The Impact of the U.S Shale Gas Development on the Northeast Asian Energy Market

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Korea Gas Corporation

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1. US Shale Gas, The Linchpin of Global Energy Market Growth

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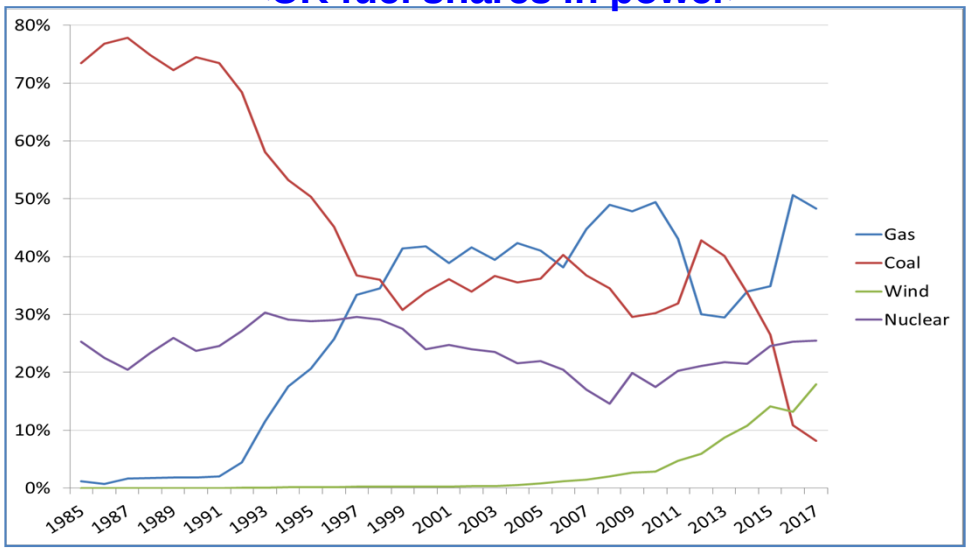
World-wide Implementation of Energy Transition Policies

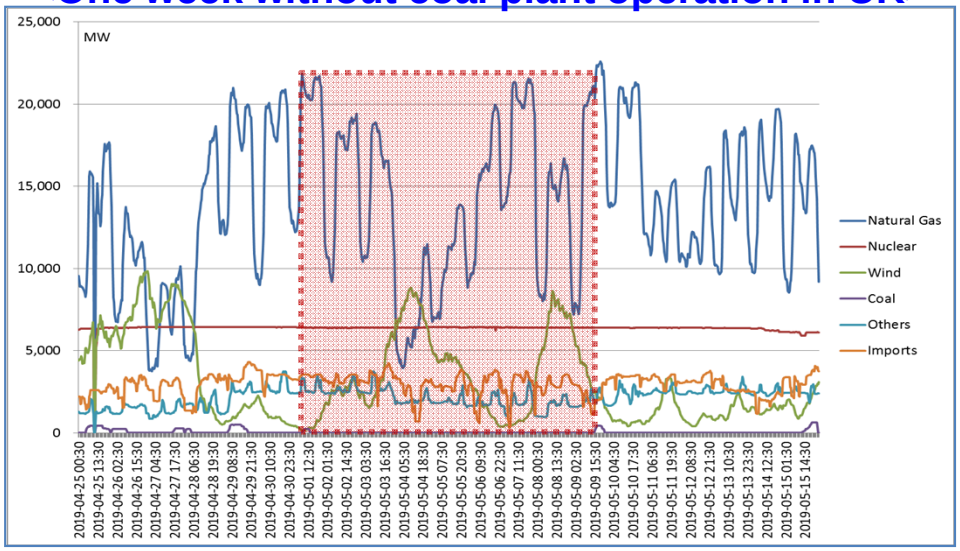
- **Greater role and importance of natural gas driven by global climate compact and world-wide implementation of energy transition policies**

<UK fuel shares in power>



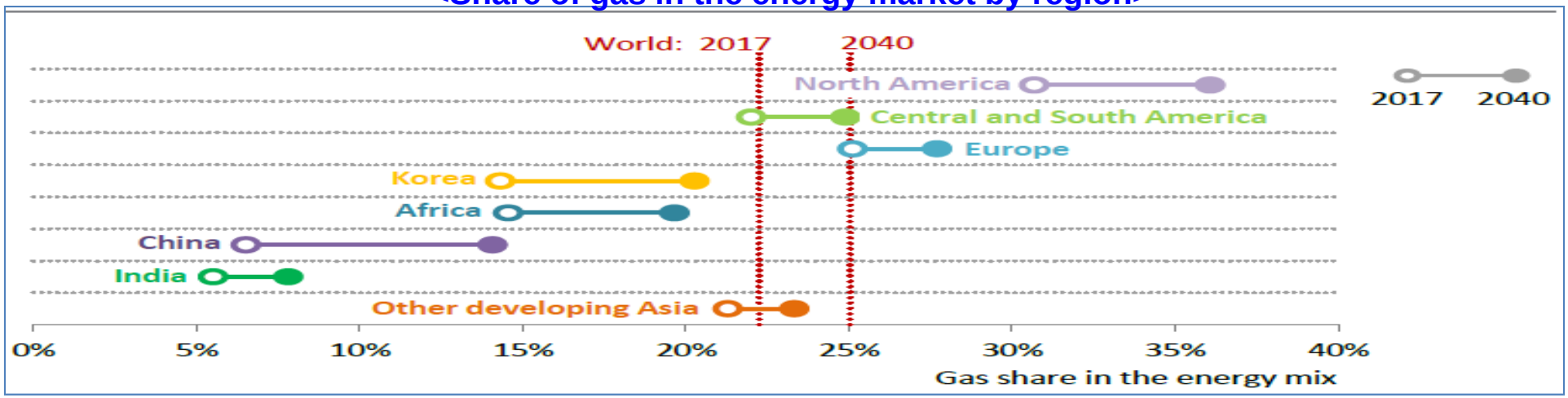
Source: BP (2018)

<One week without coal plant operation in UK>



Source: Elexon

<Share of gas in the energy market by region>

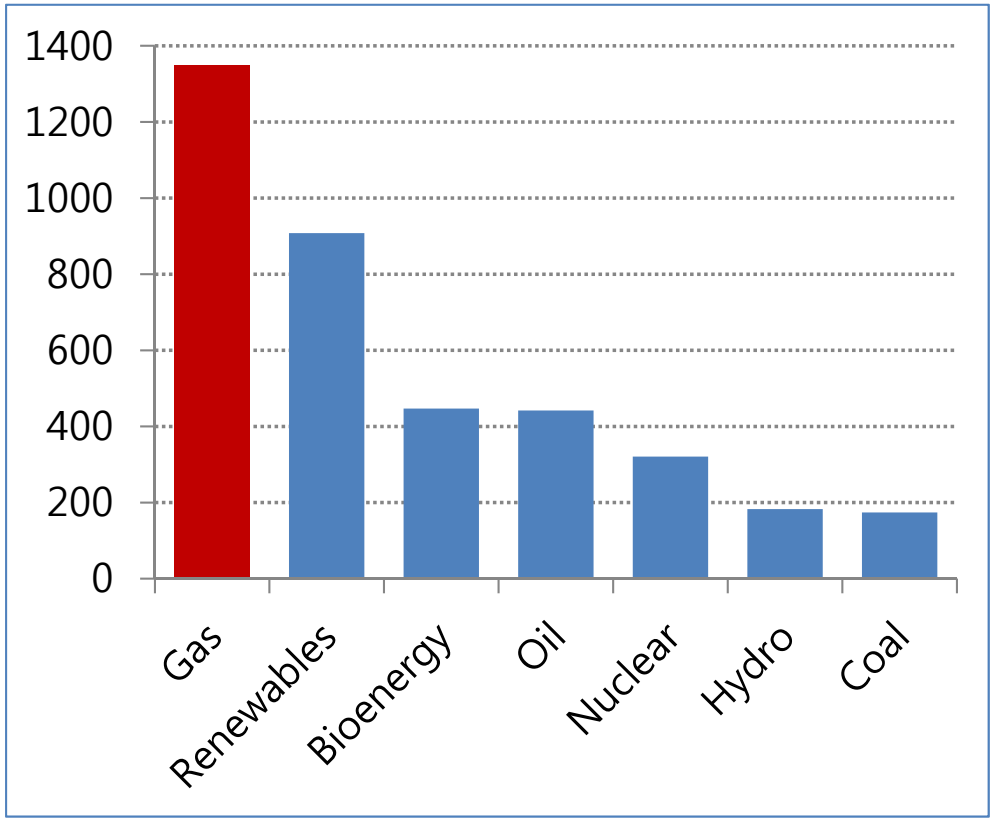


Source: IEA (2018)

Natural Gas, Spearheading Global Energy Demand

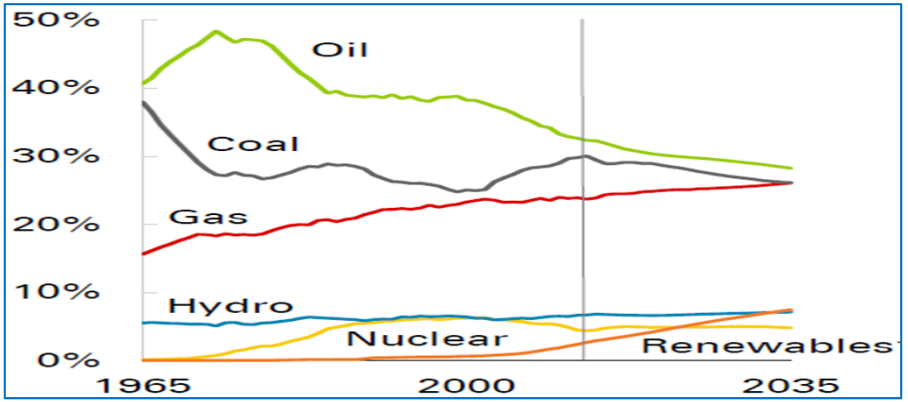
- **Natural gas is projected to account for 35% of the global energy demand growth between 2017 and 2040: Spearheading energy demand growth**
  - Annual average increase in demand(2017~2040) : fossil fuel(0.3%) vs. natural gas(1.6%)
  - Natural gas is forecast to become the 2nd most consumed primary energy source: 2035→ 2020

<Incremental energy demand (2017~2040)>

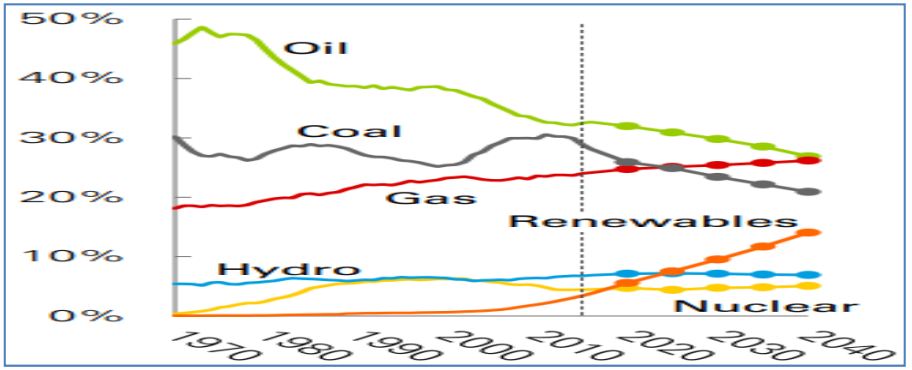


Source: IEA (2018)

<Shares of primary energy>



Source: BP (2015)



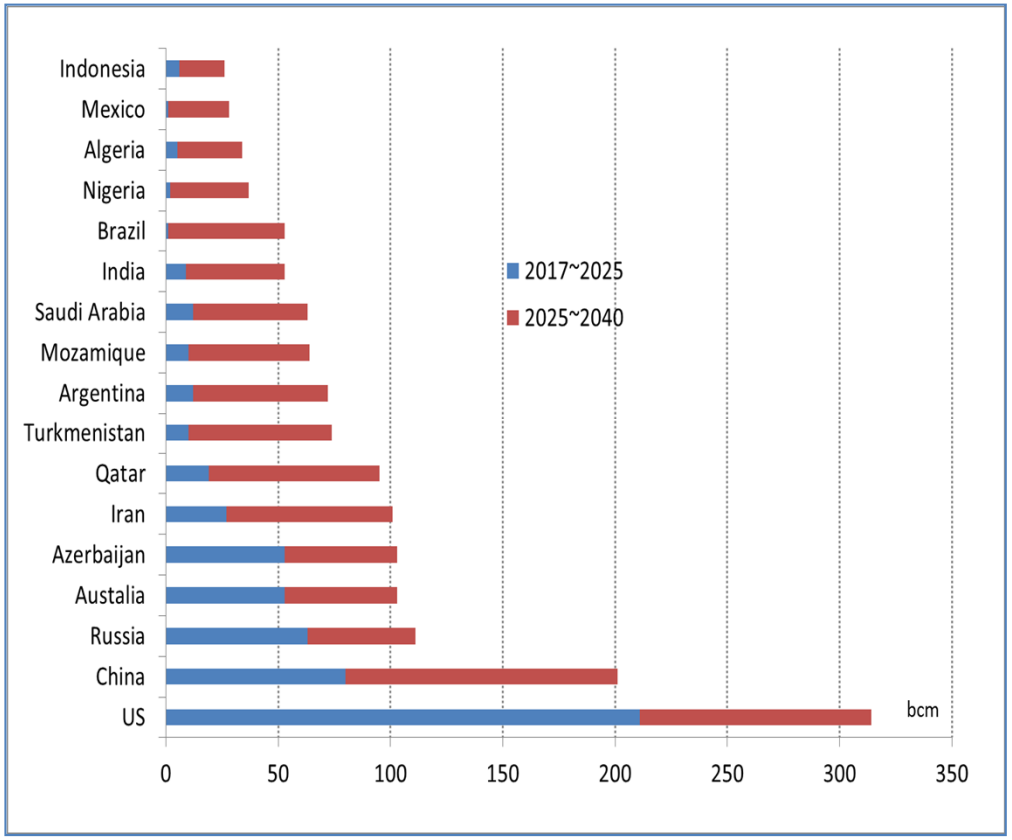
Source: BP (2018)

U.S. & NEA, Driving the Gas Market Development

- 1/5 of global natural gas supply growth is projected to come from U.S between 2017 and 2040: driving natural gas supply growth

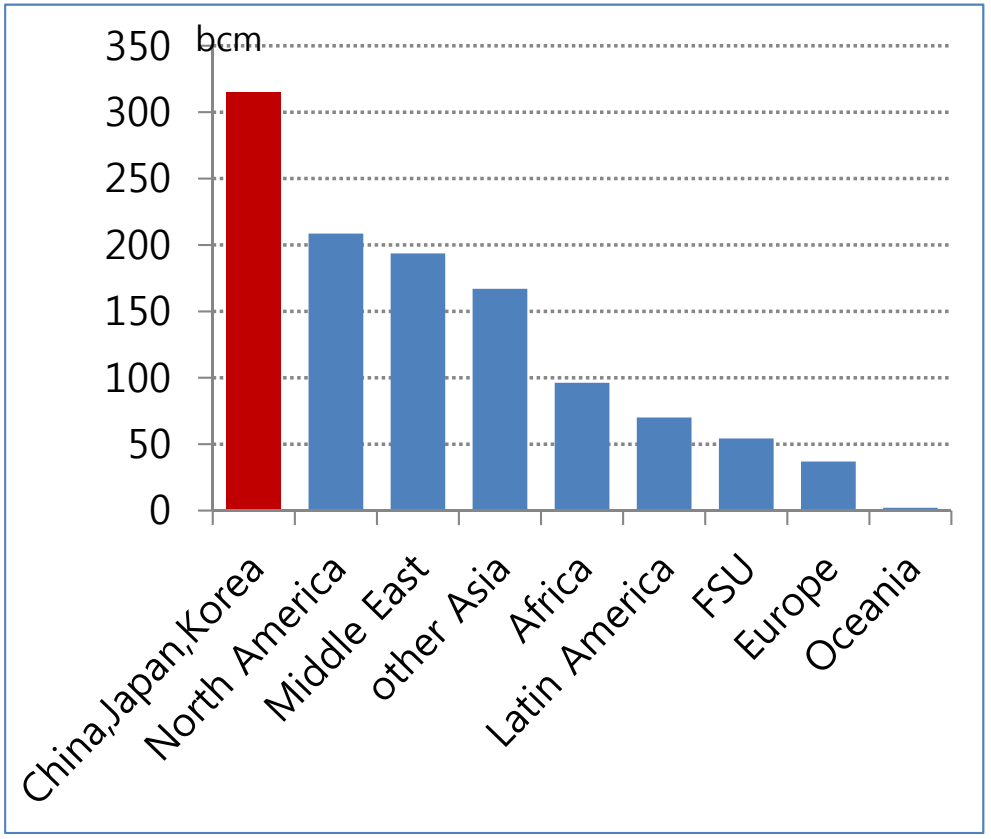
- Northeast Asia is forecast to account for ¼ of the global natural gas demand growth between 2018 and 2035: spearheading gas demand growth

<Incremental natural gas production (2017~2040)>



Source: IEA (2018)

<Incremental natural gas demand (2018~2035)>

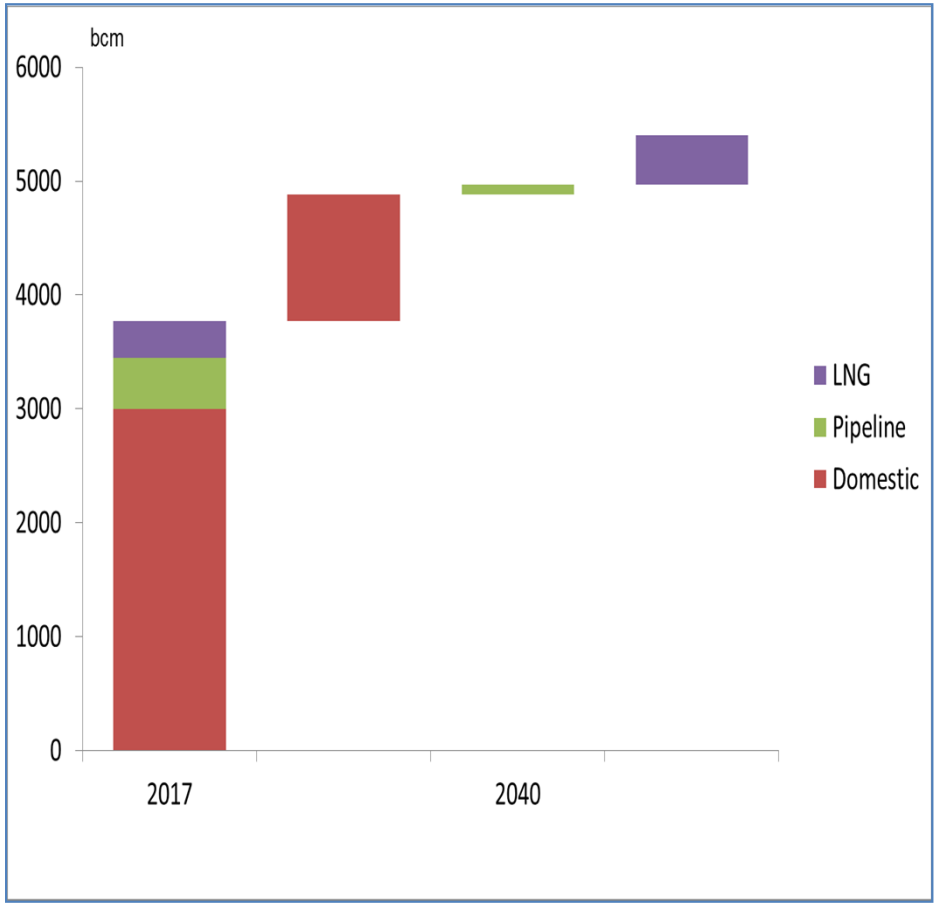


Source: WoodMackenzie (2018)

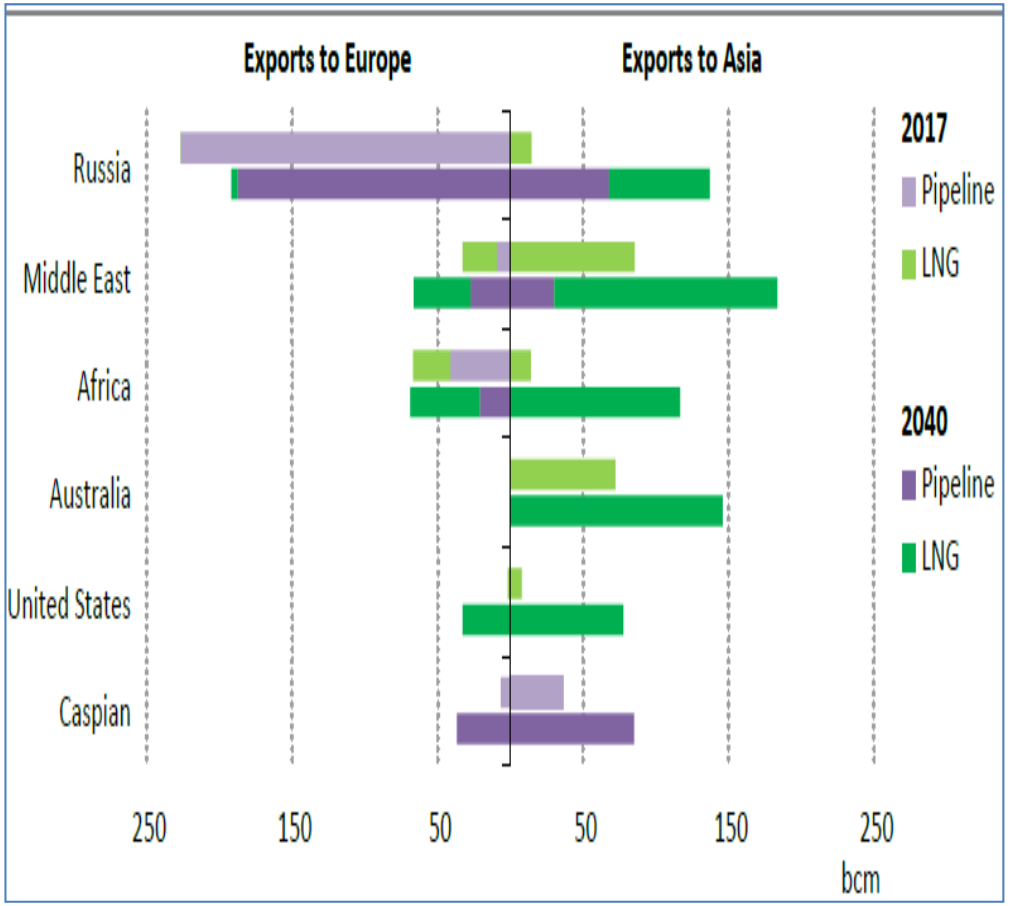
LNG, Playing a Major Role in Gas Demand Growth

- **Growth in the natural gas demand will be largely driven by the increase in the LNG demand. This is because about 85% of the additional global natural gas trading volume in 2017-2040 will be LNG trade.**

<Gas trade (2017-2040)>



<Gas exports to Europe and Asia>

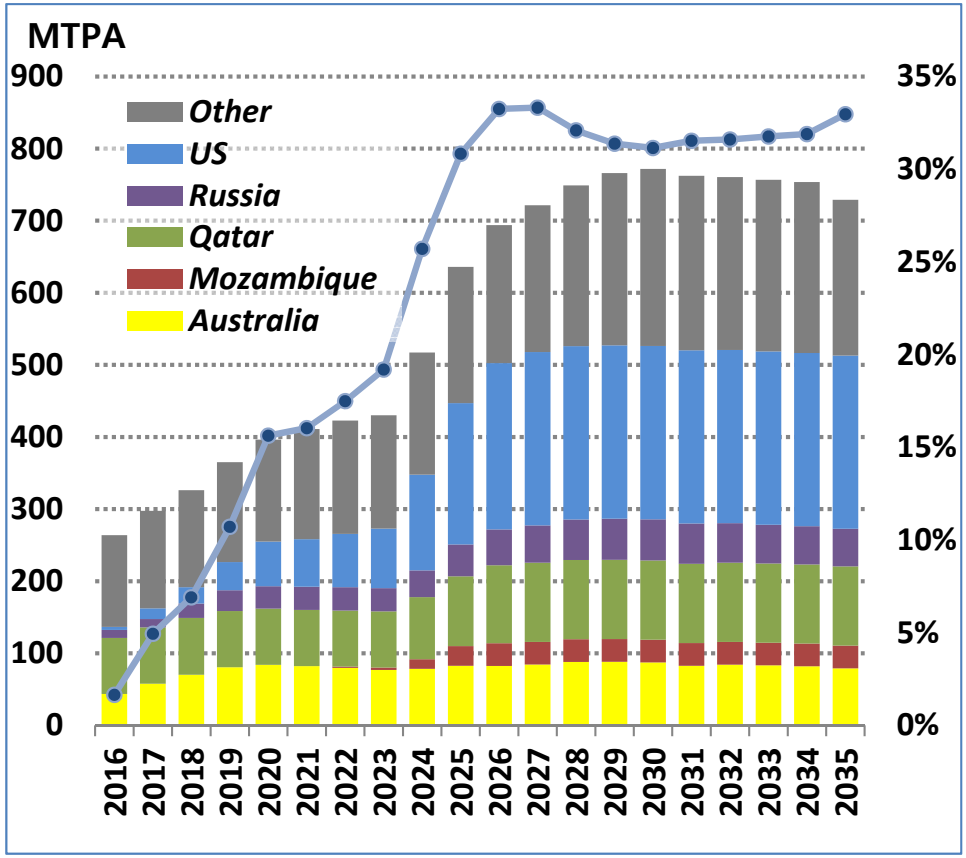


Source: IEA (2018)

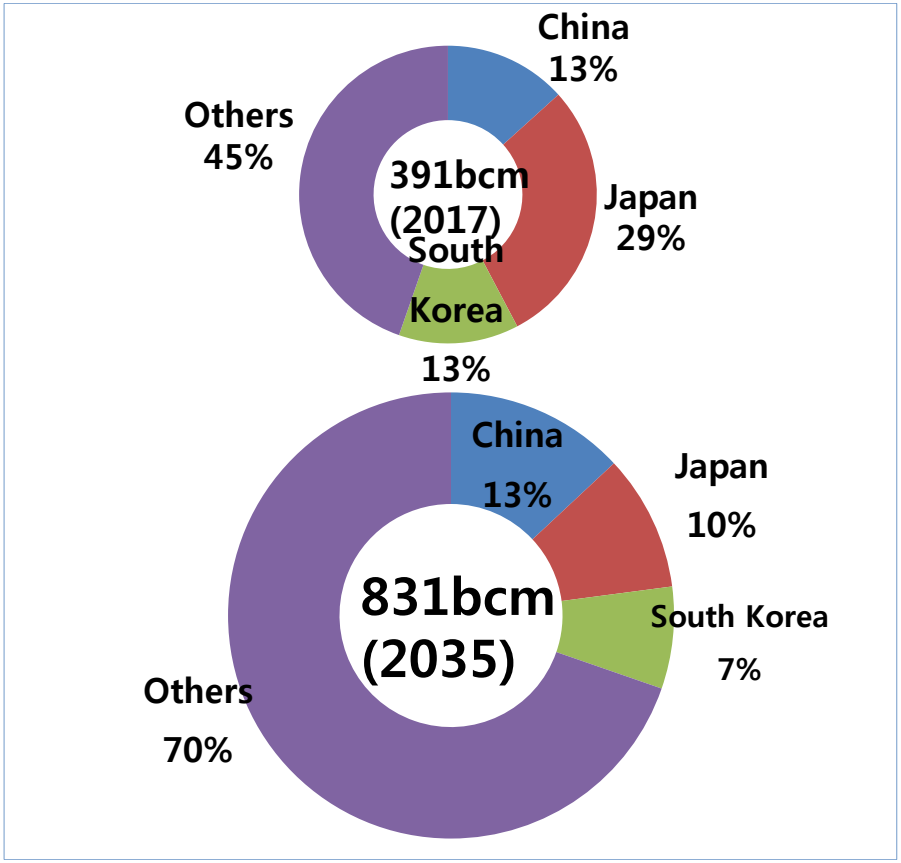
U.S. & NEA, Driving the LNG Market Development

- U.S's share of global LNG supply: 5%(Year 2018) → 30%(Year 2025)
- NEA's take-up in global LNG demand: 55%(Year 2017) → 30%(Year 2035)
  : NEA is expected to exert huge influence continuously

<Global LNG supply>



<Global LNG demand>



Source: WoodMackenzie (2018)

2. Effects of the U.S. Shale Gas Development on the Global Gas Market

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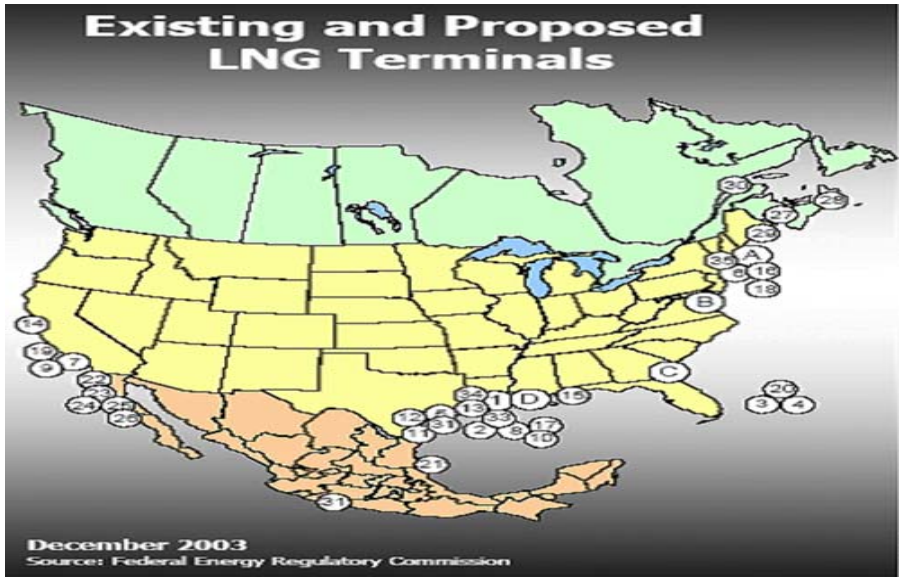
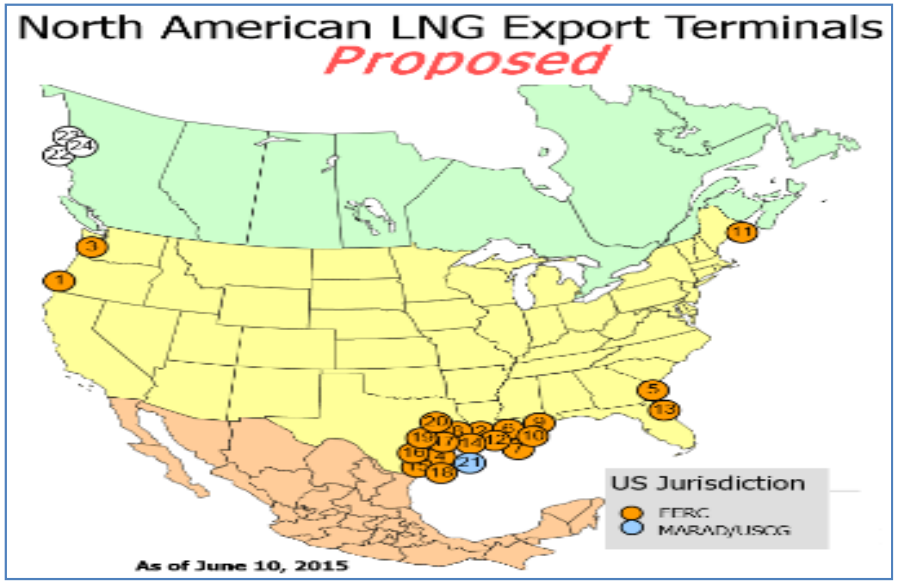
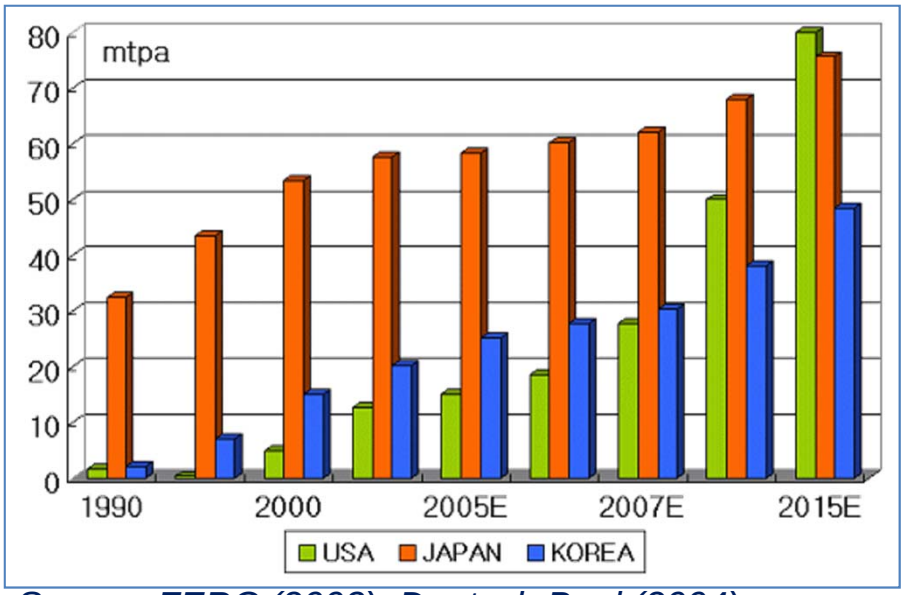
Enhancing Energy Supply Security



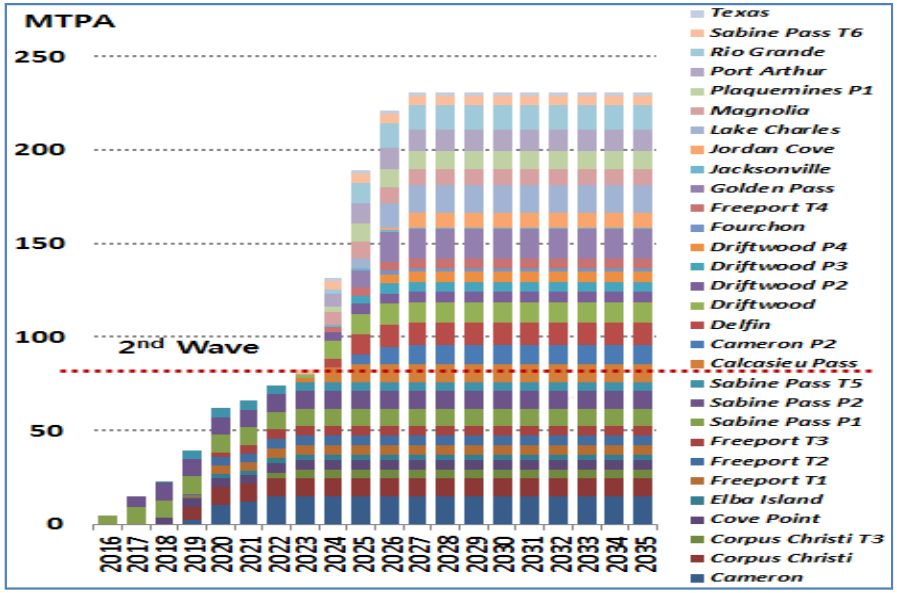


<US LNG import forecast (As of 2004)>



Source: FERC (2003), Deutsch Bank(2004)

<US LNG export forecast (As of 2019)>

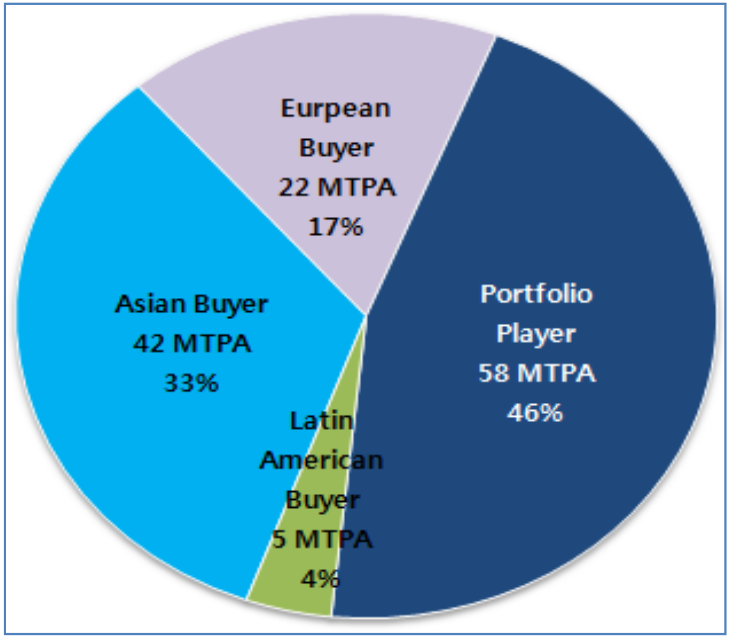


Source: FERC (2015), WoodMackenzie (2019)

Increasing Liquidity and Flexibility in the Gas Market

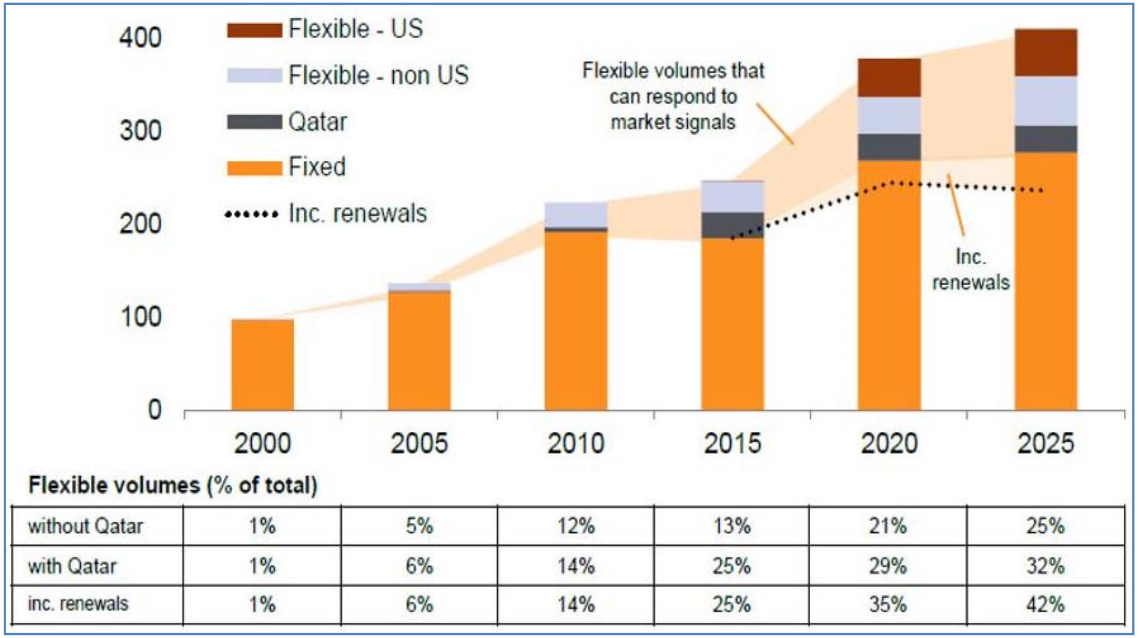
- US LNG that free from destination restriction will greatly enhance the liquidity of LNG trading
- Majority of US LNG export volumes have been contracted by LNG portfolio aggregators. As Aggregators utilize contract flexibility it will drive an increase in LNG market liquidity
- US LNG export are estimated to almost double the amount of flexible contracted LNG to 25% by 2025

<Contracted volume of U.S LNG by region>



Source: WoodMackenzie (2019)

<Flexible volumes of global LNG>



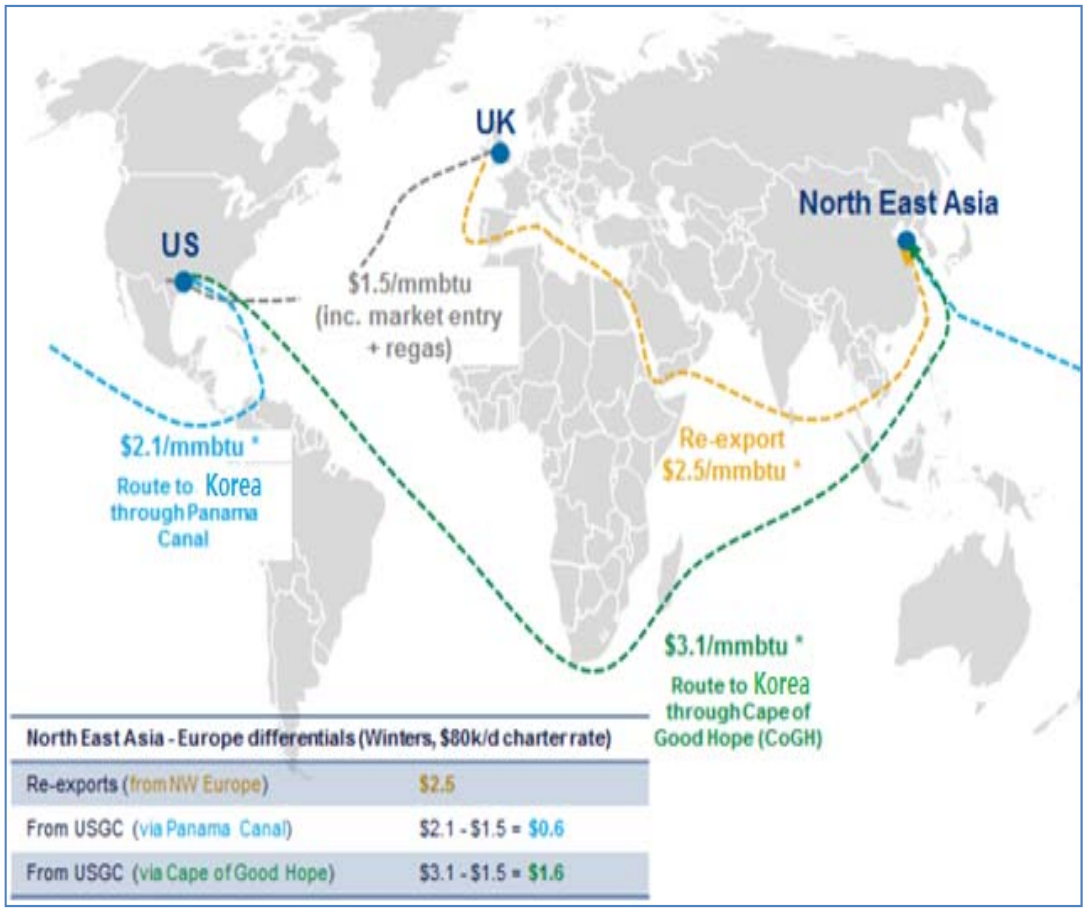
Flexible volumes (% of total)

without Qatar	1%	5%	12%	13%	21%	25%
with Qatar	1%	6%	14%	25%	29%	32%
inc. renewals	1%	6%	14%	25%	35%	42%

Source: BG (2015)

Catalyzing Globalization by Connecting Regional Markets

- US LNG allows buyers to source gas on a Henry Hub rather than oil-indexed price basis.
- Henry Hub price connects the US gas market with the global LNG market. This allows buyers complete destination flexibility to respond to prevailing global spot price signals



North East Asia - Europe differentials (Winters, $80k/d charter rate)	
Re-exports (from NW Europe)	$2.5
From USGC (via Panama Canal)	$2.1 - $1.5 = $0.6
From USGC (via Cape of Good Hope)	$3.1 - $1.5 = $1.6

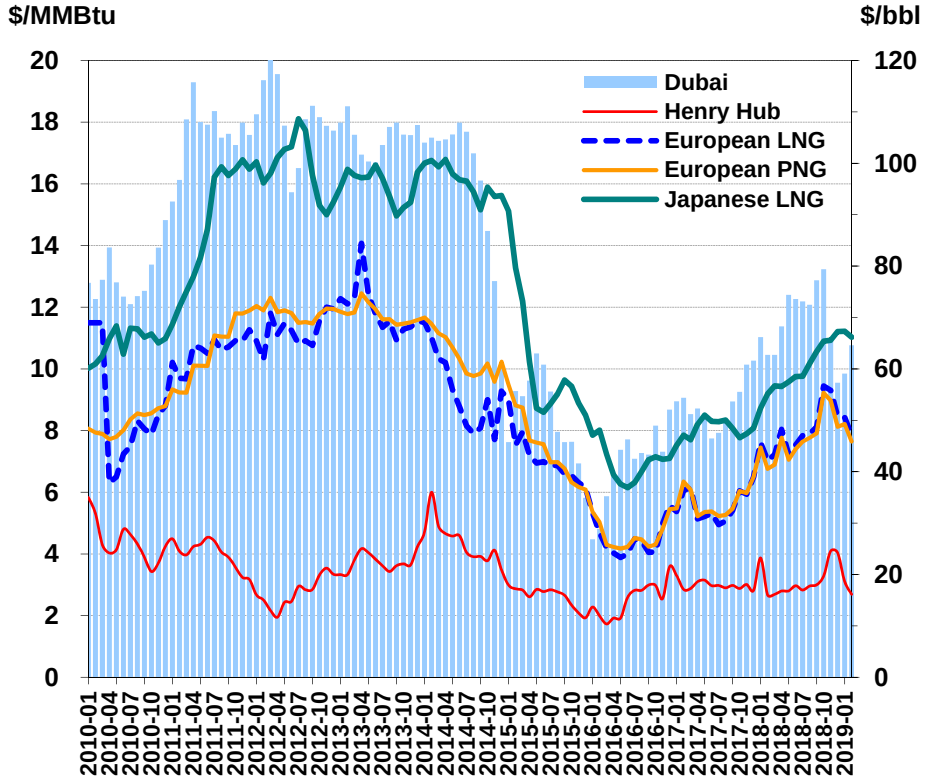
Source: WoodMackenzie (2018)

Existing LNG	$P_{LNG} = A \times P_{Crude} + B$ P_{LNG} : LNG Price($/MMBtu) P_{Crude} : Price of Crude Oil($/bbl), (A , B = constant)
U.S. LNG	$P_{LNG} = A \times HH + B$ P_{LNG} : LNG Price($/MMBtu) HH : Henry Hub Price($/MMBtu), (A =constant, B=Liquefaction fee) (Merchant Contract : FOB)

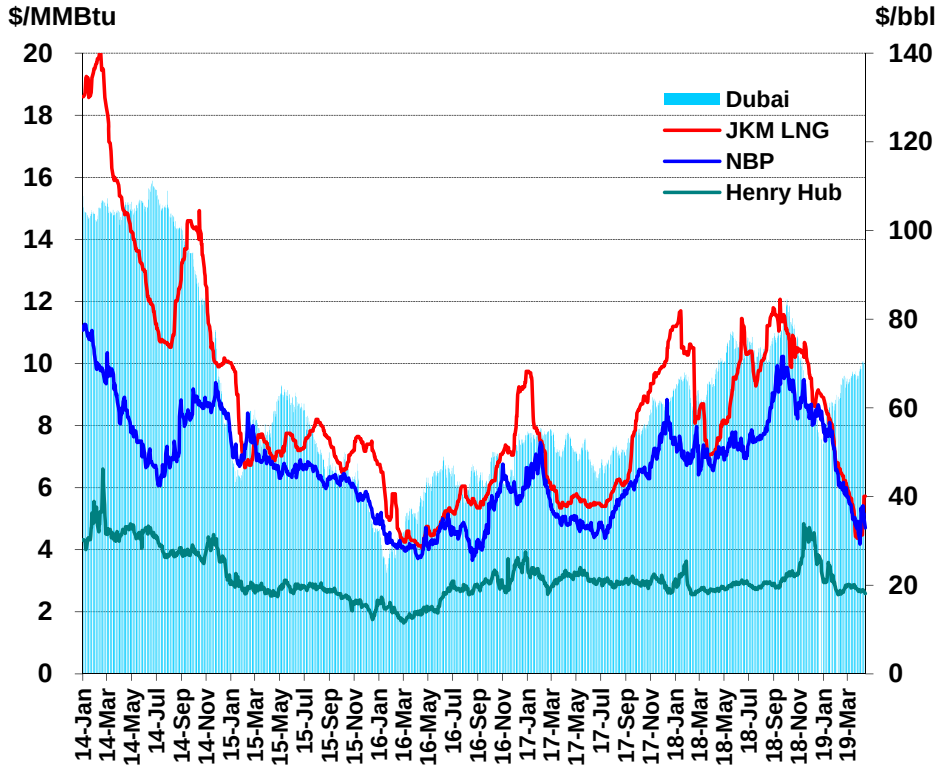
Sustaining Gas Price Stabilization

- Flexible US LNG will have an important impact on global pricing dynamics
  - Global price convergence: US LNG tends to flow to the highest price market on a netback basis
  - Reduced LNG spot price volatility: US LNG increases the volume of flexible gas to respond to fluctuation in global spot prices, dampening volatility

<Regional gas long-term prices>



<Regional gas spot prices>



Sources: IGU (2018)

3. Impacts of the U.S Shale Gas Development on the Northeast Asian Gas Market

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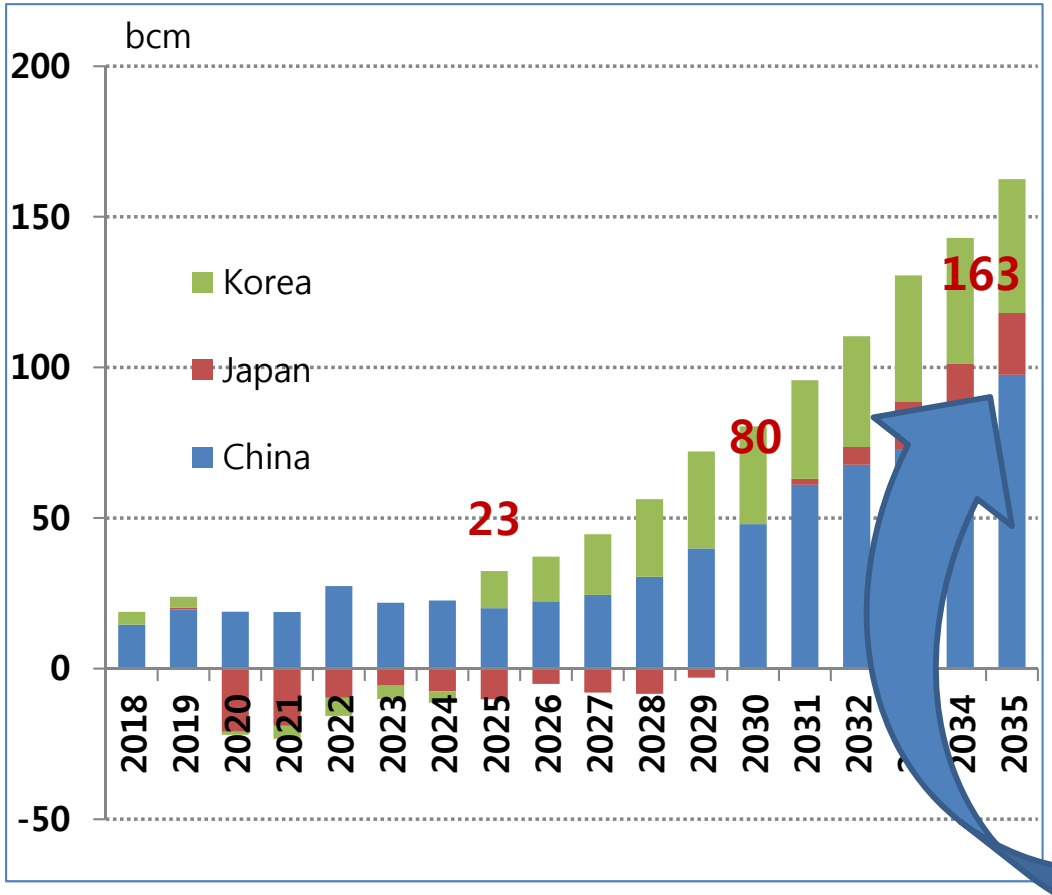
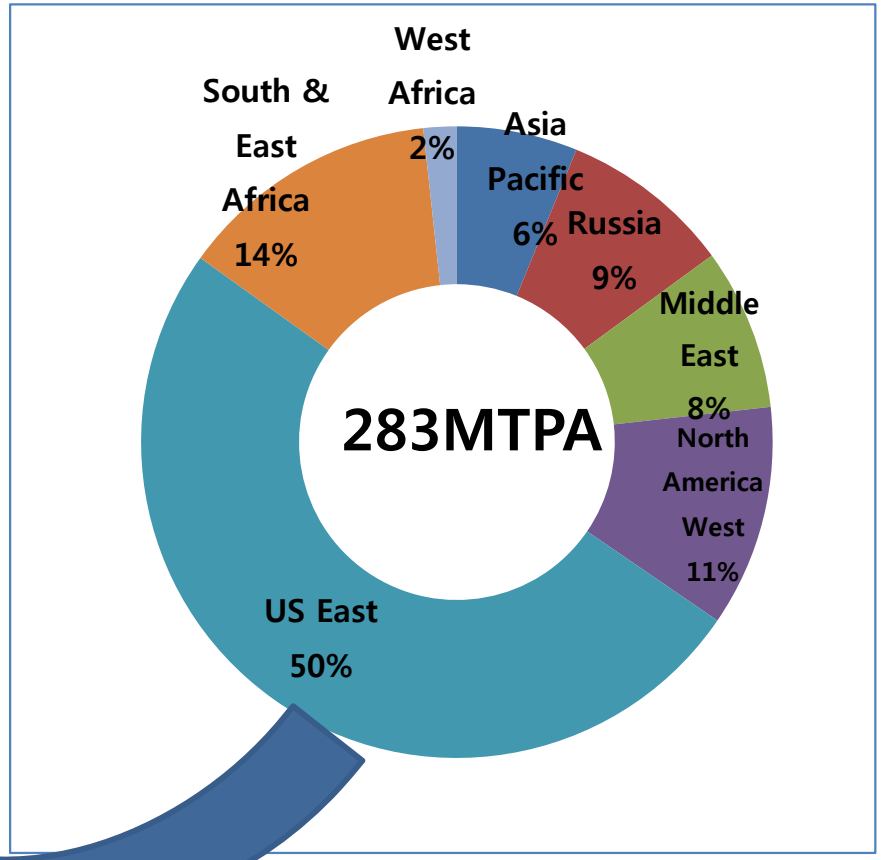
Improving NEA's Energy Security

- Northeast Asia need to stably procure large volumes of natural gas given its rapid demand increase. US LNG makes it easier for NEA to secure gas it needs

<Need to Secure Gas in Northeast Asia>



<Possible LNG projects (2023~2028)>

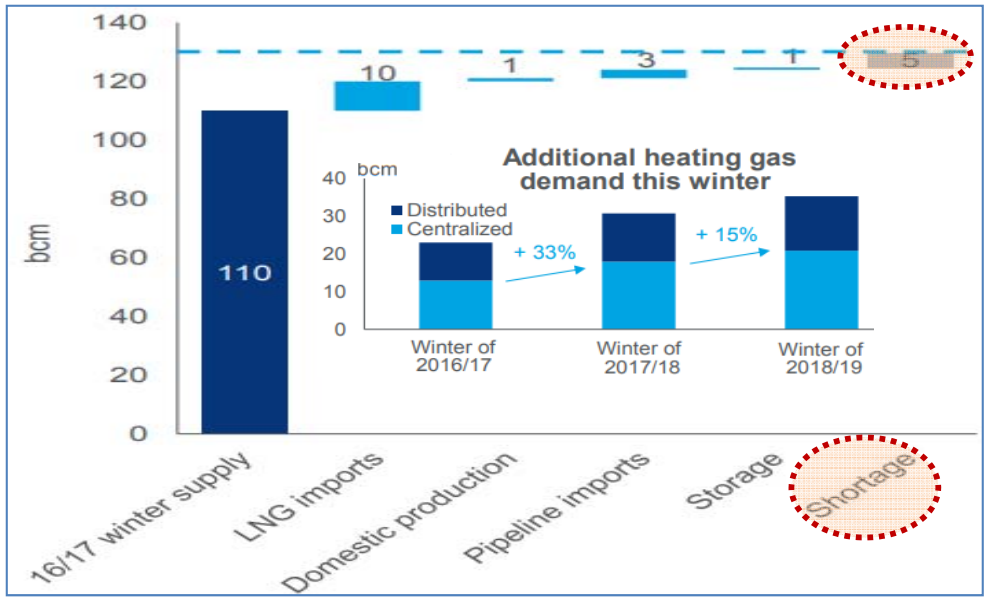


Source: WoodMackenzie (2018)

Enhancing Response to Short-term Gas Demand Volatility

- Northeast Asia need to prepare for spike in short-term gas demand stemming from market uncertainty, and increased demand fluctuations during winter season
  - China: experienced shortage in winter when its Energy Transition Policy was fully implemented, which can be recurring
  - Japan: any disruption to the planned resumption of nuclear power plant's operations can lead to a sudden increase in short-term gas demand
  - Korea: gas demand for power generation under Korea's 13th Energy Plan increased significantly compared to the 12th plan, leading to greater gas demand uncertainty

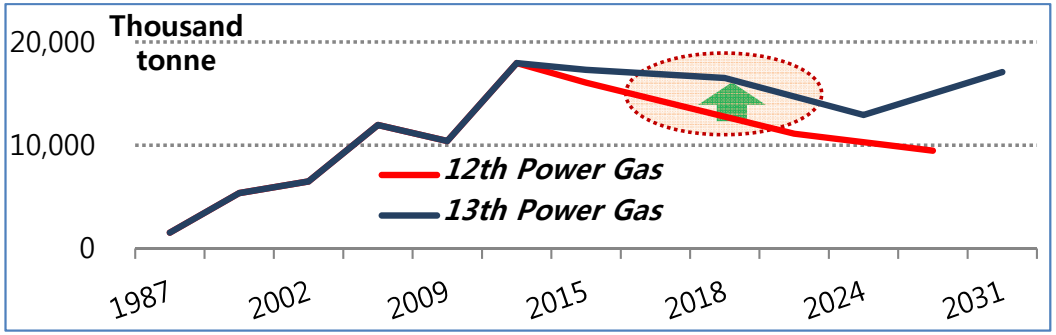
<Natural Gas Shortage Last Winter in China>



<Nuclear Plants Restart Schedule in Japan>

Plant Name	Company	Capacity	Status	Restart date	Likely fuel to be impacted
Genkai-3	Kyushu Electric	1,180	Planning to restart	Mar-18	Coal/gas
Genkai-4	Kyushu Electric	1,180	Planning to restart	Apr-18	Coal/gas
Ohi-3	Kansai Electric	1,180	Planning to restart	Jul-18	Oil/gas
Ohi-4	Kansai Electric	1,180	Planning to restart	Aug-18	Oil/gas
Shimane-2	Chugoku Electric	820	NRA safety inspection	Feb-19	Oil/gas
Onagawa-2	Tohoku Electric	825	NRA safety inspection	Apr-19	Oil/gas
Shimane-3	Chugoku Electric	1,373	Under construction	Jan-20	Oil/gas
Tomari-1	Hokkaido Electric	579	NRA safety inspection	Apr-20	Oil/gas
Tomari-2	Hokkaido Electric	579	NRA safety inspection	May-20	Oil/gas
Tomari-3	Hokkaido Electric	912	NRA safety inspection	Jan-21	Oil/gas

<Korean National Plan for Power Gas Demand>



Source: WoodMackenzie (2018), MOCIE (2017)

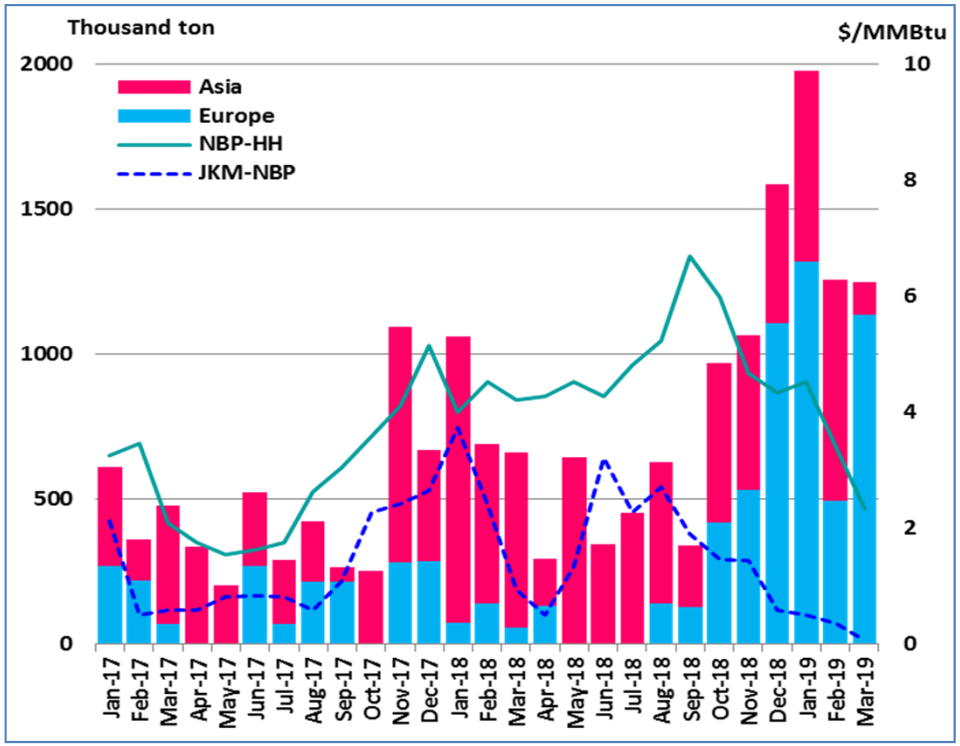
Increasing LNG Swap and Trading in NEA

- LNG Swap deal and trading is expected to activated , due to factors such as seasonal fluctuations in demand
  - A great majority of LNG trading in NEA are location swap transactions
  - In recent 3 years, location swap transactions take up less than 1% of the total LNG transactions made between Korea, China, and Japan
  - As US LNG trading with greater flexibility increases, the number of swing suppliers and location swap transactions is expected to rise significantly
  - Subsequently, NEA countries will have greater opportunities for cooperation in LNG trading due to the US LNG

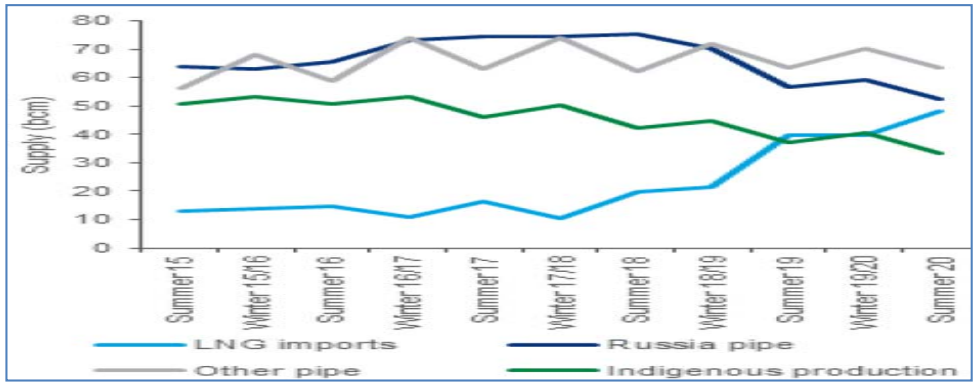
Intensifying Competition between Gas Supply Sources

- Competition among LNG projects targeting Northeast Asia as well as between LNG and Pipeline Gas projects would be intensified
  - Sustaining gas price stabilization at a low level deepens competition among new LNG projects
  - NEA & Europe gas price convergence suggests that a substantial volume of US LNG will be sent to Europe: driving Russian pipeline project into Northeast Asia
  - Russian pipeline project should secure considerable competitiveness compared to the time before US shale gas development

<US LNG export to Asia, Europe>



<Europe gas supply>



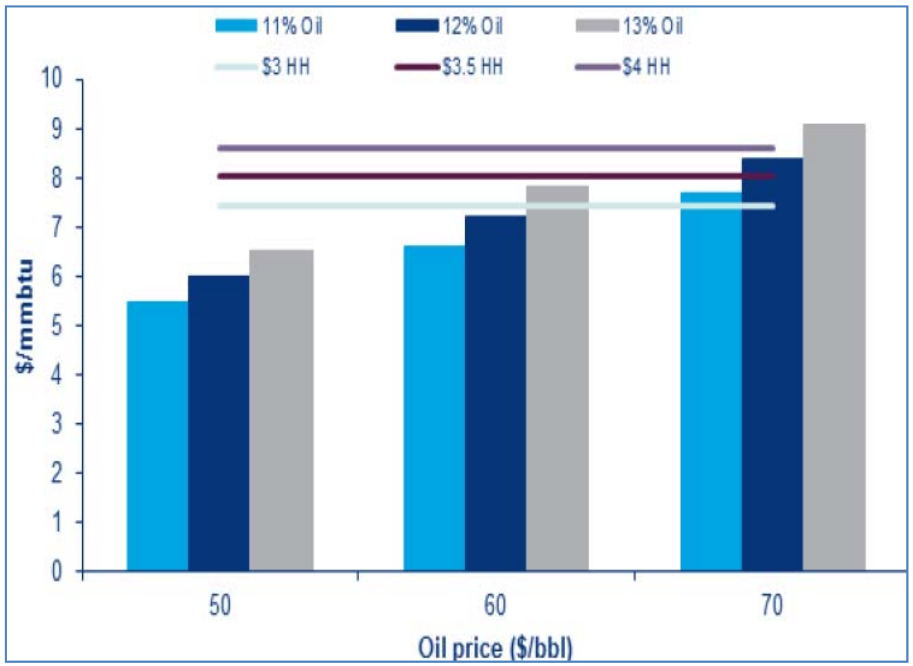
<Pipeline gas projects in NEA>

Source: Poten & Partners (2019)

Application of Various Gas Pricing Indices in NEA

- NEA is able to continue to connect with the global gas market without being isolated through the application of various price formulas of US LNG
  - It is likely to be possible to apply various gas pricing schemes such as HH, NBP, and Hybrid to US LNG
  - This allows buyers complete destination flexibility to respond to prevailing global spot price signals in NEA
  - Ultimately, a market-indexed pricing system should be established, which reflects demand and supply in the NEA gas market

<Indexation: Oil vs. Henry Hub>

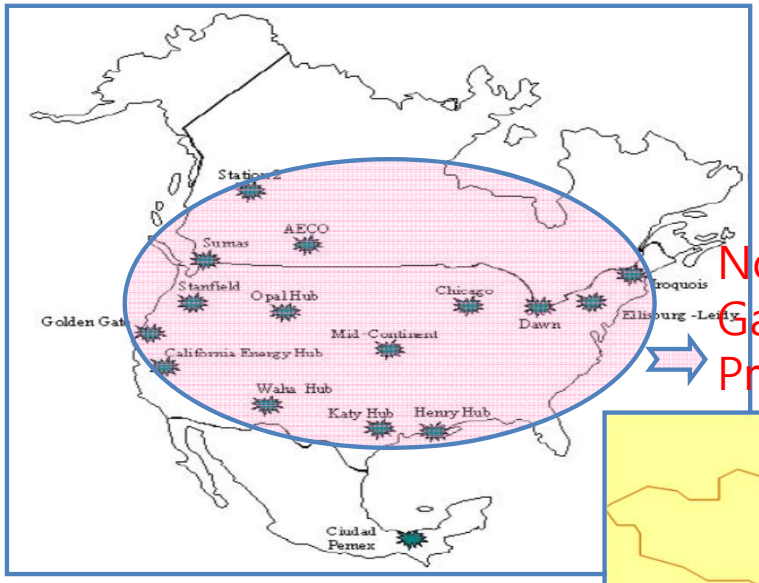


Source: WoodMackenzie (2018)

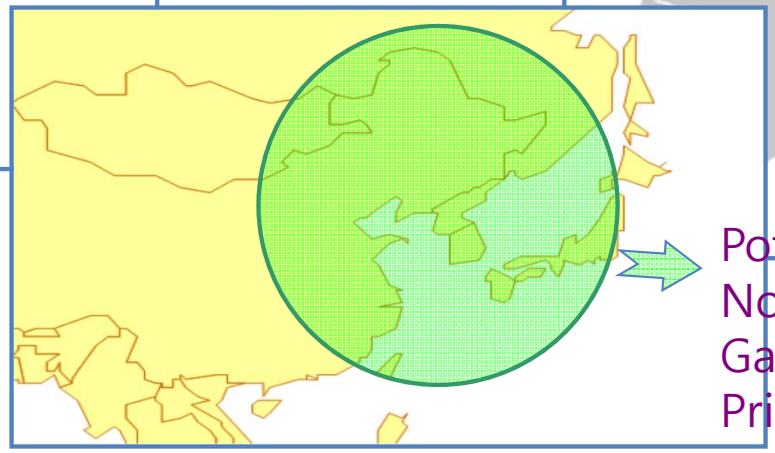
<Various proposed pricing formula>		
U.S. LNG	Case 1	$P_{LNG} = A \times HH + B$
	Case 2	Fixed-Price Contract
	Case 3	JKM Index Pricing
	Case 4	Coal Index Pricing
	Case 5	Brent-linked Pricing
	Case 6	Hybrid Pricing

Promoting the Gas Reference Price Index in NEA

- Developing gas price index reflecting demand and supply in NEA's market
  - Promote gas transactions in NEA by catalyzing LNG trading and increasing the connectivity of gas pipelines in the region
  - By doing so, development of a gas price index faithfully reflecting NEA's market situation will be facilitated
  - Subsequently, a gas trading hub will be formed in NEA, enabling the development and advancement of NEA's gas market through active gas transactions

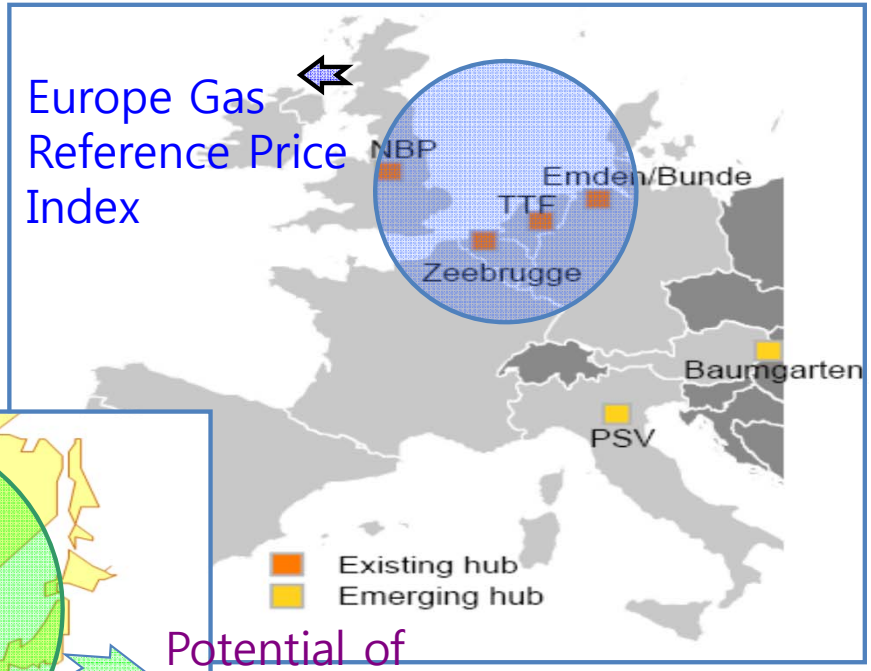


North America Gas Reference Price Index

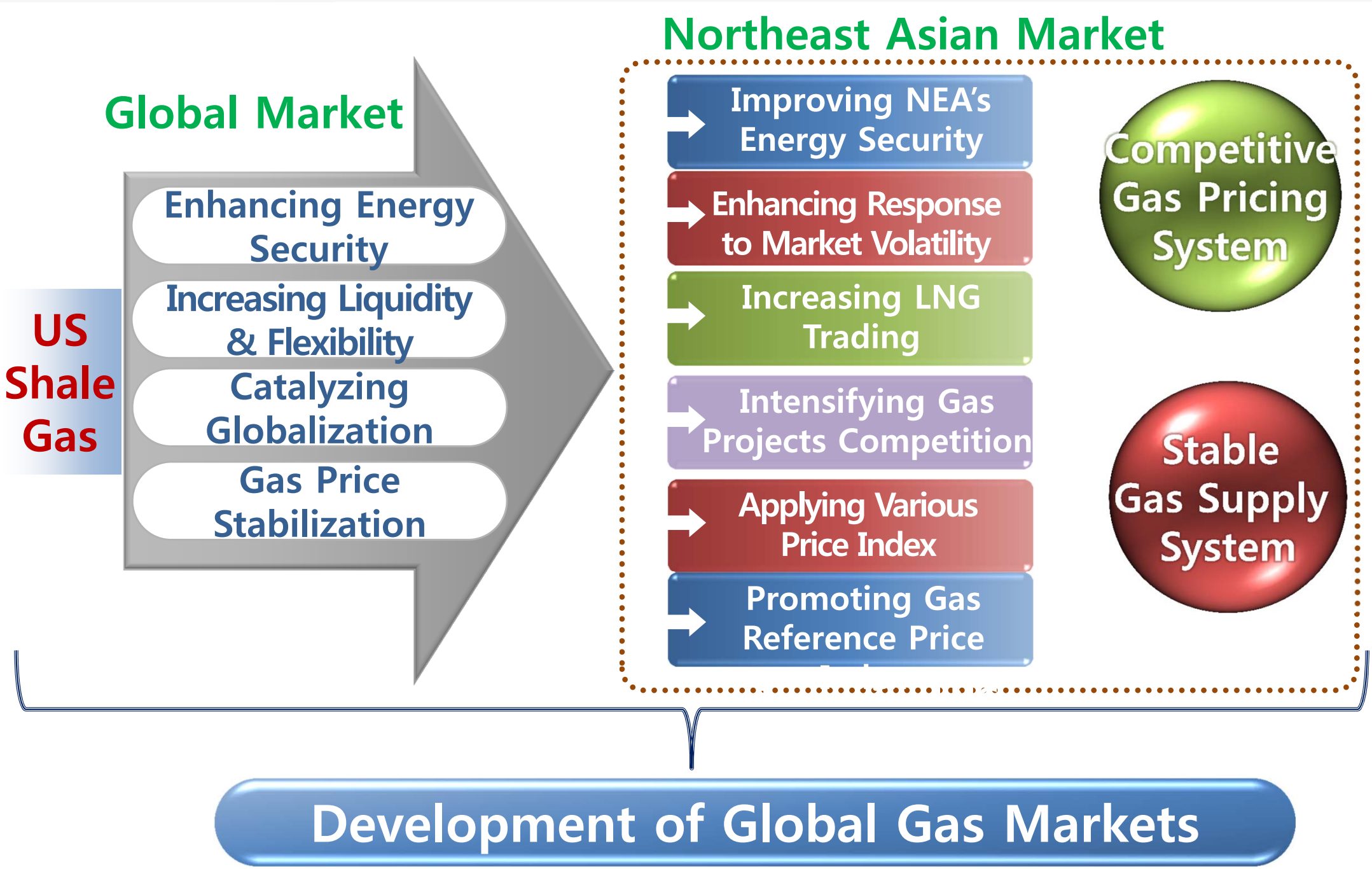


Potential of Northeast Asia Gas Reference Price Index

Europe Gas Reference Price Index



Conclusion


Global Market
US Shale Gas
Enhancing Energy Security
Increasing Liquidity & Flexibility
Catalyzing Globalization
Gas Price Stabilization
Northeast Asian Market
Improving NEA's Energy Security
Enhancing Response to Market Volatility
Increasing LNG Trading
Intensifying Gas Projects Competition
Applying Various Price Index
Promoting Gas Reference Price
Competitive Gas Pricing System
Stable Gas Supply System
Development of Global Gas Markets

Thank you

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