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A Global Model of Natural Gas Markets: Some Case Results

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Overview and Motivation

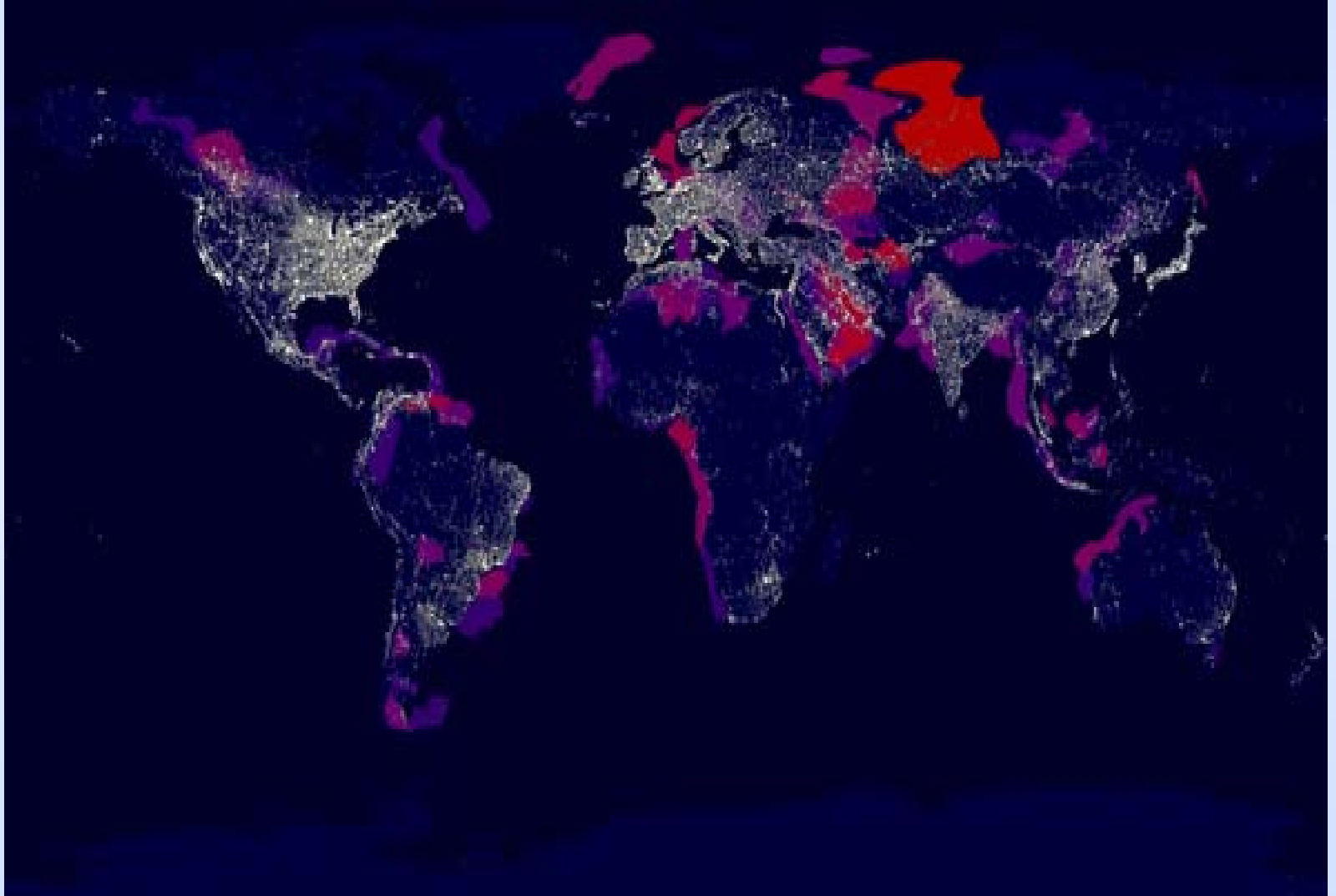
- North America has essentially been self-sufficient for natural gas supplies until recently
- Current and projected tightness of the North American natural gas market has highlighted the need for new sources of natural gas
- LNG can provide much of the needed supply... but North America must become part of a larger marketplace.
- Most current modeling efforts assume LNG supply availability at certain costs at scheduled intervals into North America...
 - ◆ Ignores global competition for scarce resources
 - ◆ Ignores the dynamic aspect of profitability in the LNG value chain
 - ◆ Ignores comparative costs of delivery to disconnected markets, and the emerging relationship imposed by increased LNG capacity between those markets



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Demand sinks and supply sources are regionally disconnected!



Source: USGS

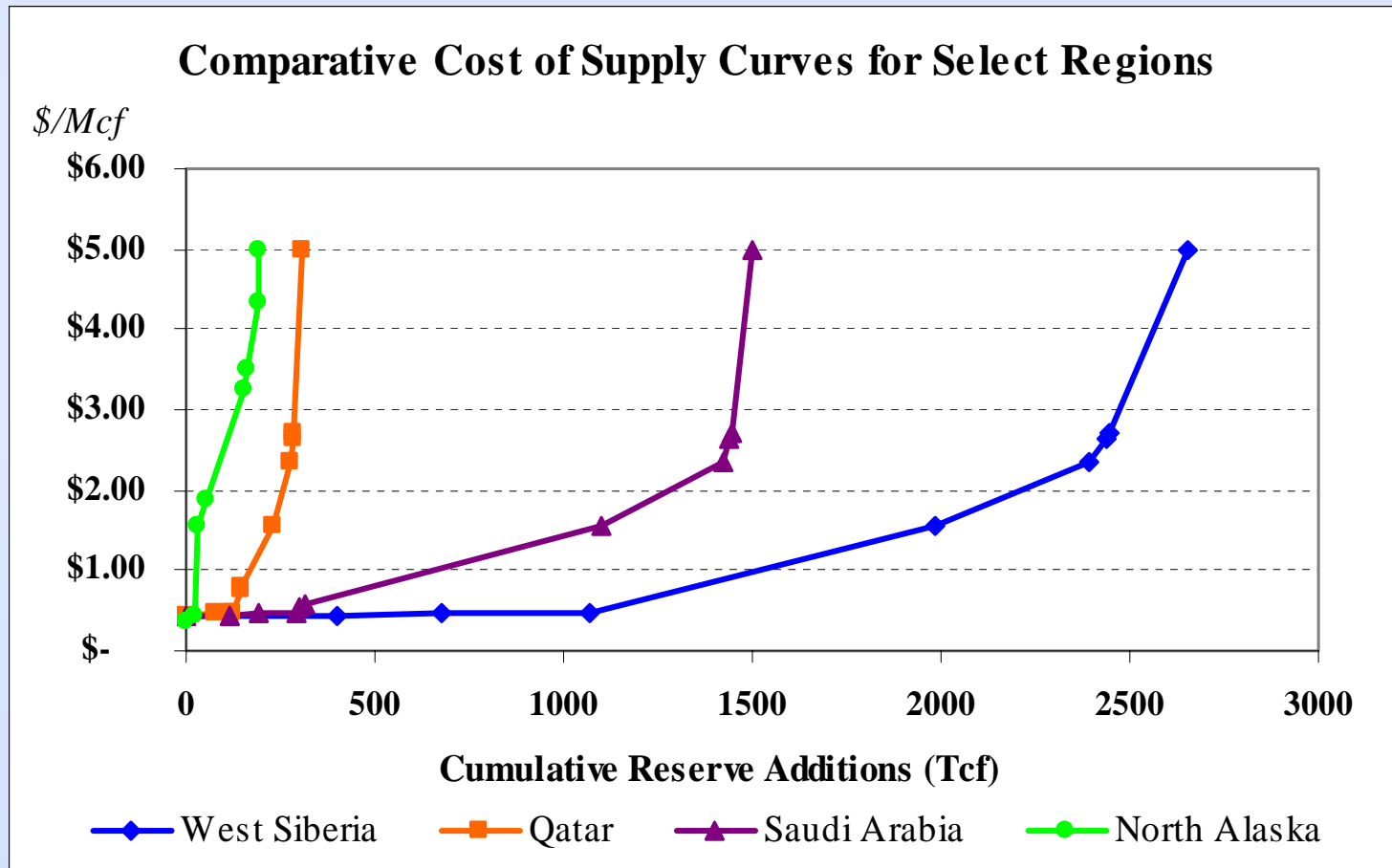


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An important point regarding supply

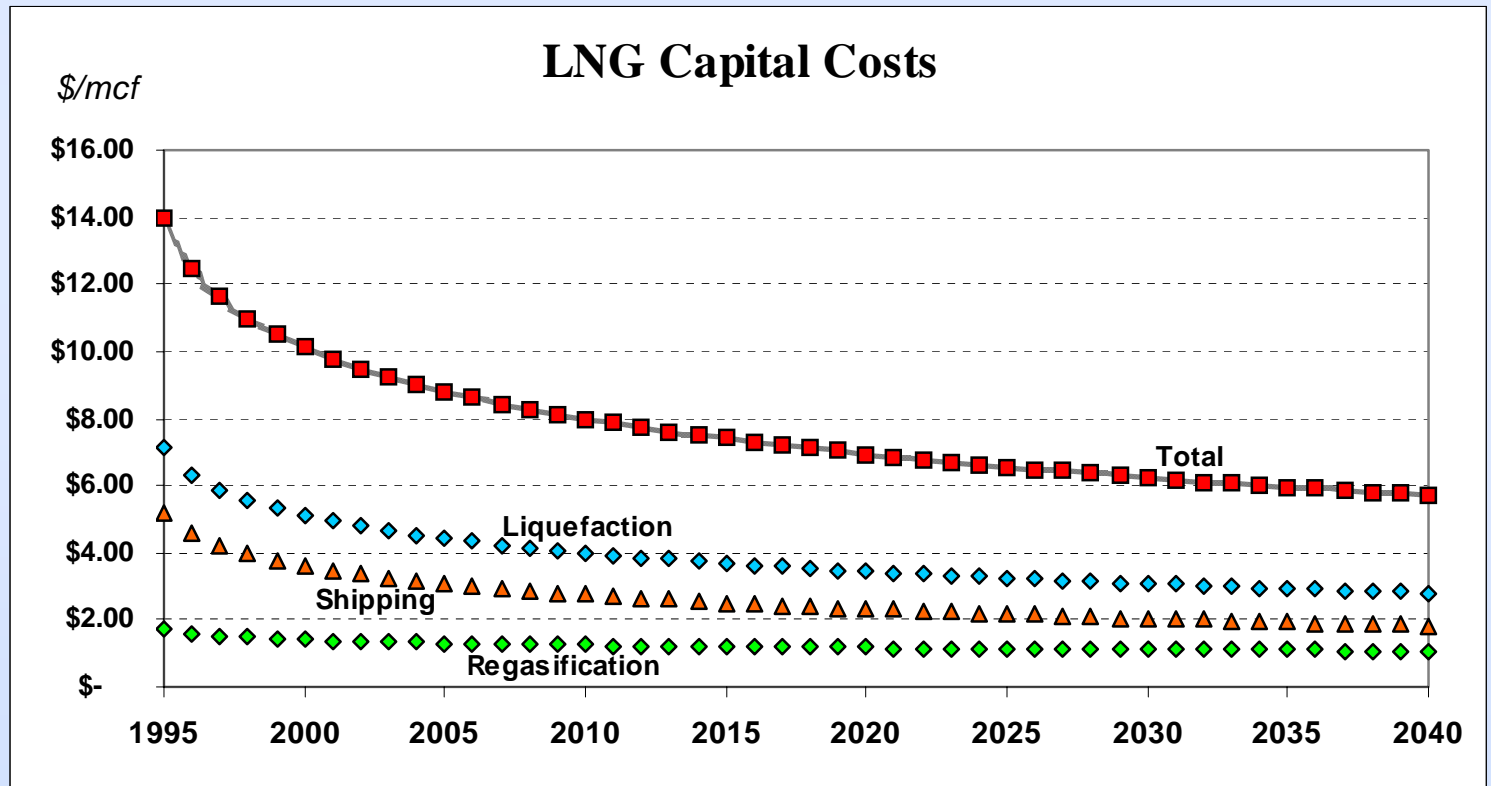
- Long term market influence determined by more than just proved reserves. Resource assessment matters...





Experiment #1: Technological Change in LNG

- Falling LNG transport, liquefaction, and regasification costs – capital and O&M
 - Rates of change based on statistical fit of WEIO rates





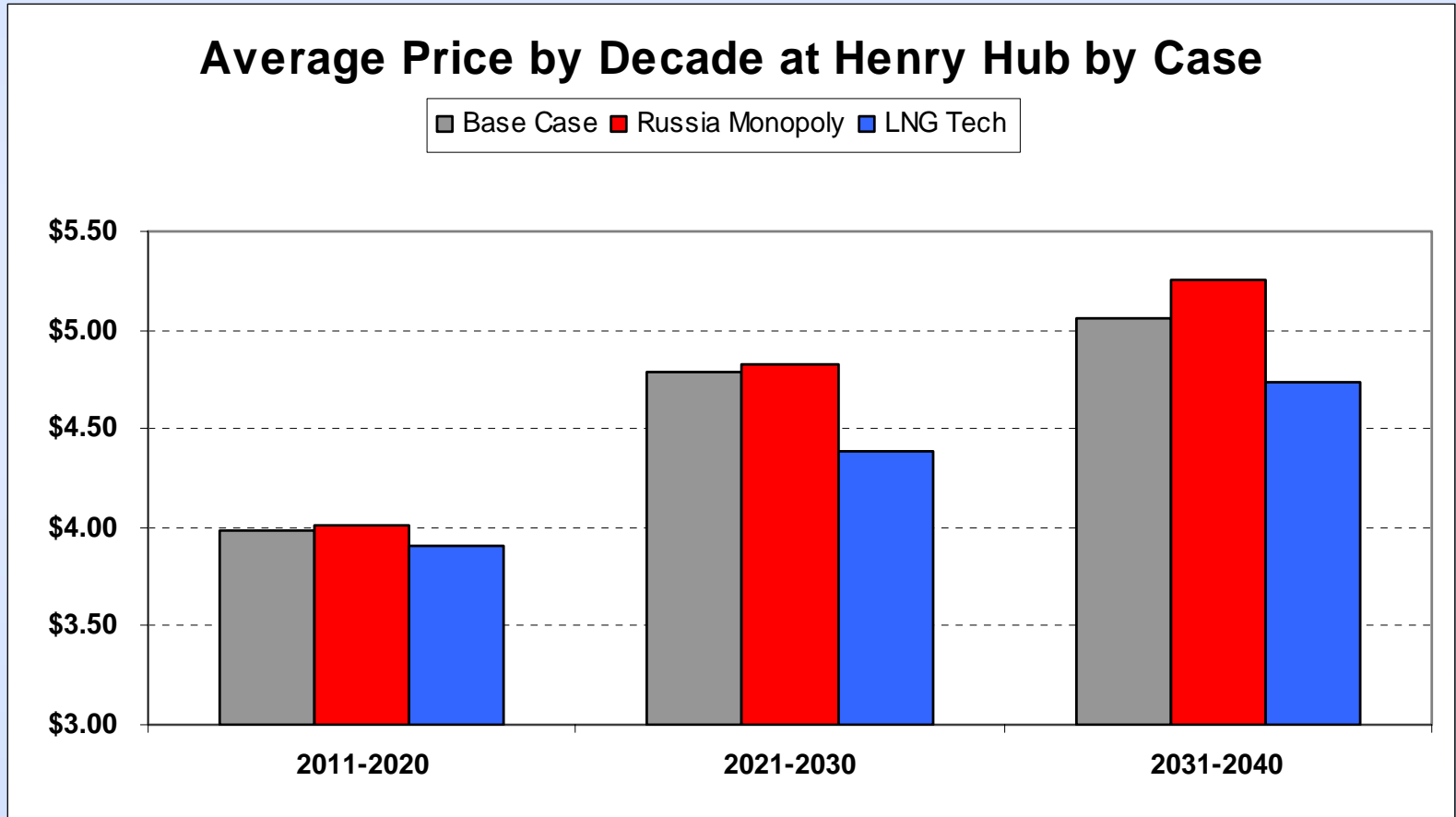
Experiment #2: Russia as a Dominant Producer

- Raise the required rate of return on supply projects in Russia... monopoly rents



Comparing the Cases

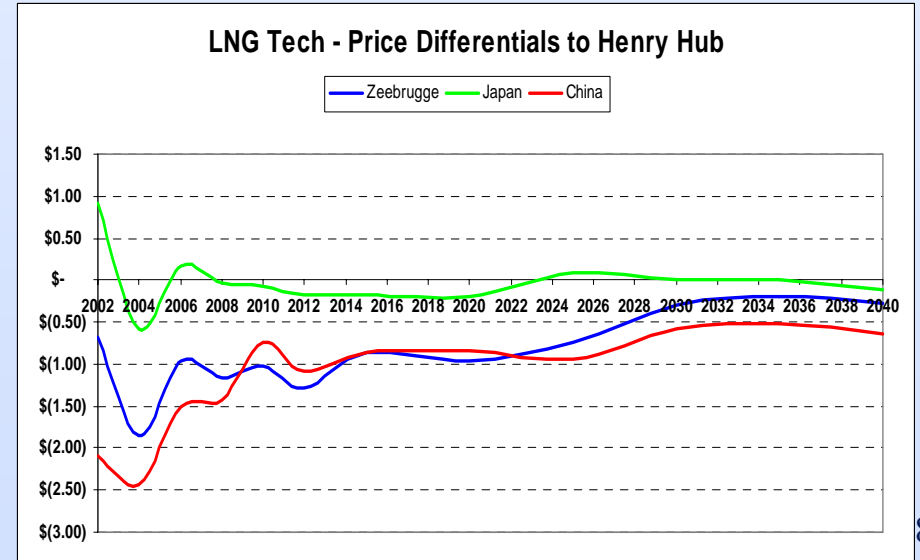
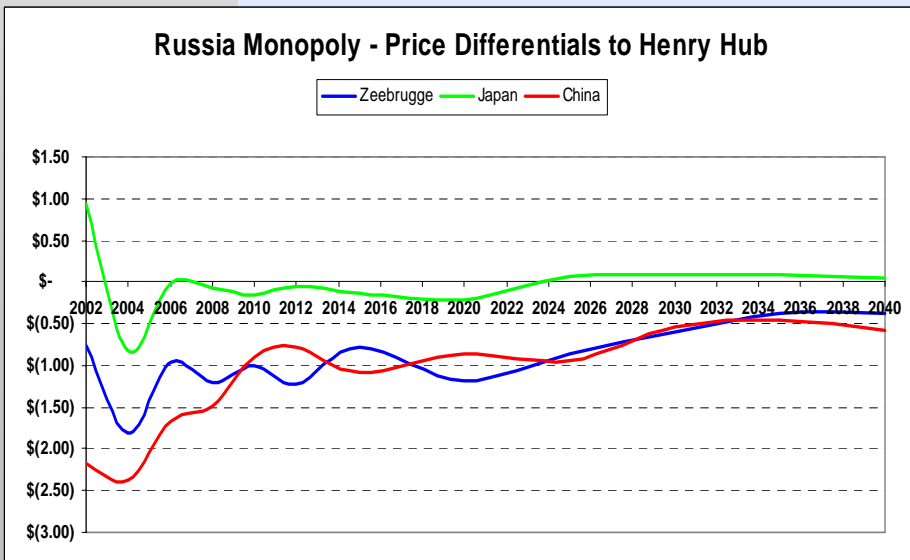
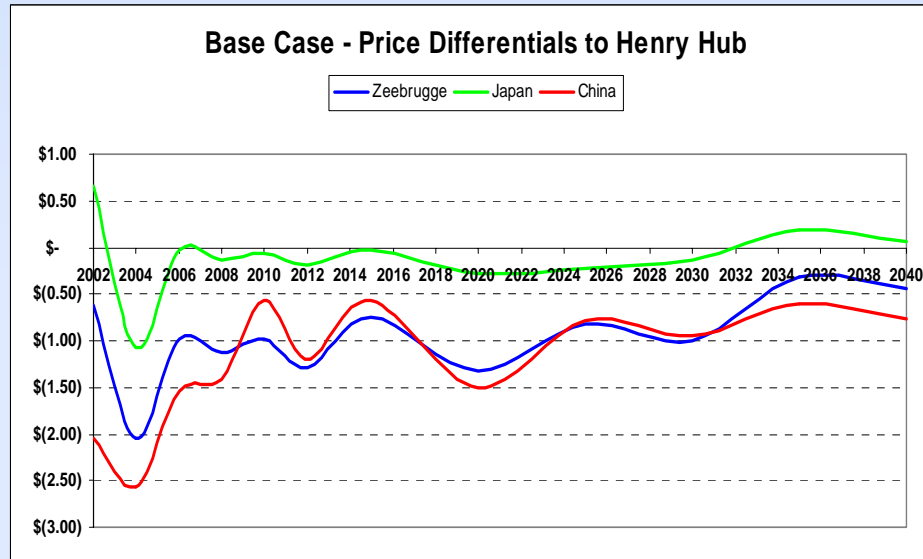
- Henry Hub (long term)





Comparing the Cases (cont.)

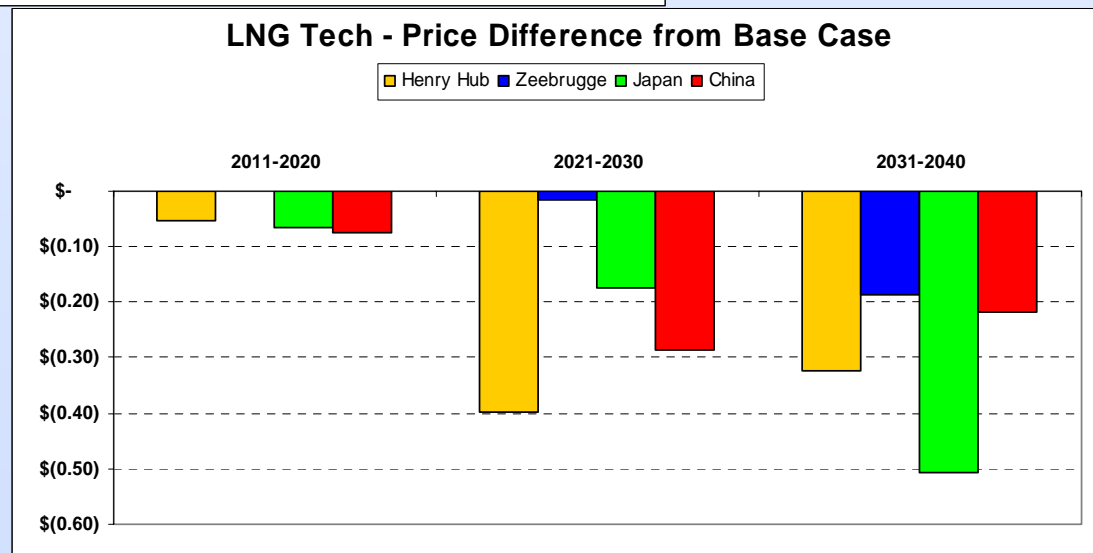
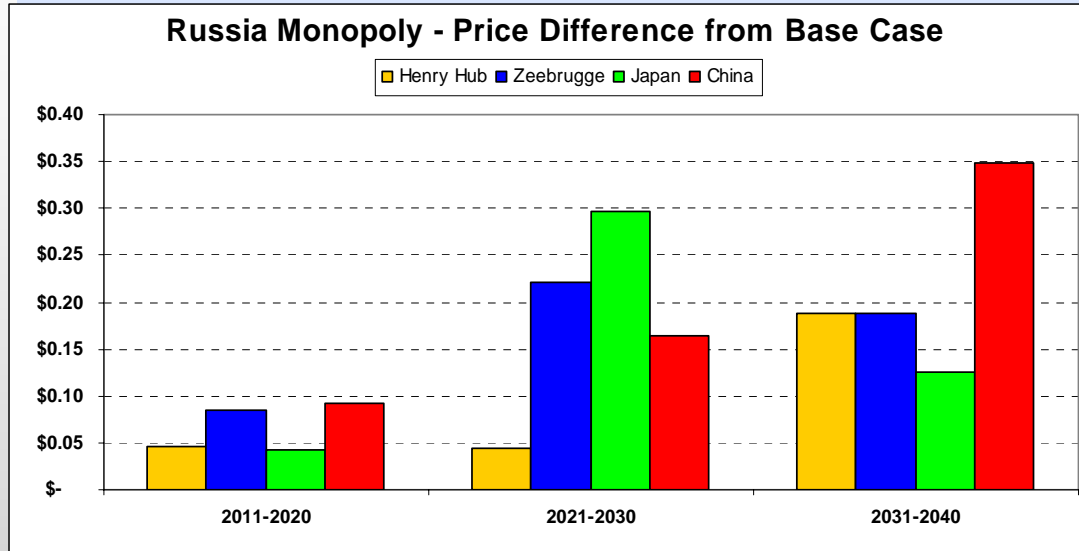
- Regional price comparisons
 - Price convergence is greater with increased LNG trade





Comparing the Cases (cont.)

- Price Delta to Base Case by Select Region
 - ◆ Asian impact generally larger in Russia case

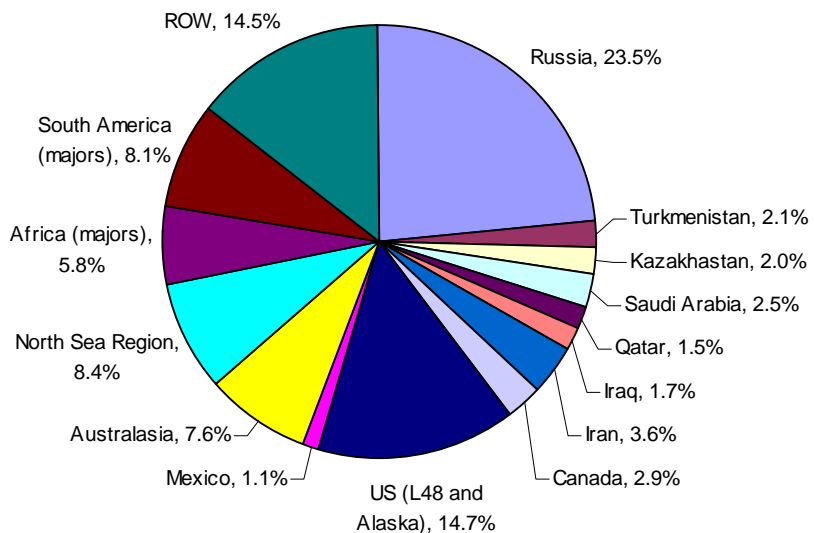




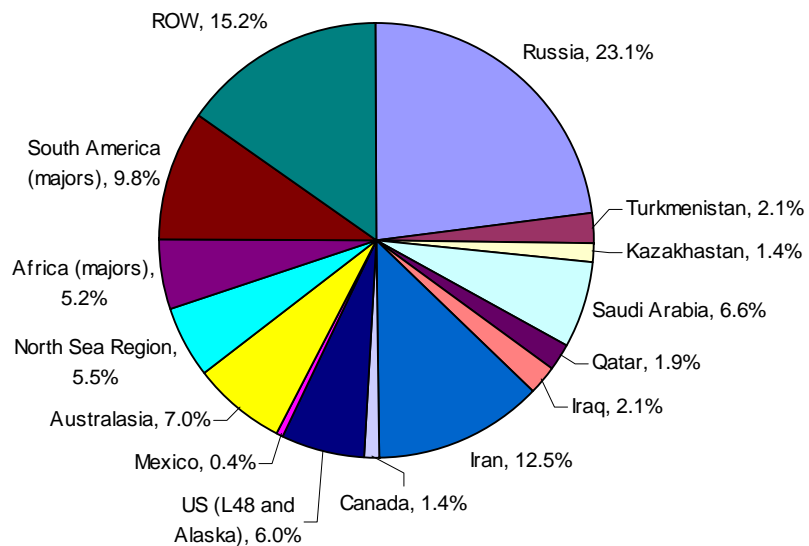
Comparing the Cases (cont.)

- Production Share by region – Base Case

2020 Production Share



2040 Production Share





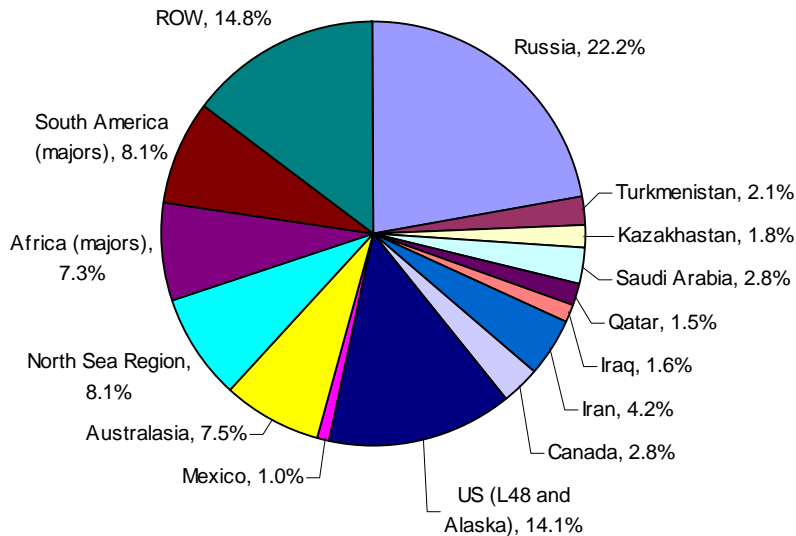
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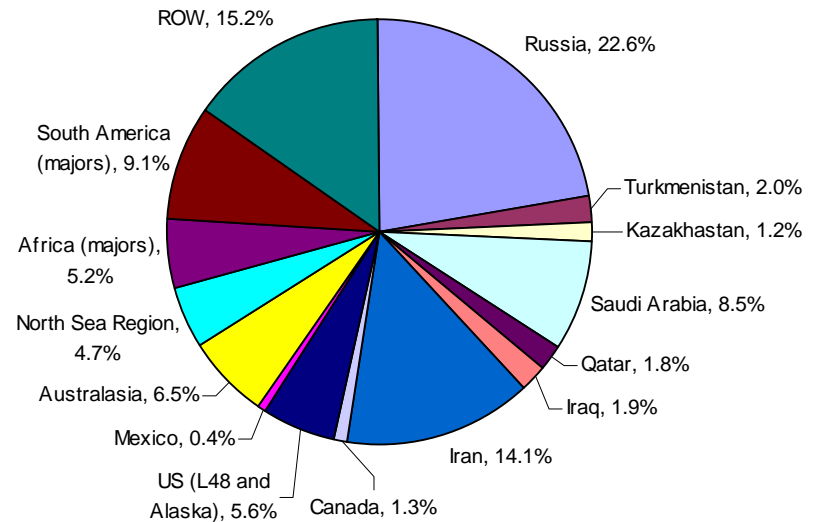
Comparing the Cases (cont.)

- Production Share by region - LNG Tech

2020 Production Share



2040 Production Share

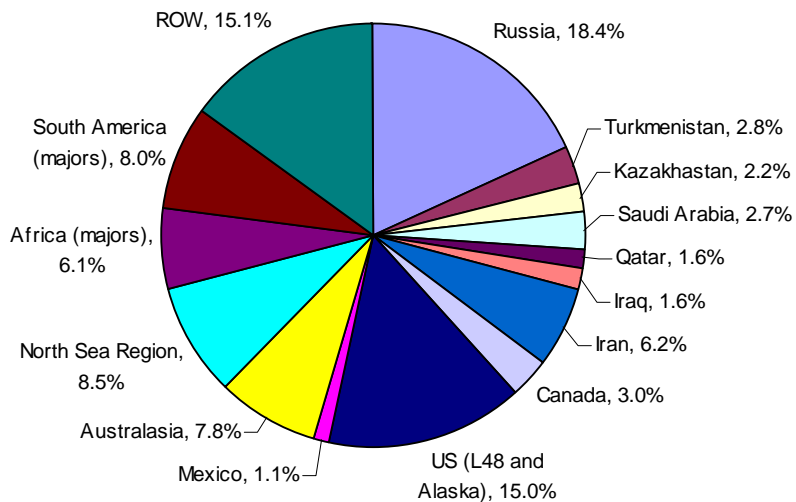




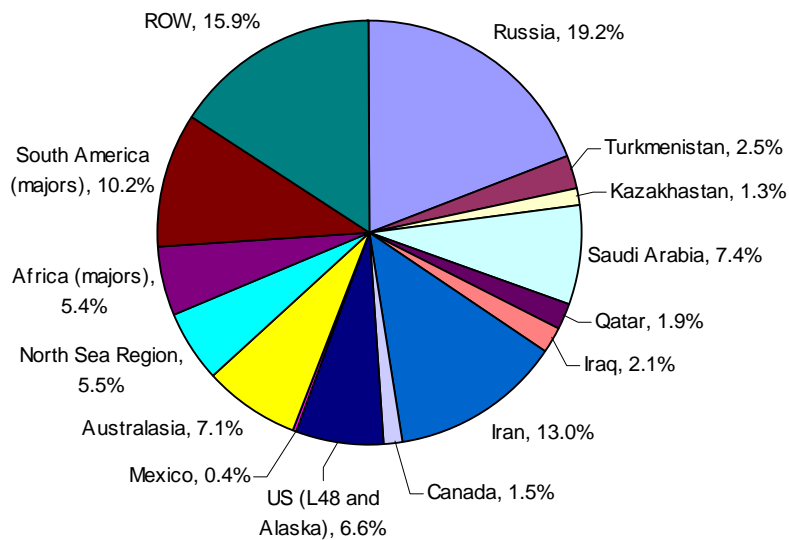
Comparing the Cases (cont.)

- Production Share by region – Russia Monopoly

2020 Production Share



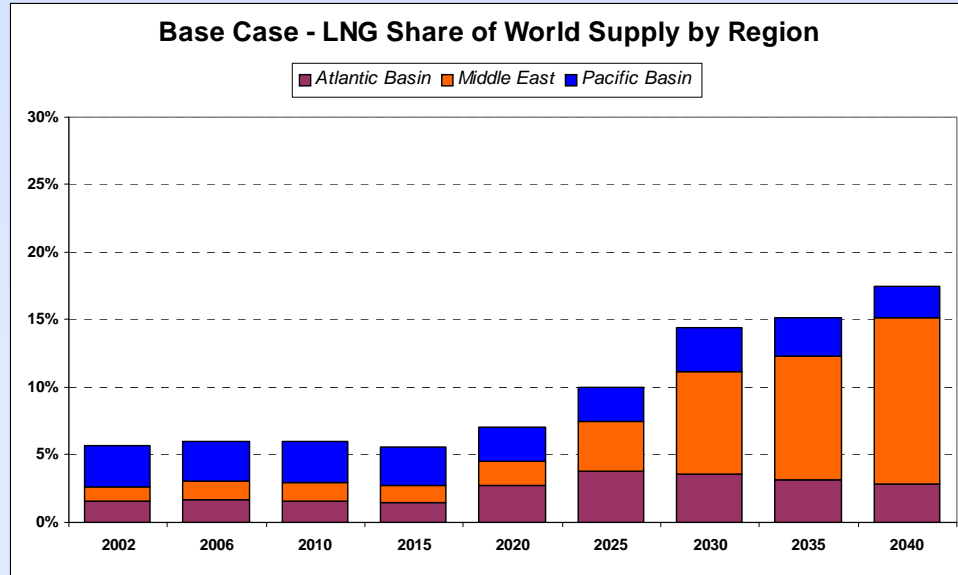
2040 Production Share





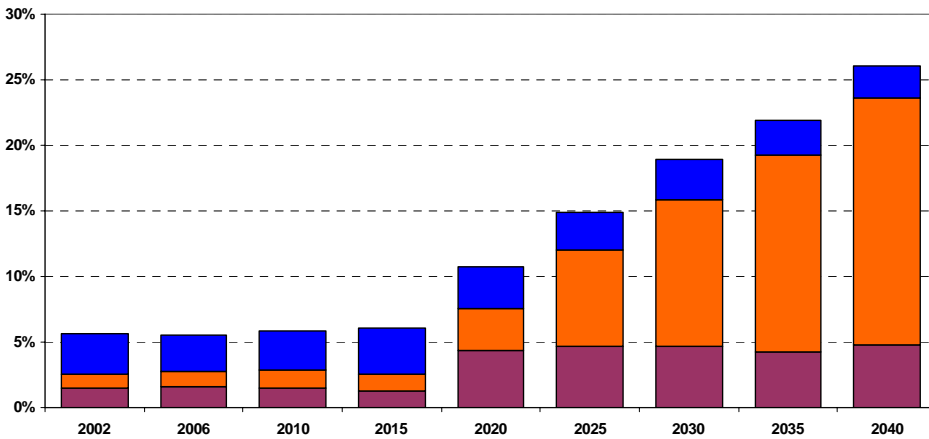
Comparing the Cases (cont.)

- LNG Share by region



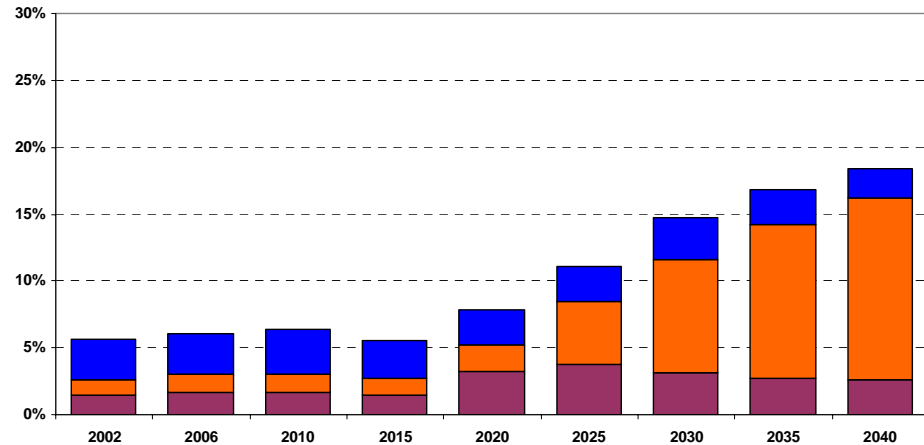
LNG Tech - LNG Share of World Supply by Region

■ Atlantic Basin ■ Middle East ■ Pacific Basin



Russia Monopoly - LNG Share of World Supply by Region

■ Atlantic Basin ■ Middle East ■ Pacific Basin



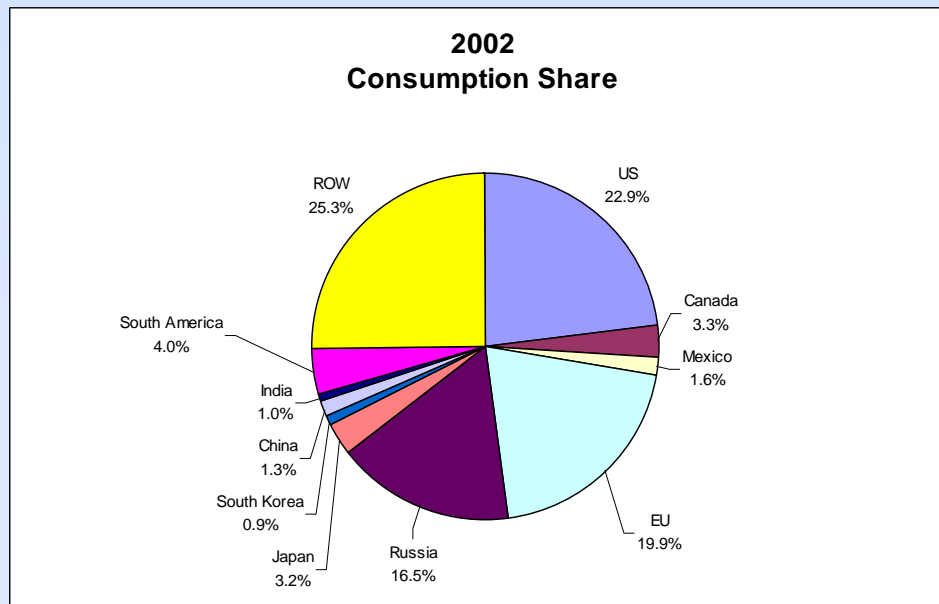


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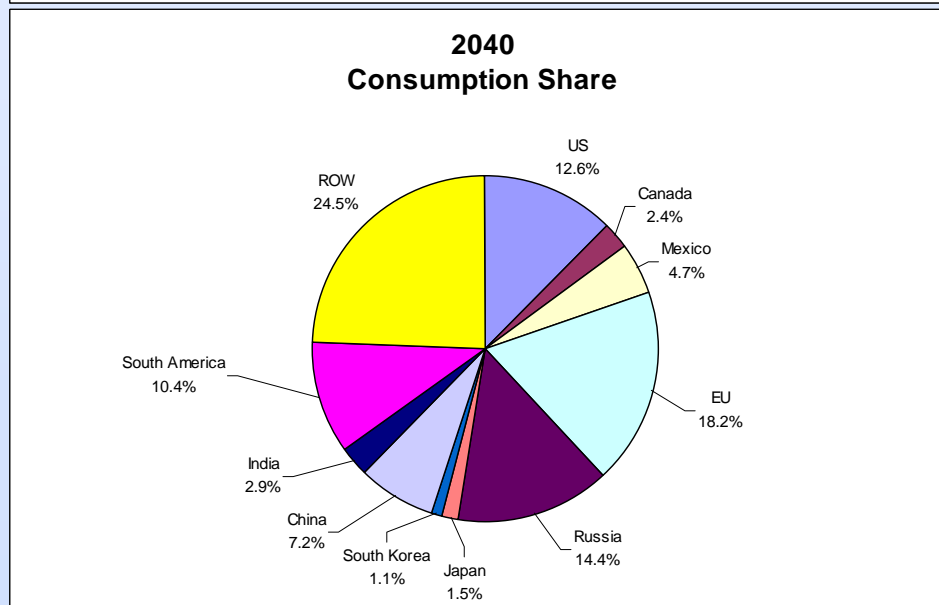
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Comparing the Cases (cont.)

- Base Case - World Demand by Region



- 90 Tcf



- 263 Tcf

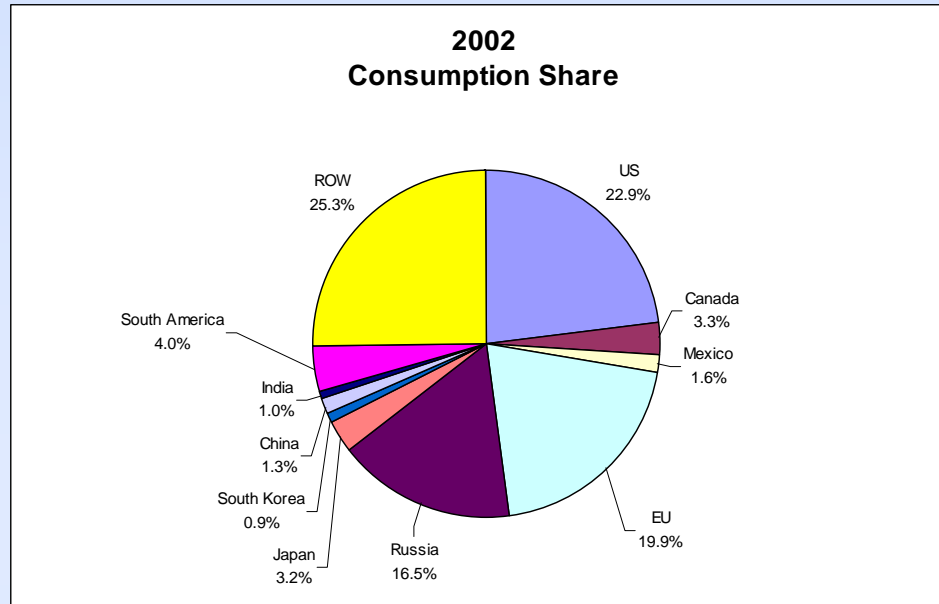


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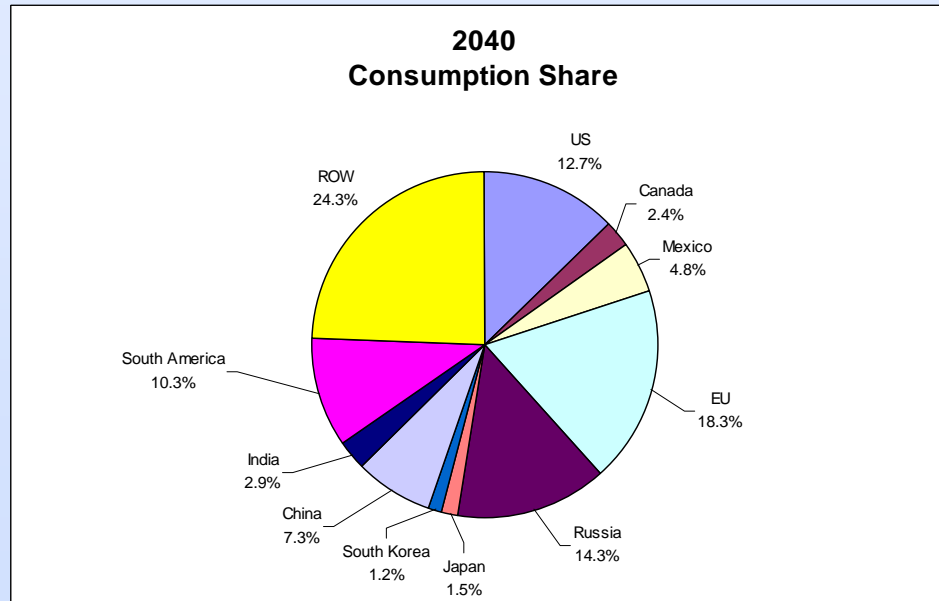
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Comparing the Cases (cont.)

- LNG Tech - World Demand by Region



- 90 Tcf



- 265 Tcf

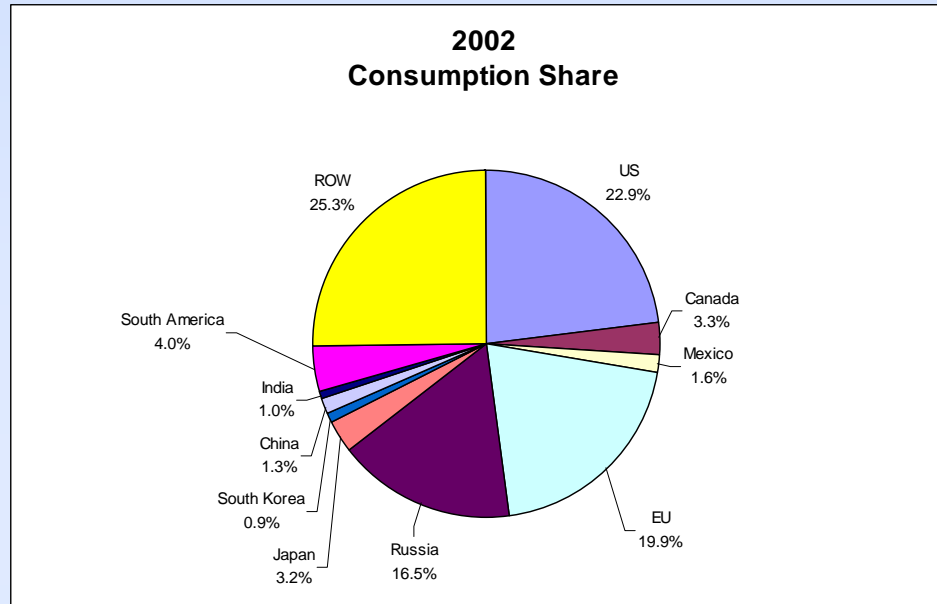


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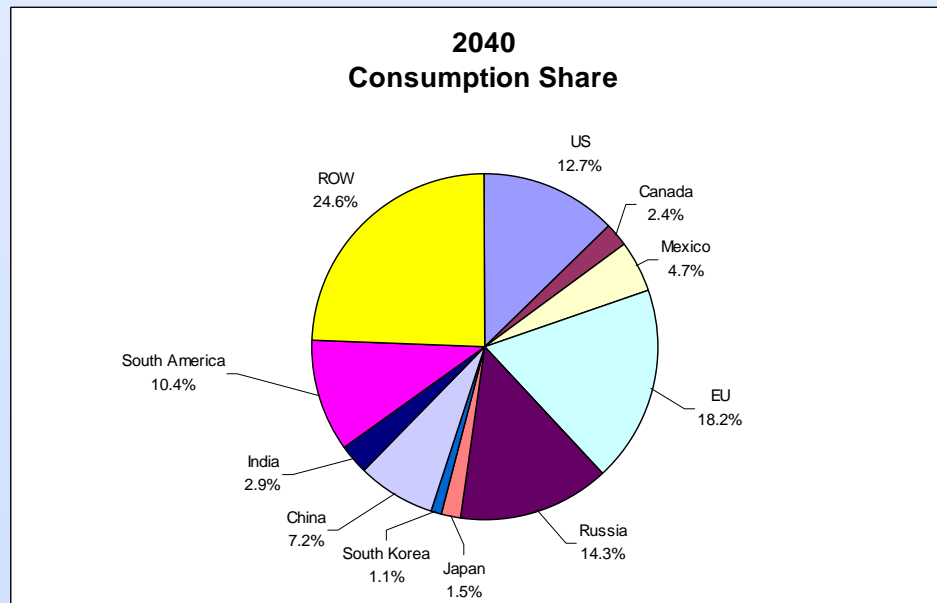
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Comparing the Cases (cont.)

- Russia Monopoly - World Demand by Region



- 90 Tcf



- 260 Tcf



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Comparison of Select Results

■ Japan

- ◆ Base Case: 2010 - Sakhalin pipeline. Market served by both LNG and pipe. National grid not constructed.
- ◆ LNG Tech: No Sakhalin pipeline.
- ◆ Russia Monopoly: 2010 - Sakhalin pipeline. Market served by both LNG and pipe. National grid not constructed.

■ South Korea

- ◆ All Cases: 2015 - Pipeline from Nahodka. Market served by both LNG and pipe.

■ China

◆ Base Case

- 2012 - East Siberian pipeline to North China.
- 2020 - LNG to South China.
- 2030 - Kazakhstan pipeline to West China.

◆ LNG Tech

- 2012 - East Siberian pipeline to North China.
- 2020 - LNG to South China.
- No Kazakhstan pipeline.

◆ Russia Monopoly

- 2012 - East Siberian pipeline to North China.
- 2020 - LNG to South China.
- 2035 - Kazakhstan pipeline to West China. Lower Russian production pulls supply away.



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Comparison of Select Results (cont.)

■ India

◆ Base Case

- 2025 - Iran to India (trans-Pakistan) pipeline.
- 2020 - Bangladesh to India pipeline.
- No LNG.

◆ LNG Tech

- 2025 - Iran to India (trans-Pakistan) pipeline.
- 2020 - Bangladesh to India pipeline.
- 2030 - LNG Imports begin

◆ Russia Monopoly

- 2025 - Iran to India (trans-Pakistan) pipeline.
- 2020 - Bangladesh to India pipeline.
- No LNG

■ Russia

◆ Base Case

- 2030 - West Siberia to East Siberia Pipeline... access to China.
- 2030 - Barents Sea LNG

◆ LNG Tech

- 2035 - West Siberia to East Siberia Pipeline... access to China.
- 2025 - Barents Sea LNG

◆ Russia Monopoly

- 2035 - West Siberia to East Siberia Pipeline... access to China.
- No Barents Sea LNG

■ Venezuela

- ◆ All Cases: 2020 - LNG exports begin.



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Comparison of Select Results (cont.)

■ EU

◆ Base Case:

- LNG market share:
 - ✦ 1.9% by 2010 (1.2 bcf/d), 4.7% by 2025 (4.1 bcf/d), and 11.6% by 2035 (13.3 bcf/d).

◆ LNG Tech:

- LNG market share:
 - ✦ 2.2% by 2015 (1.3 bcf/d), 10.7% by 2025 (9.4 bcf/d), and 20.6% by 2035 (23.7 bcf/d).

◆ Russia Monopoly:

- LNG market share:
 - ✦ 3.5% by 2015 (2.1 bcf/d), 6.0% by 2025 (5.2 bcf/d), and 12.1% by 2035 (13.7 bcf/d).

■ US

◆ Base Case:

- 2015 - Alaska pipeline.
- 2030 - Demand reaches 30 Tcf.
- Aggressive LNG import growth post-2015. LNG market share:
 - ✦ 7.5% by 2015 (5.3 bcf/d), 20.9% by 2025 (17.0 bcf/d), and 35.0% by 2035 (30.7 bcf/d).

◆ LNG Tech:

- 2015 - Alaska pipeline.
- 2025 - Demand reaches 30 Tcf.
- Aggressive LNG import growth post-2010. LNG market share:
 - ✦ 7.7% by 2012 (5.2 bcf/d), 33.4% by 2025 (27.4 bcf/d), and 63.1% by 2035 (56.0 bcf/d).

◆ Russia Monopoly:

- 2015 - Alaska pipeline.
- 2030 - Demand reaches 30 Tcf.
- Aggressive LNG import growth post-2010. LNG market share:
 - ✦ 7.2% by 2015 (5.1 bcf/d), 20.4% by 2025 (16.5 bcf/d), and 37.6% by 2035 (32.9 bcf/d).



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Future Work

- Continuing review of model architecture
 - ◆ Infrastructure and data as information is made available.
 - ◆ Reasonable assumptions regarding technological change... possible starting points – NPC 2003, IEA WEIO 2003.
- From experiments to scenarios
 - ◆ Experiments involve singular changes...
 - No Sakhalin to Japan Pipeline
 - No Nahodka to South Korea Pipeline
 - No Iran to Pakistan to India Pipeline
 - US LNG import terminals in Gulf Coast only
 - ◆ Scenarios involve multiple changes
 - Consider different states of the world and assess the resulting impact on the development of global natural gas market.