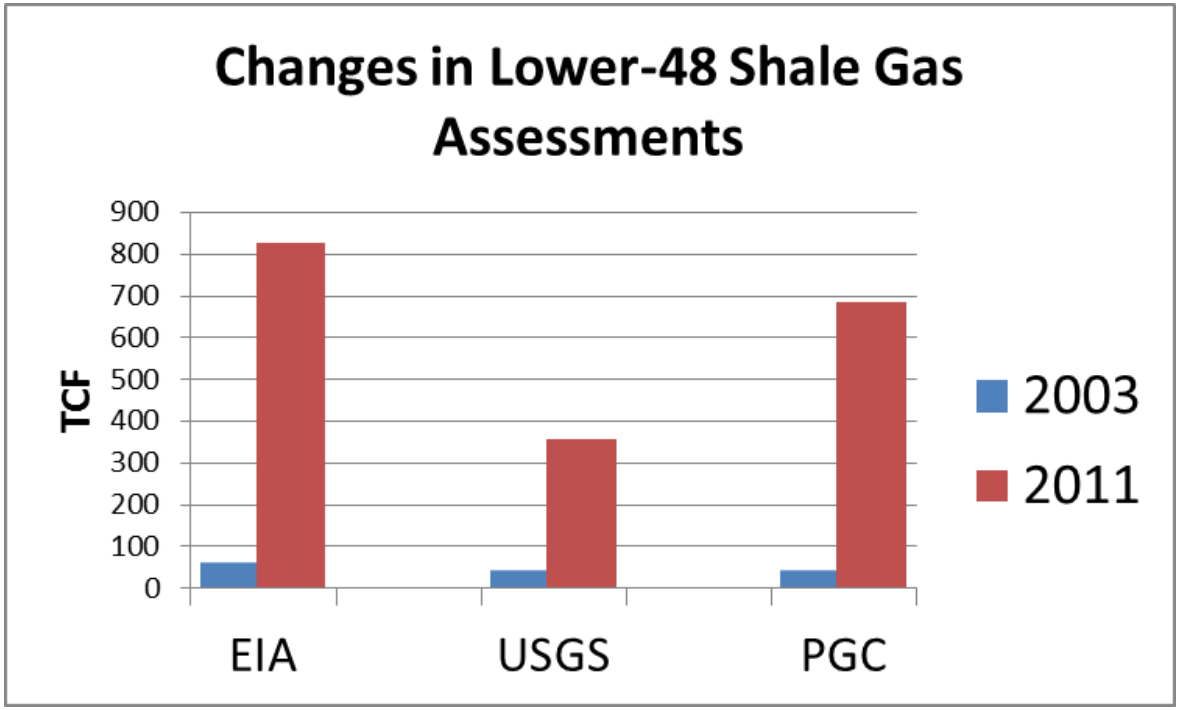
- Energy exports have always been a political problem under the rubric of energy independence
- Recent hearings in the Senate showed lawmakers' concerns
  - Would exports lead to higher gas prices – both by increasing demand and by causing U.S. prices to be pulled up international price levels
  - Is gas supply was sufficient to allow exports
  - "U.S. energy security requires reliable and affordable energy prices, not just reliable supplies." (Sen. Bingaman)
  - "Where will DOE draw the line?" (Sen. Wyden)
- The Energy Department has asked the Energy Information Administration to examine how exports affect prices and another study , on the net impact on jobs and the economy.

Summary of the Policy (and Politics) of Exports

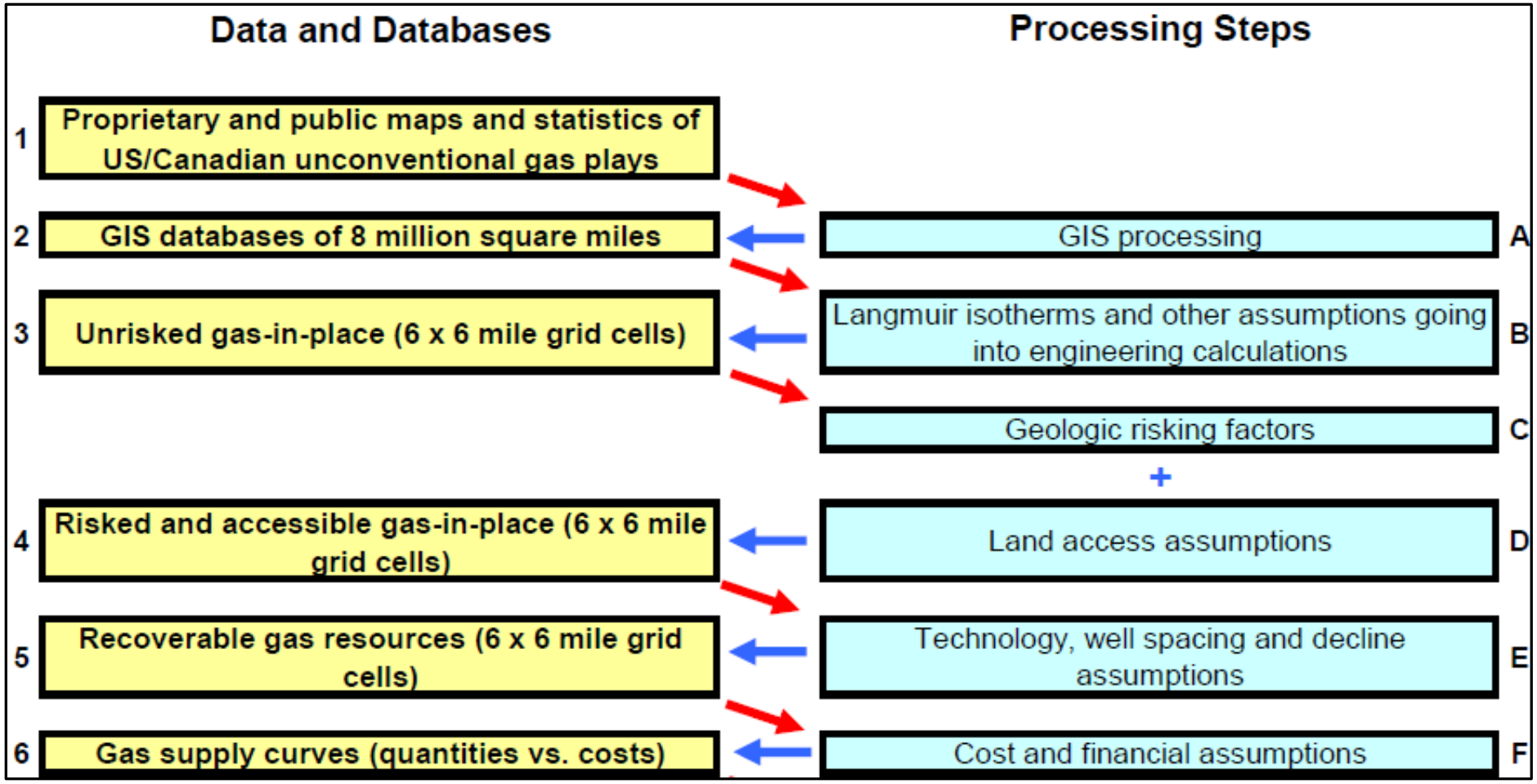
- Policy and political issues turn on four major questions
  - How do LNG exports affect domestic gas supply? What is the incremental cost of providing additional supply to meet export demand
  - How do exports affect the operations of the North American gas market?
  - Do exports of LNG provide any incremental economic benefits in terms of jobs or other gains from trade?
  - How much gas can we export given gas resource developments around the world and can world prices influence U.S. domestic prices?

Recent Years Have Seen Large Increases in Published Shale Gas Resource Assessments

- Gas in place was known to exist
- Low prior assessments reflected technology and understanding of the time of the assessment



ICF Evaluation Approach to Resource Base Estimates



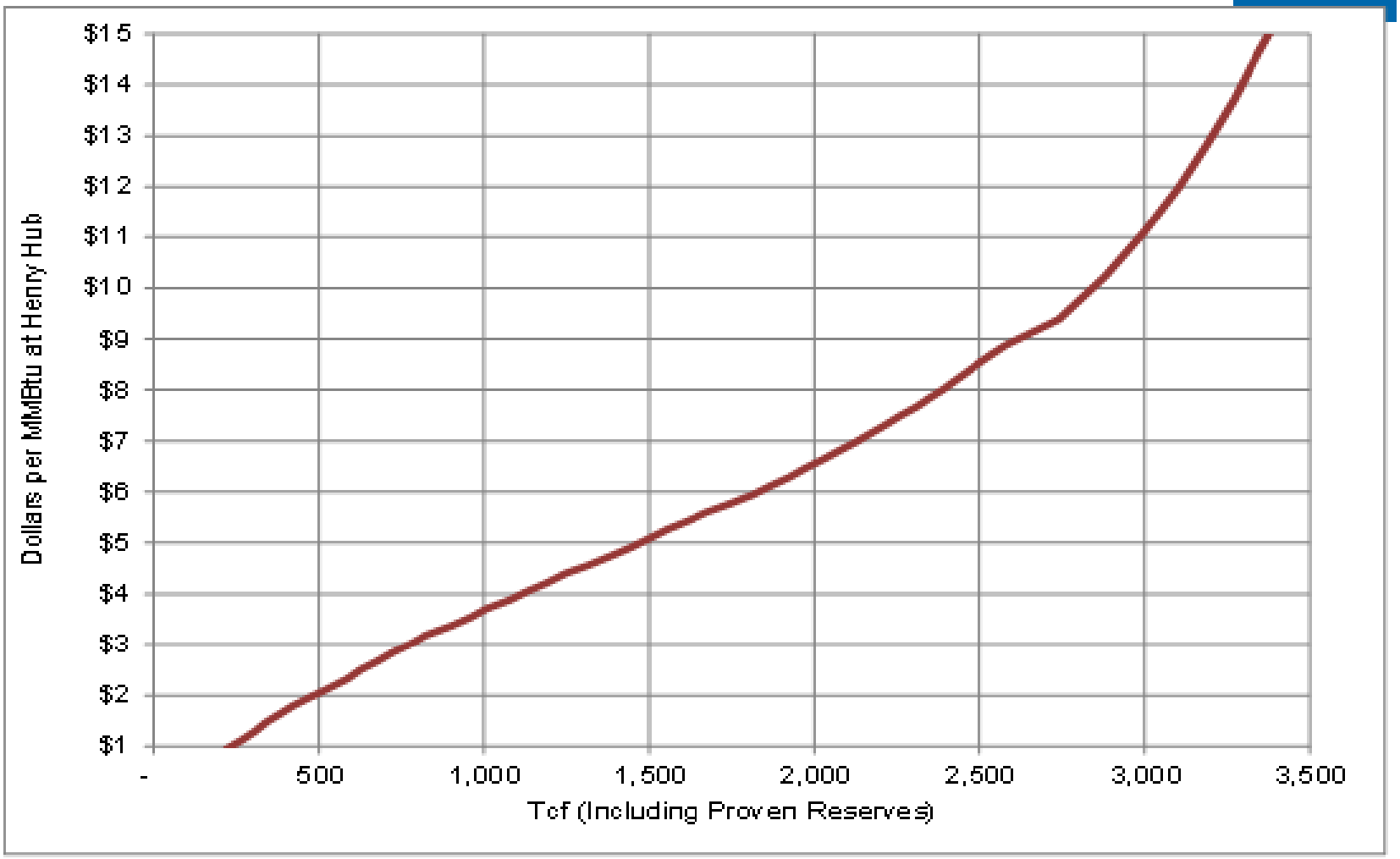
Comparison with Other Assessments

- ICF shale gas much higher than other published assessments
- More plays assessed; entire play included; engineering based "bottom-up" approach; risking
- Infill drilling evaluated

Published Lower-48 Gas Resource Assessments ICF, November, 2011 TCF of technically recoverable gas; excludes proved reserves					
Group	Shale Gas and Tight Oil	Tight Gas	Coalbed	Conventional	Unproved Total
ICF, 2011	2,031	438	66	707	3,242
EIA AEO, 2011	827	369	117	703	2,016
PGC, 2011	687	(with conv.)	102	858	1,647
MIT, 2011	631	173	115	951	1,870

US + Canada Gas Supply Curve

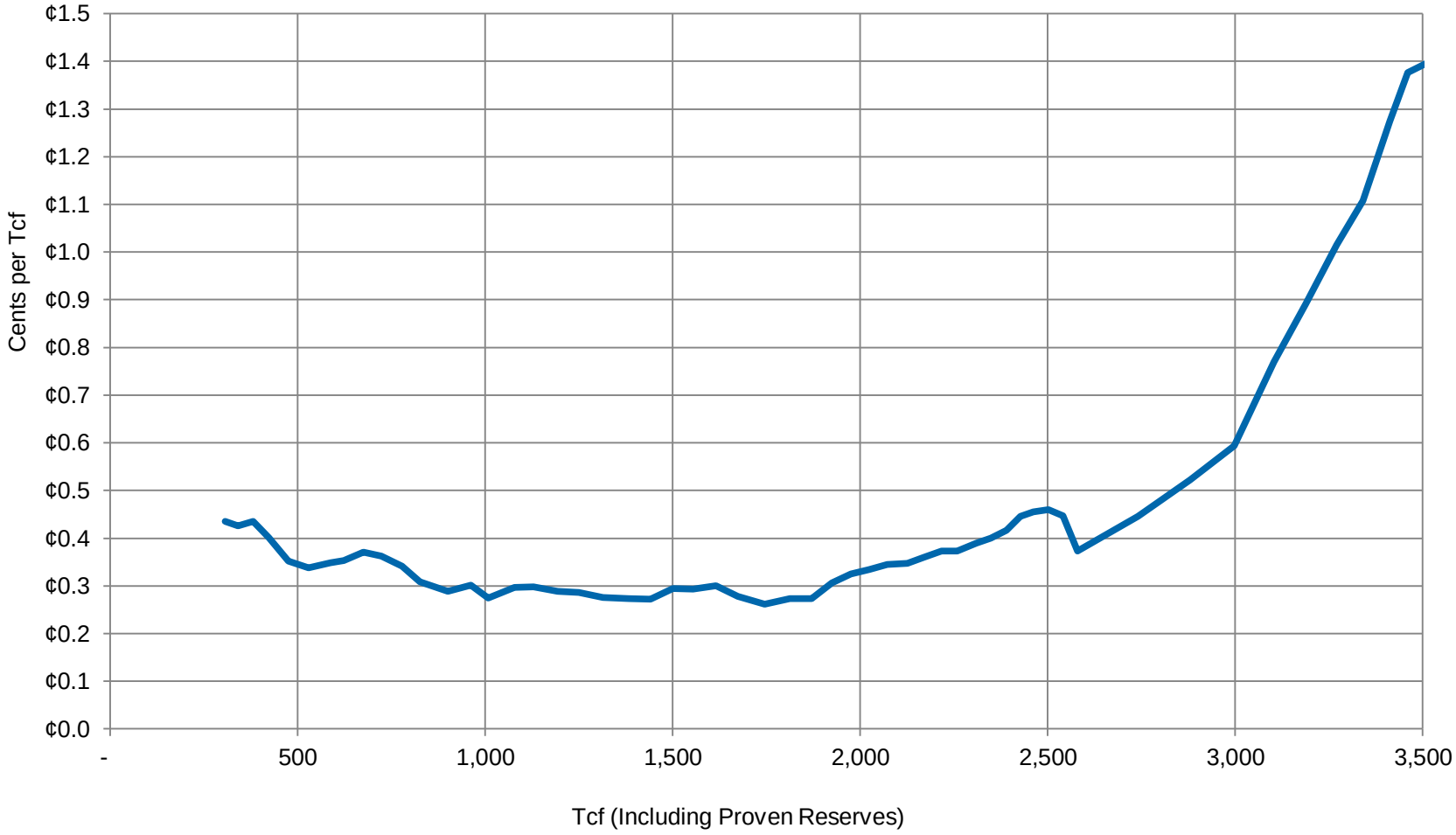
(at constant drilling costs, on dry gas basis, liquids valued at $75/bbl RACC)



Source: ICF Analysis, September, 2011. Supply curve is at constant cost of drilling services and does not include short-run "drilling activity" price effect which will depend on drilling activity levels and state of drilling services markets..

Slope of Supply Curve

Cents per Tcf at constant drilling costs

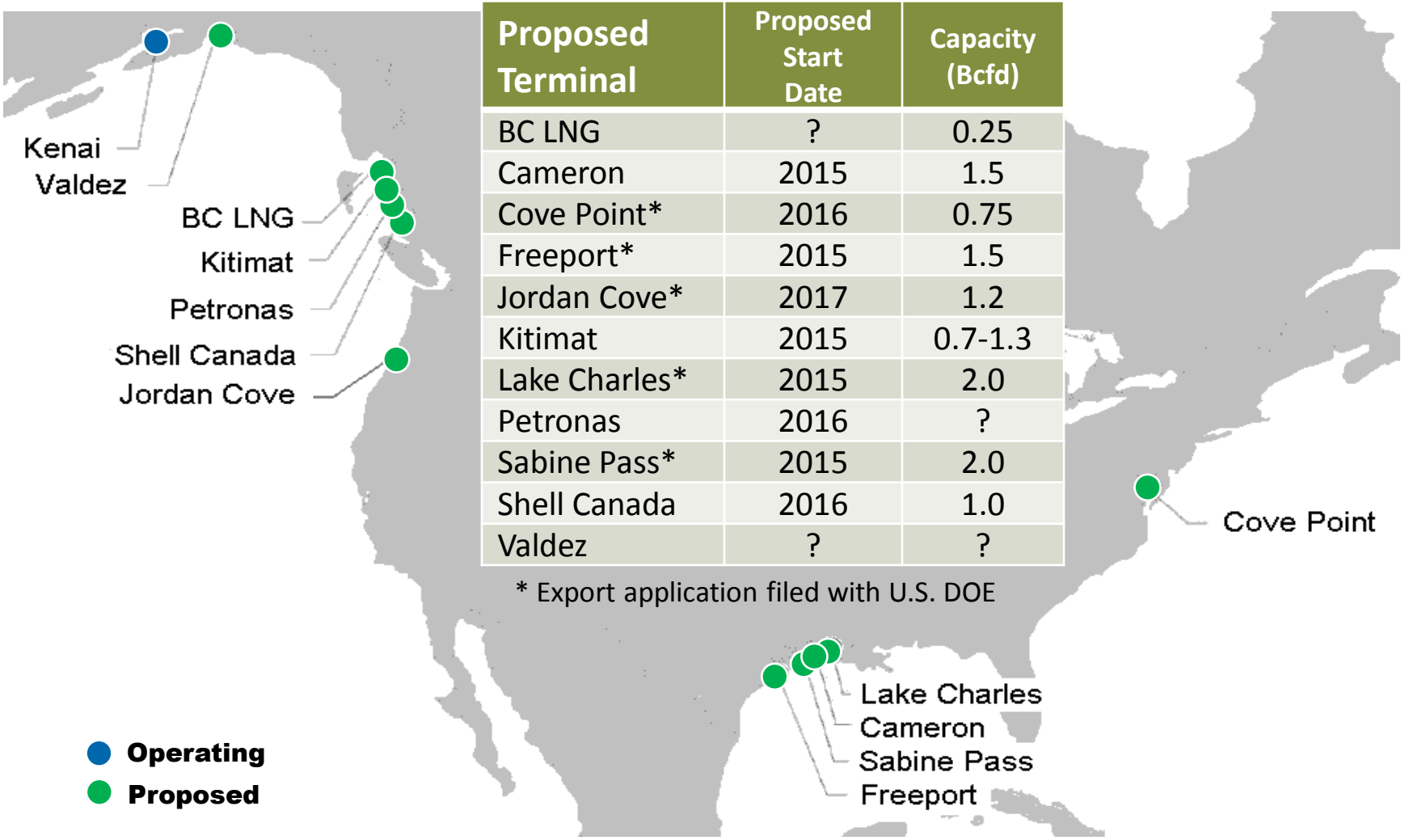


Source: ICF Analysis, September, 2011. Slope is indicative of potential long-run “resource cost” price effect from changes to aggregate gas demand and does not include short-run “drilling activity” price effect which will depend on drilling activity levels and state of drilling services markets..

Questions Have Been Raised Regarding the Impact of LNG Exports

- What are national price impacts?
- How do price impacts vary among regions?
- How certain are the answers and what are the source of uncertainties?

Proposed North American LNG Export Terminals: Over 10 bcfd of proposed capacity



Proposed Terminal	Proposed Start Date	Capacity (Bcfd)
BC LNG	?	0.25
Cameron	2015	1.5
Cove Point*	2016	0.75
Freeport*	2015	1.5
Jordan Cove*	2017	1.2
Kitimat	2015	0.7-1.3
Lake Charles*	2015	2.0
Petronas	2016	?
Sabine Pass*	2015	2.0
Shell Canada	2016	1.0
Valdez	?	?

* Export application filed with U.S. DOE

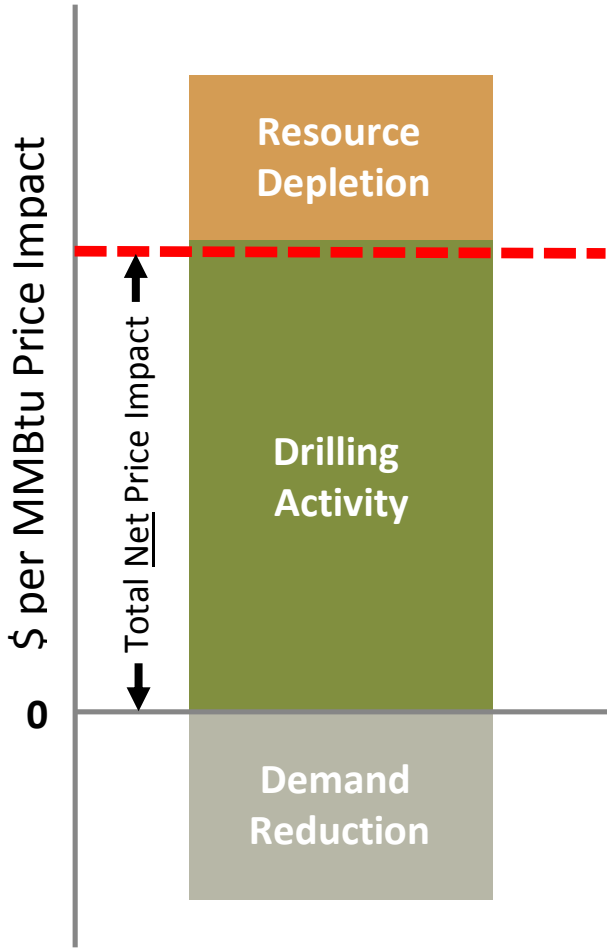
Summary of Price Impacts from DOE Filings

Henry Hub Price Impacts

Facility	Analyst	Summary of Analysis	Price Impact ($/MMBtu per Incremental Bcfd of Exports)
Sabine Pass	Navigant Consulting	5 cases examining different levels of U.S. demand and LNG export ranging from 0 to 2 Bcfd	$0.18 to $0.30
Cove Point	Navigant Consulting	7 cases examining different levels of U.S. demand and LNG exports ranging from 2.7 to 7.1 Bcfd	$0.10 to $0.30
Freeport	Delloite	Single scenario, with and without 1.5 Bcfd of exports	$0.02
Lake Charles	BGNA	Based on long-run cost curve; filing cited price impacts from 0 to 12 Bcfd of exports.	$0.02 to $0.04

The Price Impact of LNG Exports Can Be Divided Into Three Parts

- Resource Depletion Effect
  - Since more of the gas resource will have to be developed to support LNG exports, producers will have to move farther up the long-run resource supply curve.
  - The resource depletion effect is small in the early years and grows as the cumulative amount of extra natural resources increases.
- Drilling Activity Effect
  - Higher gas prices are needed to incentivize producers to drill more wells each year and to help compensate them for the higher costs usually associated with increased levels of upstream activity.
  - Because there is a larger need for incremental rigs/wells during the export ramp-up period, the drilling activity cost effect is highest during the ramp-up period and then declines.
  - May be partly offset by any "economy of scale" or "learning curve" components.
- Demand Reduction Effect
  - Higher gas prices lead to a reduction in domestic gas consumption, therefore the incremental increase in production is less than the LNG export amounts, which lessens the net increase in gas prices.
  - Demand elasticity is expect to increase over time due to capital turn-over effects.



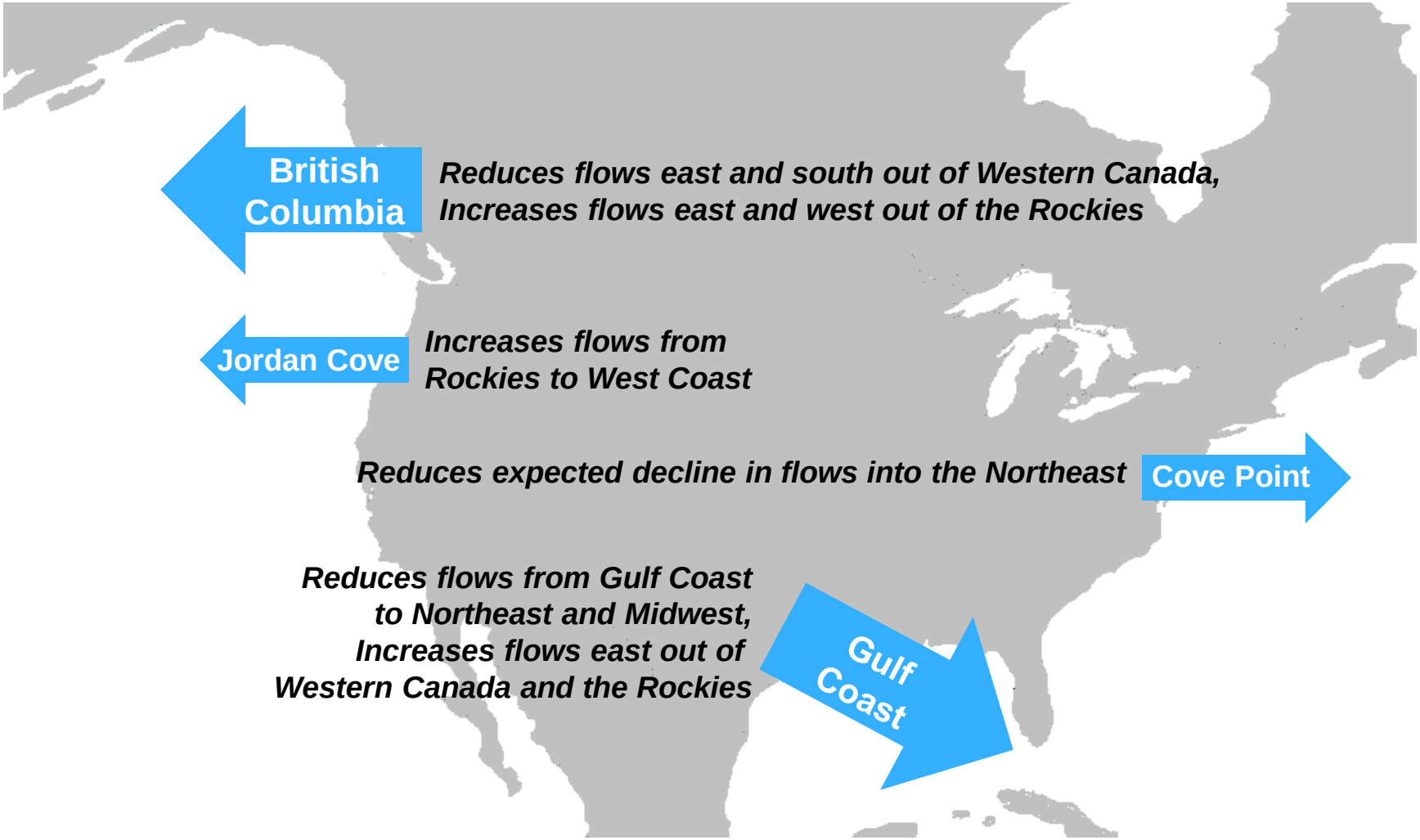
Price Differences are Partially Dependent on Analytic Approach

- Analytic approaches
  - Supply/demand equilibrium model
  - Inter-temporal optimization
  - Other approaches (e.g., long-run cost curves)
- Assumptions for LNG export facilities
  - Fixed level of exports versus price-responsive exports
  - Ability of market to anticipate and adjust to exports
- Consideration of the interactions between regional markets within North America
- Consideration of changes in international gas markets

Key Scenario Assumptions

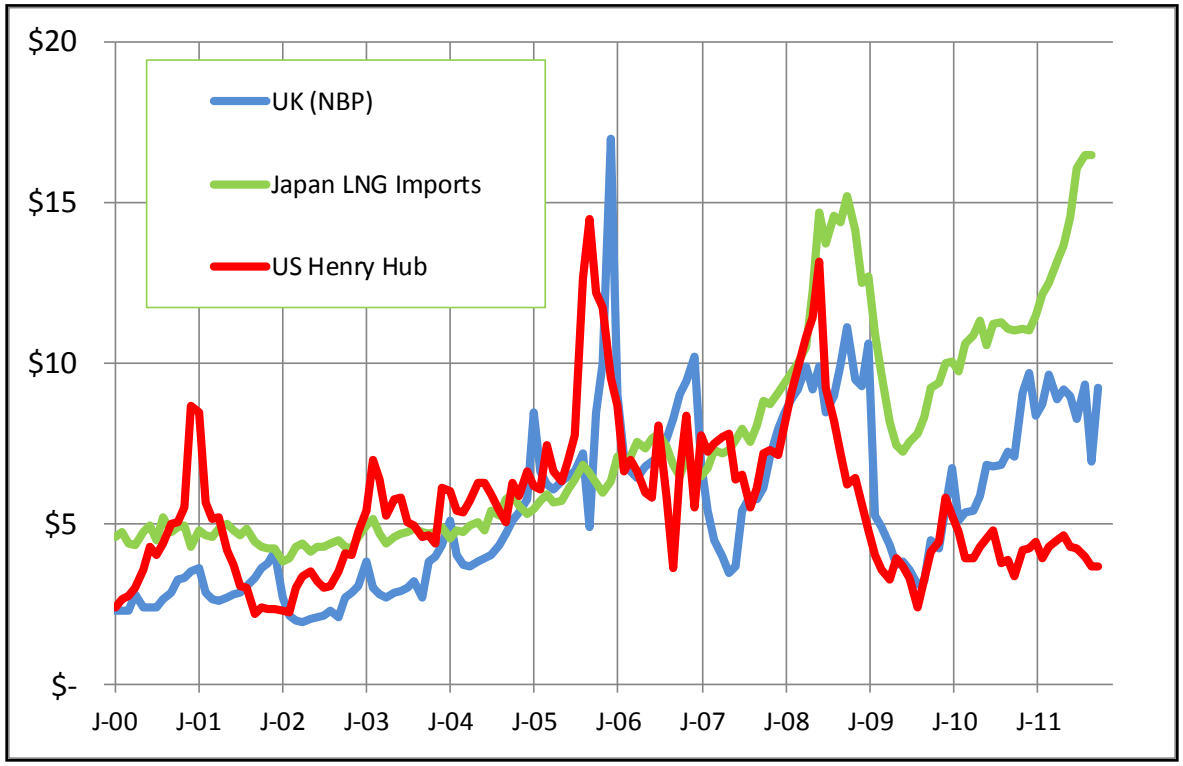
- LNG export terminals
  - How many? What locations? What size? How much flexibility will they have to vary operations on a monthly and daily basis?
- North American gas demand
  - Assumptions for economic growth, electricity demand growth, pending changes to emissions regulations, potential future GHG policies, residential and commercial demand growth, increases in energy efficiency, potential for NG vehicles.
- North American gas supply
  - Assumptions for resource base, E&P costs, impact of oil and NGL production on natural gas costs, impact of potential hydraulic fracturing regulations, assess restrictions, development of frontier supplies.
- North American infrastructure development
  - Assumptions for North American pipeline and storage expansions
- International gas markets **(What will drive the utilization of US/Can. export capacity?)**
  - Assumption for global gas demand; non-US LNG export, LNG tanker fleet, development of European, Latin American and Asian shale gas resources.

Potential Impacts on Interregional Pipeline Flows



International Natural Gas Prices

- US price were often higher than Asia and Europe from 2000 to 2007
- Increasing oil prices in 2008 drove up oil-indexed LNG prices in Asia and Europe.
- Since early 2008 US prices driven down by economic slowdown and increasing shale gas production
- Premium existing now between Asian and European LNG prices and US prices has spurred interest in LNG exports.
- Spot prices in Europe recently below L.T. contract price levels, but not usually so now in Asia.
- Recently negotiated contracts suggest long-term pricing levels of:
  - ~85% of oil (JCC) parity in Asia
  - ~70% to 80% of oil (Brent) parity in Europe



Future LNG Supply

- Global LNG supply in 2010 was 220 million metric tons (Mtpa). This is roughly equivalent to 29.4 bcfd.
- By 2020 global LNG supply is expected to be 350 Mtpa or 46.7 bcfd.
- Expected CAGR is 4.8%, but there is exists uncertainty in how many projects will proceed and at what pace. Upper end of growth expectations is about 7% CAGR or 440 Mtpa / 58.7 bcfd in 2020.
- Number of different countries supplying LNG is expected to grow from 18 in 2010. New entrants include Angola, Papua New Guinea and, possibly, Cameroon.
- Largest volume increases are possible from Australia, US, and Nigeria.

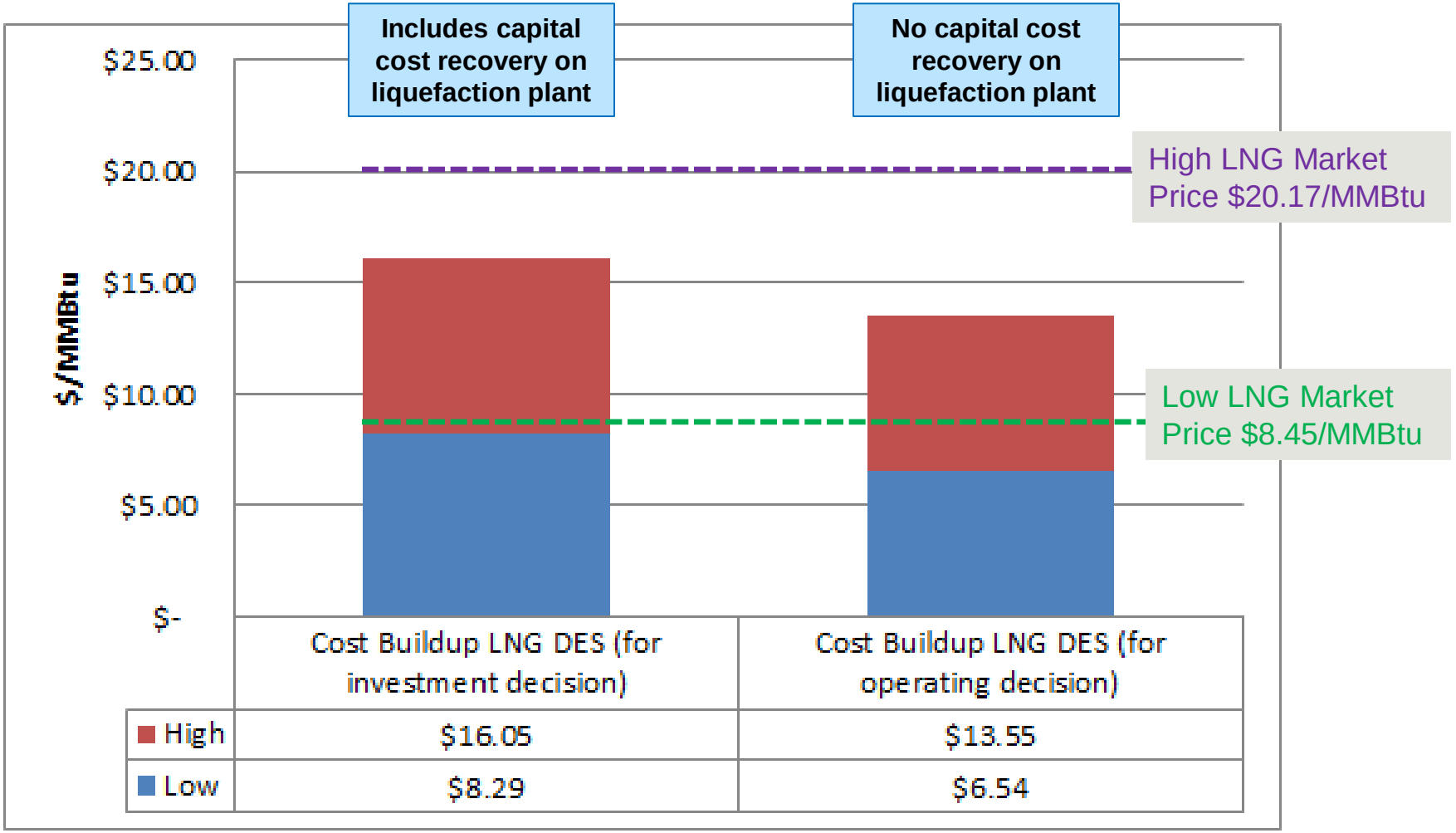
Future LNG Demand

- From 2000 to 2010 LNG consumption grew at CAGR of 8.0%.
- Number of countries importing LNG went from 11 to 23 from 2000 to 2010 and could grow to 45 by 2020.
- By 2020 growth of 4.8% CAGR is expected to be led by
  - China/India
  - Japan/Korea/Taiwan
  - Europe
- Significant competition will be against coal for power generation so long-term international coal prices are important.

	Change in Demand from 2010 to 2020		
Region	**Mtpa**	**Bcfd**	**Percent**
China-India	57.5	7.7	44%
Japan-Korea-Taiwan	28.2	3.8	22%
Other Asia	13.4	1.8	10%
Europe	15.1	2.0	12%
North America	0.0	0.0	0%
Mexico/SA	8.9	1.2	7%
Middle East/Africa	6.9	0.9	5%
Total World	**130.0**	**17.3**	**100%**

For example, capture of 10% to 25% share of incremental market would imply North American LNG exports of 1.7 to 4.3 bcfd by 2020

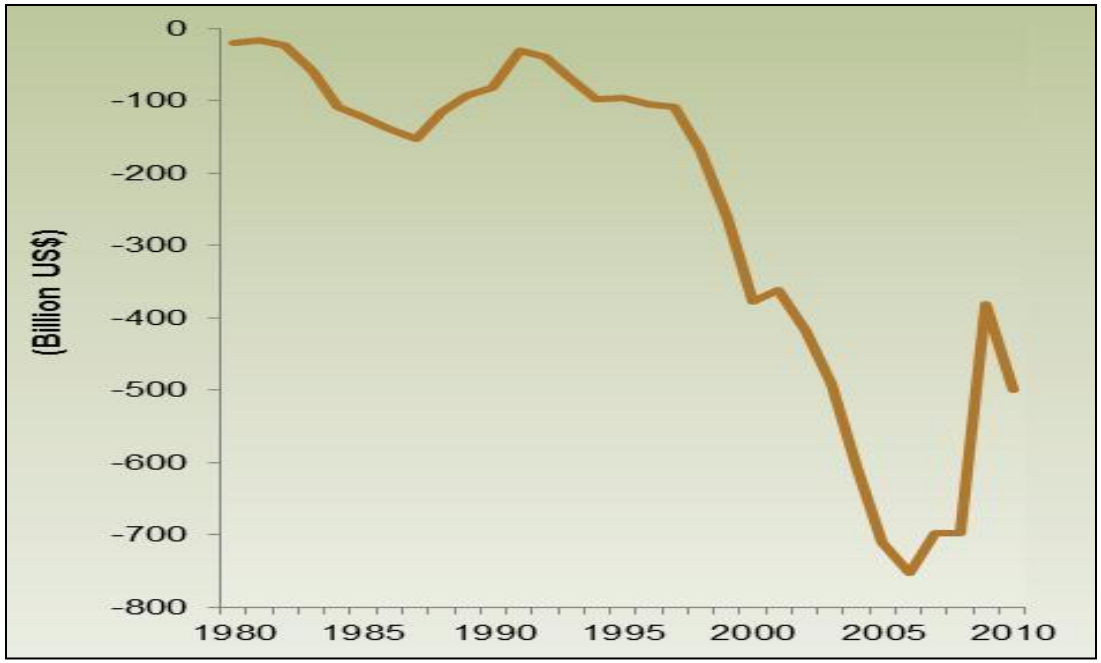
Examples of Liquefaction Plant Investment and Operating Decisions



Conclusions Regarding Price Impacts

- Analytic approaches can vary.
- The proper approach considers:
  - Resource Depletion
  - Drilling Activity
  - Demand Response
  - US/Canadian Infrastructure
  - Utilization of Liquefaction Capacity
- Scenario assumptions regarding the “base case” state of the market and market behavior will also affect the results.

U.S. Balance of Trade



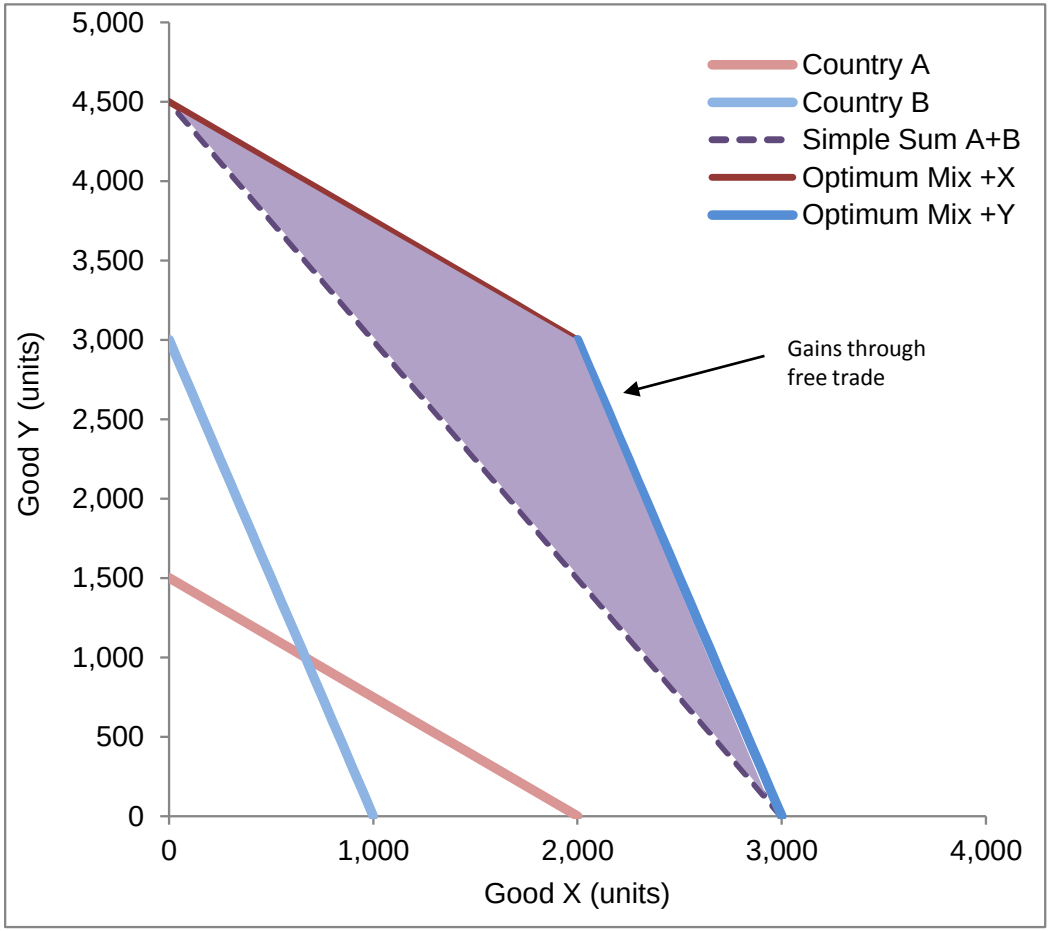
Source: U.S. Census Bureau Foreign Trade Division. Available at: http://www.census.gov/foreign-trade/statistics/historical/gands.txt

- For more than 30 years, the U.S. balance of trade has contributed to a flow of money from the U.S. to our trading partners.
- Policymakers and politicians from both parties agree that the U.S. would be better off if the trade deficit were smaller.
- But some have expressed concerns that the export of natural gas could have adverse impacts on the economy.

Economics 101: Argument 1

Comparative Advantage and Economies of Scale

Production Possibility Frontiers with and without Free Trade



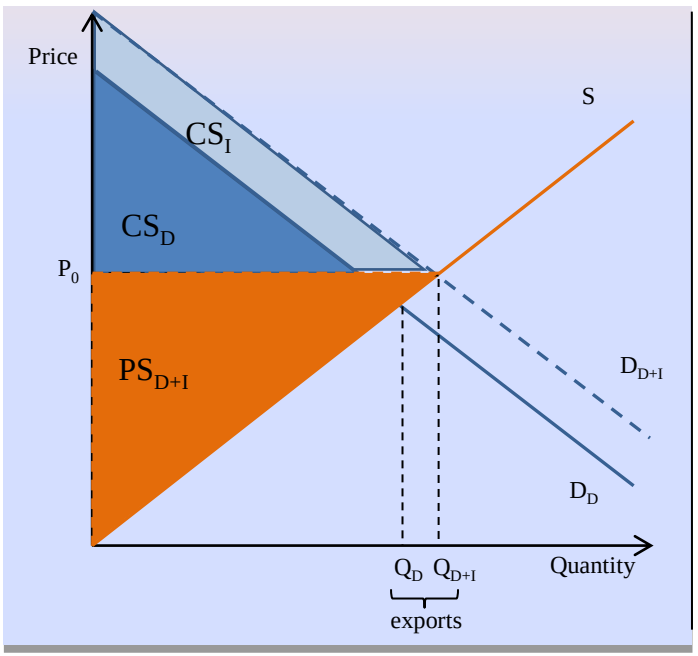
- Free trade allows each country to exercise its comparative advantage, expanding the total production potential of each country through specialization.
- Economies of scale expands the production potential of each country further, as specialization allows the marginal cost of production to decline.[1]

[1] The dotted purple line represents the simple sum of the no-trade production potential (the light red and light blue lines for Country A and Country B, respectively). Total gains to production potential associated with free trade, attributed to specialization and economies of scale, are represented by the dark red and blue production possibility frontier.

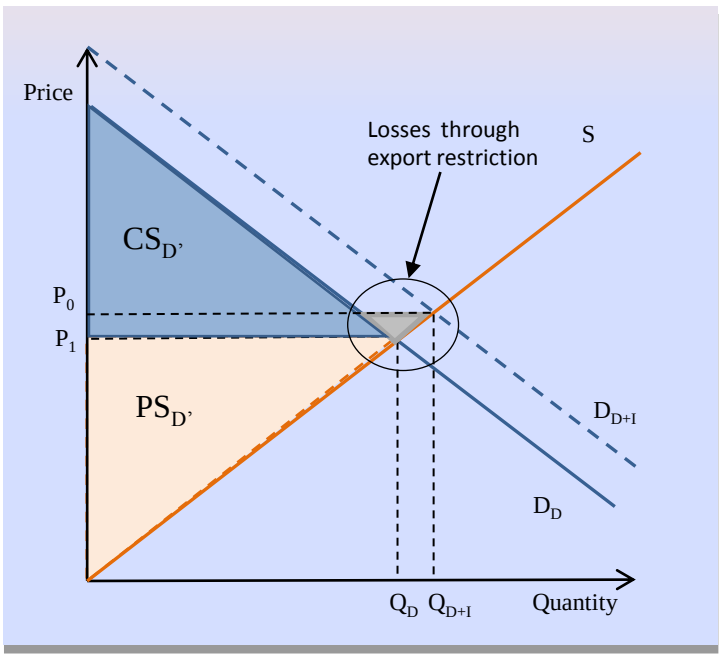
Economics 101: Argument 2

Surplus Maximization

Surplus Optimization (Exports)



Surplus Losses (Export Restriction)



- According to economic theory, gains to consumers and producers are maximized through efficient allocation of price and quantity.
- Restricting exports forces a sub-optimal (inefficient) price and quantity market solution, leading to consumer and producer losses.

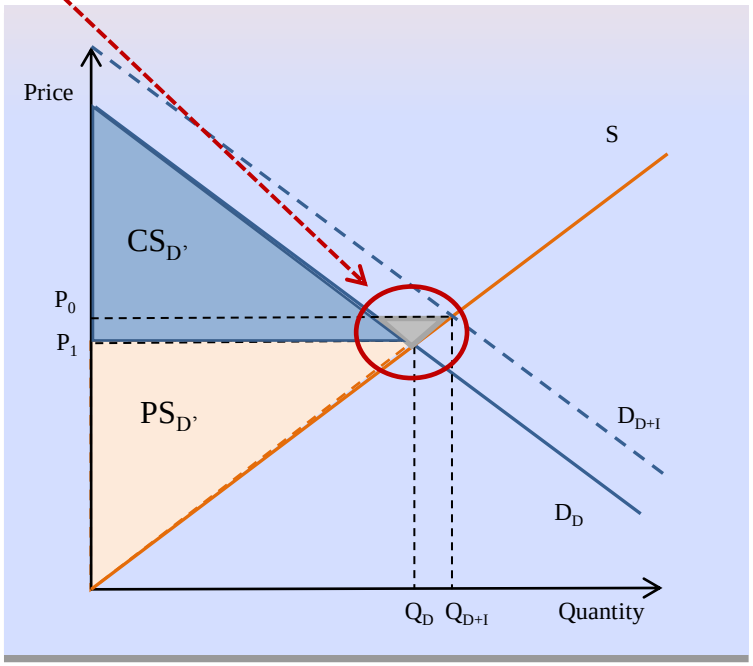
Left: Surplus optimization assumes producers export additional quantities abroad. The dotted demand curve (D_{D+I}) incorporates domestic and international demand. While domestic producers benefit from both domestic and international product demand, as shown in PS_{D+I}, CS_D indicates gains to domestic consumers and CS_I shows the gain to international consumers from domestic producer exports. **Right:** Sub-optimal conditions associated with an export restriction. While consumers would gain from a lower price, producers would lose their international consumers and be forced to sell at lower domestic prices. Society also loses, in the form of a deadweight loss, as an export restriction would create inefficient market pricing.

Economics 101: Argument 3

Economic Growth Contraction

GDP[1] Expenditure Formula:

GDP = Consumption + Investment + Government + Exports - Imports



- A restriction on exports will lead to a contraction in GDP than would otherwise be seen under free market conditions.
- In the case of the U.S., a restriction on exports would exacerbate its trade deficit.
- The contraction in GDP is equivalent to the total losses to consumer and producer surplus.

[1] Gross Domestic Product

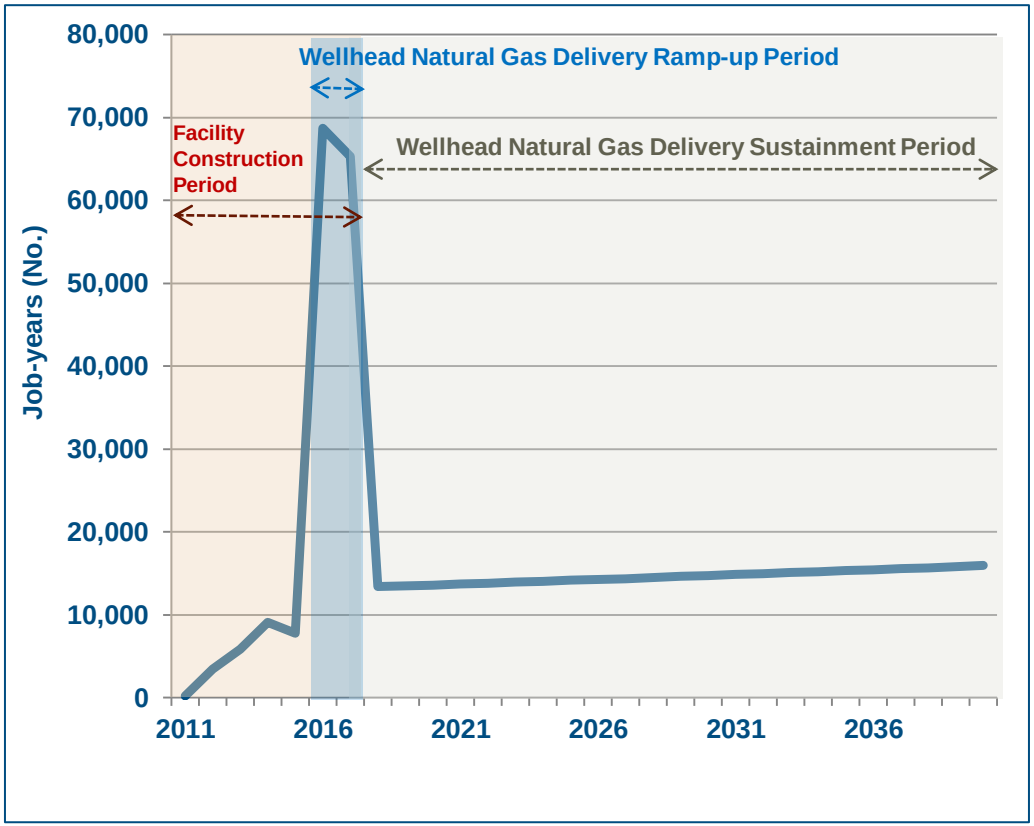
Note: Total GDP losses are equivalent to the deadweight loss above (grey triangle).

Trade and Jobs Impact

A recent ICF study[1] found that exports of 750 mmcfd are associated with the following national impacts[2]:

- **Trade balance: Annual trade gains to the U.S. of $2.8-$7.1 billion.**
- **Jobs: roughly 16,450 annual job-years**

U.S. Job Impact of LNG Exports



[1] ICF, October 2011, "Economic Impact Study of Construction and Operations." Dominion Cove Point LNG, 2011: Lusby.
[2] Figures cited are annual averages over the project life (2011-2040).

What are Net Job Effects?

- Due to the complexity of the issue, **total net** job effects have not been fully addressed in the studies submitted to DOE.
- Job loses are generally thought to result primarily from lost domestic natural GAS consumption. That is, shifts along non-export gas demand curve caused by higher natural gas prices.
- However, most shifts along demand curve do not necessarily result in net lost jobs.
  - **Reduced output levels**: could create net job losses, but even here there can be substitutions to other domestic products or complex Im/Ex effects.
  - **Fuel switching**: can create jobs in other energy industries, e.g. coal mining
  - **Conservation and process changes**: can create jobs in insulation, energy heat recovery, energy management, etc.
- Issue is further complicated by co-produced crude oil, lease condensate and natural gas liquids all of which have their own positive job impacts.
- Given that economic theory suggests that GDP will be larger if exports are unrestricted, it seems plausible that net job impacts are more likely to be positive rather than negative.

Framing the Policy Questions:
What are you really trying to do?

- If the U.S. limited exports of LNG, would it be certain that North American gas prices would be "protected?" Can U.S. policy prevent LNG exports/reduced LNG import from Canada or Mexico?
- The U.S. is becoming (has become) a net exporter of petroleum products and has always exported coal. Should these be restricted?
- If LNG exports need to be limited, should the export of products that use natural gas in production also be limited?
- Do U.S. gas residential and commercial consumers need to be protected from price increases? Fuel Use Act 1978 restrictions were based upon this argument.
- Are LNG exports and consumer protection/U.S. job growth mutually exclusive policy issues?

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