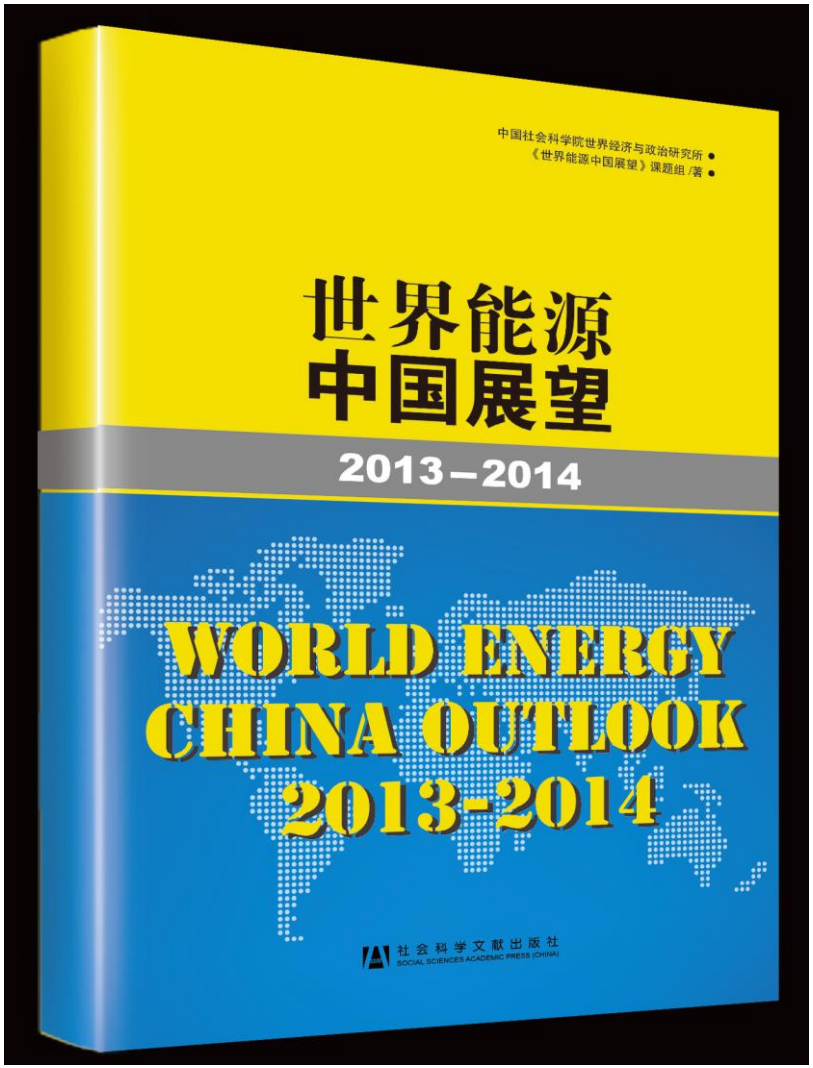

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World Energy China Outlook

Presentation

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Disclaimer

- This report in form of book is published in China in Chinese for the time being. The 2013-2014 edition is the first of its kind of researched report reflecting our insights, findings and methodology along with our database.
- This report will be produced annually by Xiaojie Xu led energy team at Institute of World Economics and Politics (IWEP) at Chinese Academy of Social Sciences (CASS).
- Please note that this is an independent annual outlook report.
- The issues in the report is calculated, analyzed, and included based on our best understanding and availability of sources. Not necessarily accurate and complete.
- Our findings, recommendations and data are ours rather than official ones
- Also, all views and data used in the report are not those of the IWEP or CASS or any other parties with which we have worked, official or unofficial.

Table of Content of the WECO

Before Main Findings

The Report Title:

- ***World Energy China Outlook*** *(WECO)*
- Existing outlooks concluded the same findings on China but failed to explain the country as a black swan

My Thoughts:

- Energy issues in and of China are world's, vice versa. This is very interesting times when we deal with demand/supply, im/exports, manufacturing, CO2 emission, and climate changes.
- A closer look at and interactive outlook on China is a must
- I decided to start with report last year. This report remains the very first of its kind in China in spite of some issues and drawbacks.

Before Main Findings

Our Approach

- Our research and review emphasize energy policy and its role in energy developments with a set of assumptions on population, economics, market competition and technology innovations.
- We take IEA World Energy Outlook as a comparative case in 2013 edition. IEA's New Policy Scenario is its central scenario. However, its NPS on China is not fully developed yet. Therefore, we decided to develop our own central policy scenario to back up our research and outlook within the same outlook period (2011-2035).
- Based on our observation and research on energy policy in China, we coined our own policy scenario as Eco-friendly Energy Strategy in the report.
- In order to have a better understanding of our approach, we have to revisit and review energy policy in China in little bit details.

Our Six Assumption

	Current Policy Scenario, IEA	Eco-Energy Strategy Scenario, IWEP
1. GDP	Global GDP growth rate 3.6% in 2011-2035 while China GDP 8.1% in 2011-2020, 5.7% in 5.7% in 2011-2035	**China GDP growth rate 7.2% in 2011-2020 (7.5% in 2013, 7.3% in 2014), 5-6% in 2020-2035**
2. Population	Worldwide: 7-8.7 billion from 2012 to 2035 with annual growth rate at 0.9%	**China: 1.354 bn in 2012, projected to be 1.44 bn with annual growth rate 0.77%. 1.47 bn in 2030 with annual rate 0.21%**
3. Energy Price	Oil: imported at $113/bbl in 2020 and $128/bbl in 2035. Gas price gap narrowed. Coal price remain lower than oil.	**China: oil product prices will be international. Domestic gas price will be reformed upward as benchmarking in Asia by 2018.**

Our Six Assumptions *continued*

	Current Policy Scenario, IEA	Eco-Energy Strategy Scenario, IWEP
4. Subsidies	Fossil fuel subsidies will be diminished in at least 10 years	**Such subsidies will be maintained, esp. for new renewables, agriculture sector.**
5. CO2 Emissions	Global: CO2 emission will increase 34% by 2035 from 8% in 2012. If carbon marketing initiated in all sector, carbon price could $30 per ton in 2035 from $10/ton in 2020.	**In China, carbon emission will be reduced by reducing coal and smart use before 2020; Chinese target 45% reduction of emission is subject to energy efficiency and CCS after 2020. carbon tax could be optional and net benefited than carbon marketing.**
6. Technology	Technology in use or under development will be cost effective in association of energy supply and demand	**Technology innovation presents huge potential in China, esp. clean coal, energy efficiency and CCS will be expanded wider afterwards. Therefore, outcome of energy saving and emission will outstrip those envisioned by the IEA.**

Our Assumptions – GDP, Population and Urbanization

	IEA NPS		IWEP EES	
	2011-2015	2011-2035	**2011-15**	**2011-35**
GDP Growth	3.6%	4%	**7.4%**	**5.7%**
GDP per capita	2.2%	2.2%	**7%以上**	**5.4%**
Population	1.1%	0.9%	**0.72%**	**0.4%－0.45%**
Urbanization	51%（2012年）	61%（2035年）	**55%**	**65%－70%**

Chinese new four drives campaign

Assumptions - Pricing

	2012	2020 IEA	2035 IEA	2020 IWEP	2035 IWEP
Oil $/bbl	100+	113	128	**120**	**130**
Gas NA, $/MMBTU	2-3	5	7	**5**	**7**
Gas EU, $/MMBTU	12	12	13	**12**	**13**
Japan LNG, $/MMBTU	17	16	15	**15**	**14**
China LNG, $/MMBTU	4	8	12	**10**	**13**
Coal, $/ton	99	106	110	**106**	**110**
Carbon, $/ton	10	33	40		

Energy efficiency, energy productivity, wastes generation, trading and investments are fully calculated.

Assumptions – 10 sets of technologies

	Global	China	Forward Looking
Clean Coal	Coal chemical and coal power integration	Clean coal tech spread around 2020, coal2gas under development	Cost reduction and water solutions to be explored
Unconventional Drilling	US, Poland, Australia, etc.	Development approach toward tight gas, CBM and shale. Unconventional rate will be upward to 67% in 2020	Comprehensive solutions dealing with uncertainties in geology, technology, infrastructure and regulations
Deep Water	Deep and ultra-deep water E&P activities and produce 200 Mt in 2020	Moving to deep water for production 50 Mt in 2020	Further openness and technology & equipment innovation
Renewable electricity	Solar PV capacity grow at 42% while wind capacity grow at 27%	Solar and wind power sector are under restructuring for higher increases	Cost effectiveness and policy supports are required。
Nuclear	Nuclear plants are under review and re-start. 15-20 nuclear plants could be restored, Nuclear power could account for 15%.	Currently, 17 nuclear plants under operations, 30 more plants are planned.	Benchmarking pricing and safety & security, plus public awareness
CCS	13 large CCS pilot projects are under operation or construction	CCS is listed into state 5-year energy Hi-tech planning	Enhance financing and policy supports, increase pilot projects in line with carbon marketing campaign
Bio energy	Enhance policy supports and further investment dealing with over investments	Promoting bio energy diversification (fuel, power, gas) fitting local requirements	Provide policy incentives to build up confidence and promote R&D while promote international cooperation
HEV/EV	HEV/EV sale increase sharply for better future	Working on HEV technical routes and standards and promote in major cities in 2015	Further reduce battery life and costs, plus logistics。
Energy Efficiency	Majority of consumers released incentive and policy	Efficiency is developed in details	Diminishing obstacles
Environmental		Release further development energy saving and environmental protection proposals in August 2013	Take energy saving as a new life style by launching “new energy, new life” campaign

Assumptions – Extensive dimensions of policy

	IEA's NPS	IWEP's EES
Energy sector trends	Further development in the energy sector will be witnessed by 2025 and then slow down for structural balancing	**Structural reform is gaining momentum in the late 12th Five Year Plan. Gas and renewables will be stressed while pushing internationalization**
Policy priorities	CO2 reduced 40-45% by the end of 2020, carbon marketization	**Energy policy will be adjusted to target demand growth and environmental concerns and good governance at home and abroad**
Public Policy dimensions	No discussion	**Public interests are calculated in principle.**

- Energy policy set by the government is by no means dominated by the state.
- Those national interests have to be in line with the public requirements, especially those growing expectations for clean and green energy, safety and health.
- Hence, transparency, accountability and social acceptance are required in the policy-making and policy execution. A type of "social license" is badly needed to all energy projects.

Main Findings

1. Polycentric Energy Supplies against Eastbound Demand Persist
2. Natural Gas and Renewables Are Stars of Neo-Energy Revolution
3. Eco-friendly Energy Strategy Repositions Energy Policy
4. China Enters the Age of Unconventional Gas
5. Renewables Are Subject to Market Competition and Technology Innovation
6. China's Energy Demand Is the Largest Variable of the World
7. Advanced Energy Mix in China Contributes to Curbing Global Climate Change Greatly
8. Enhanced Energy Efficiency is A Key to Softening China's Demand Growth
9. China Has to Build Up Global Energy Trading and Investment Systems
10. New Concept of Energy Security Is Envisioned to Dictate Its International Attitude, Responsibilities and Obligations to Good Governance
11. A Gas Price Baseline Could Be Benchmarked in 2020
12. Energy Policy Has to Deal With Uncertainties
13. Energy Policy Has to Be Adaptive to Changing Realities
14. Interactions Are Musts for Good Governance at Home and Abroad
15. Public Policy Interests To Be Served

Key Selected Findings

1. **Megatrends** – What is the future we are seeing today?
2. **Fundamental** – How to closely look at China energy D/S in the long run?
3. **Gas** – Golden age of gas or unconventional times witnessed in China?
4. **Renewables** – What is the future of renewables in China?
5. **Emission** – What outcomes could be possible in China?
6. **Dependency** – how to deal with energy imports?
7. **Security** – What type of energy security identified by the country?
8. **Interactions** – How to tackle with the rest of the world, bilaterally and multilaterally for good governance?

1. Megatrends

- We have to tackle a number of challenges facing us today. A new round of energy transformation is in need and has revealed brand new prospects:
  - (1) conventional patterns of energy utilization are about to be terminated;
  - (2) hydrocarbon fuels (coal, oil, gas) could co-exist instead of being replaced by one another continuously, being developed in favor of ecological and environmental protection and utilized in cleaner, more efficient, globally competitive manners;
  - (3) natural gas and renewable energy sources will be joining these forces to grow on the stage reflecting higher human expectations and environmental requirements around the world.

1. Megatrends

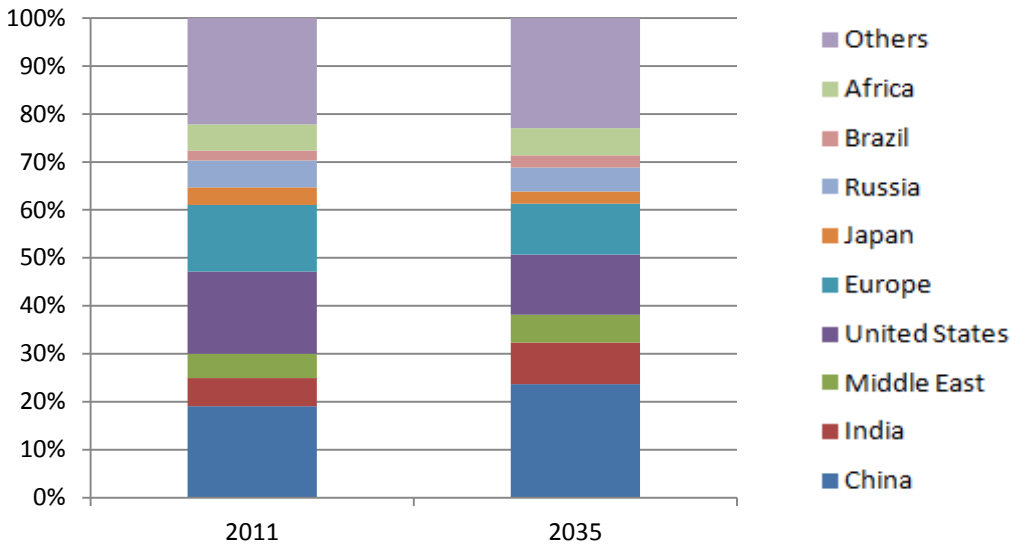
- We believe that the upcoming *Neo-Energy Revolution* would lead to unprecedented industrial innovation and transformations in thoughts, technology, and management and trigger a new round of de-carbonization on the ground.
- Every country has to live with the new expectations and explore a new development pattern through industrial innovation and systematic reforms.
- China is in the way to restructure its current energy strategy, policy and management system in the coming decade, launching a new round of Four Drives with wider and deeper implications at home and abroad.

1. Megatrends *continue…*

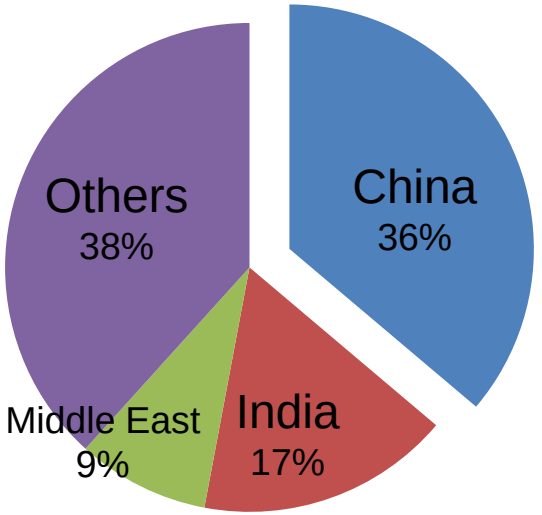
- The year 2013 has witnessed a continuous grand shift in energy demand towards the Eastern Hemisphere amid an economic slowdown in such emerging economies as China, India, the Middle East and African countries.
- Although *New Middle East* and *Energy Independence* in the U.S. is repositioning the growing importance of energy supply in North America, multiple sources from multiple supplying centers gain polycentric momentums in the energy world, such as, oil renaissance in Iraq, oil and gas exports from the Caspian Sea/Central Asia, gas discovery in East Africa, and upward production in the deep waters around the world in addition to the *New Middle East*. The landscape of world energy is featured by polycentric supplies against eastern bound movement in demand. Such a trend will continue for years to come.

China takes the lead in demand outlook

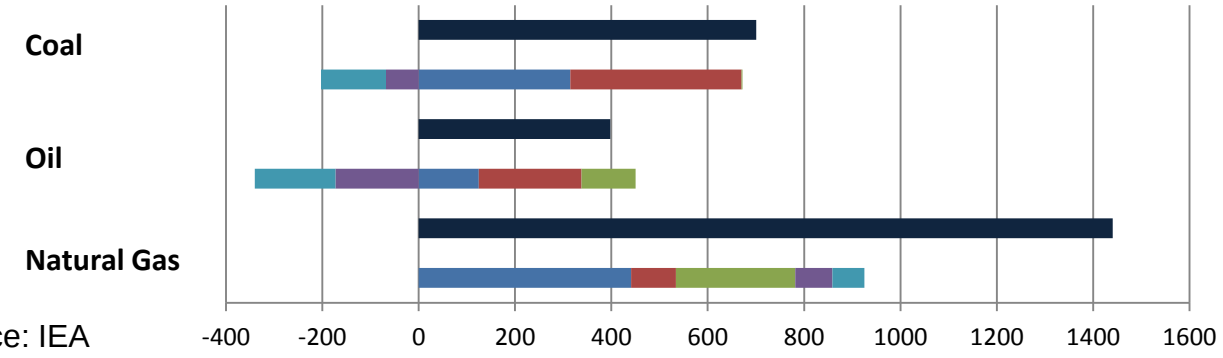
World Energy Demand by Region



World in Net Increase in Energy Demand, 2011-2035



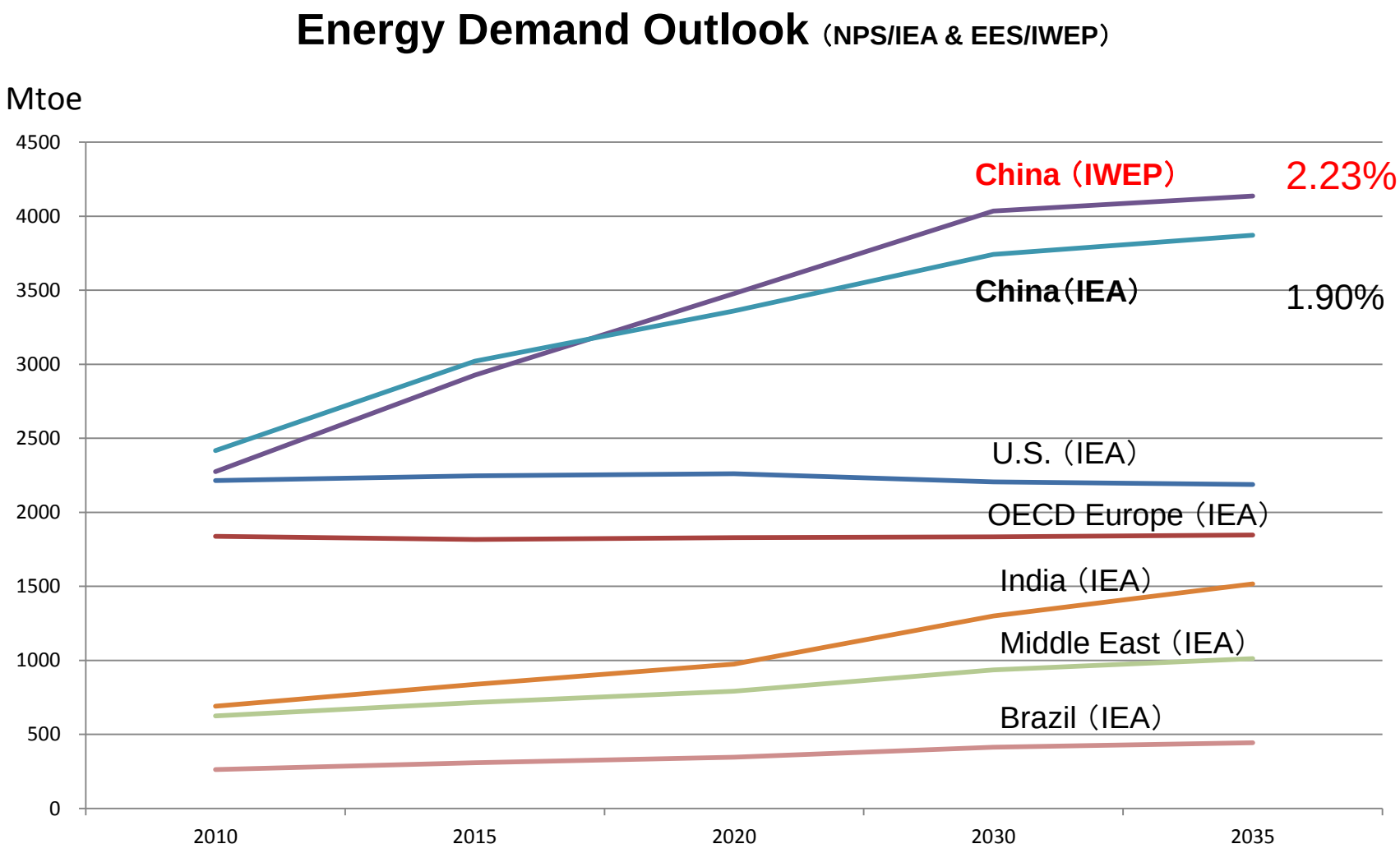
Change in Fossil Energy, 2011-2035



Mtoe

Source: IEA

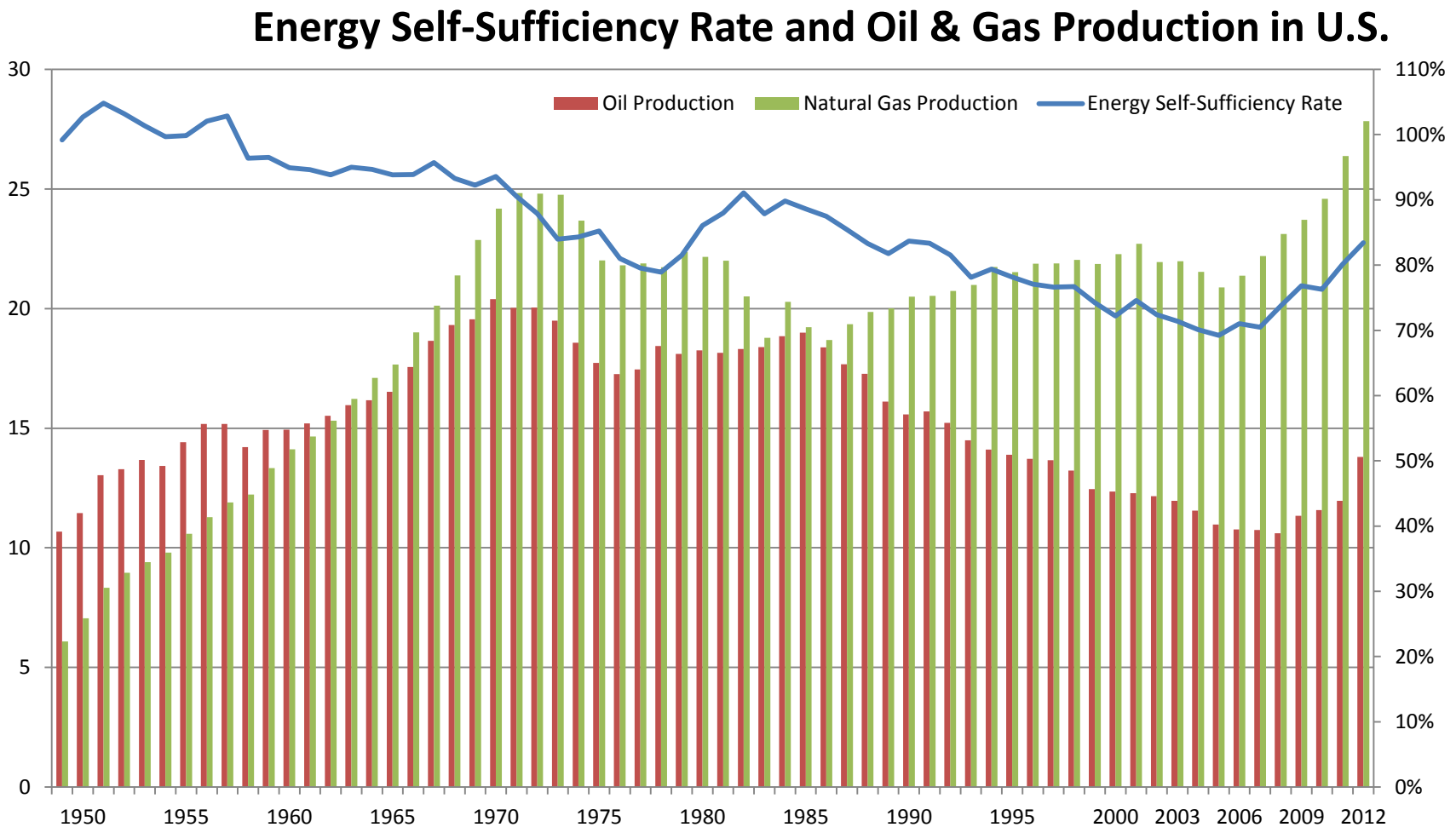
China is the *Middle East* of Demand



Sources: IEA, IWEP.

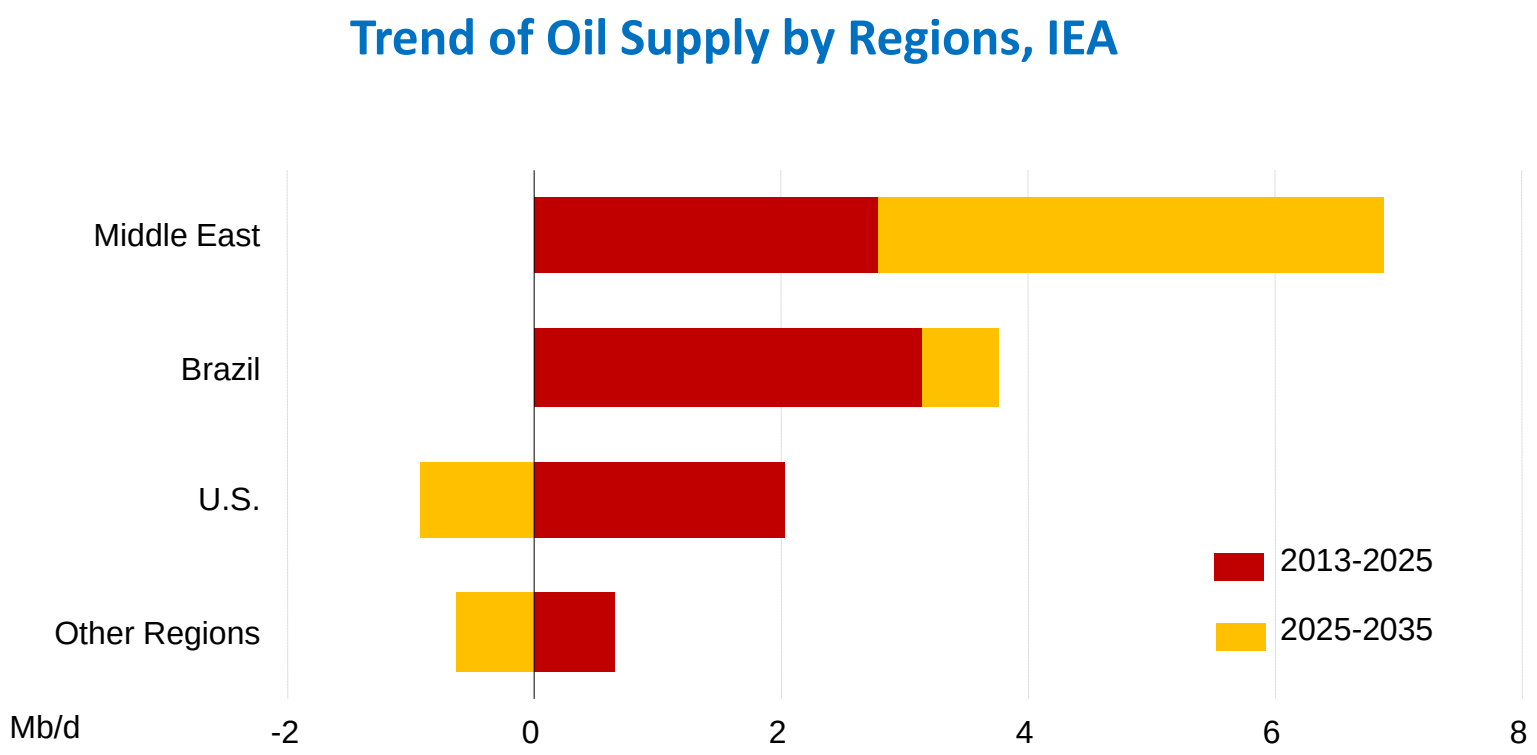
Eastbound Movement Is Obvious in Demand

North America will be a *"new Middle East"* in Supply



Unit: Quadrillion Btu; Source: EIA

The Middle East Remains the major sources of oil

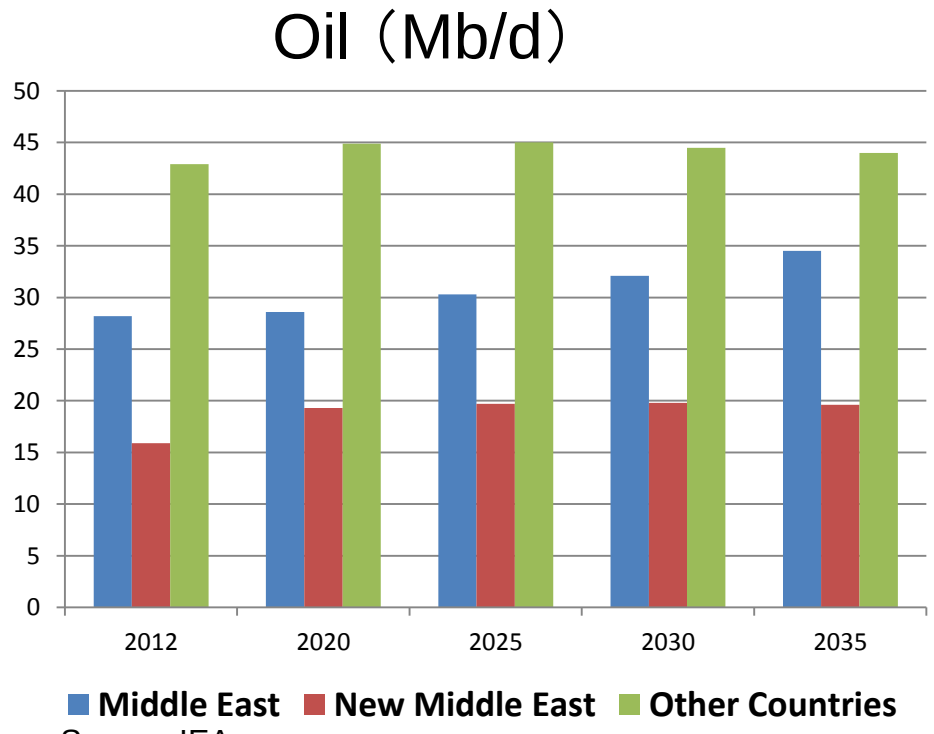


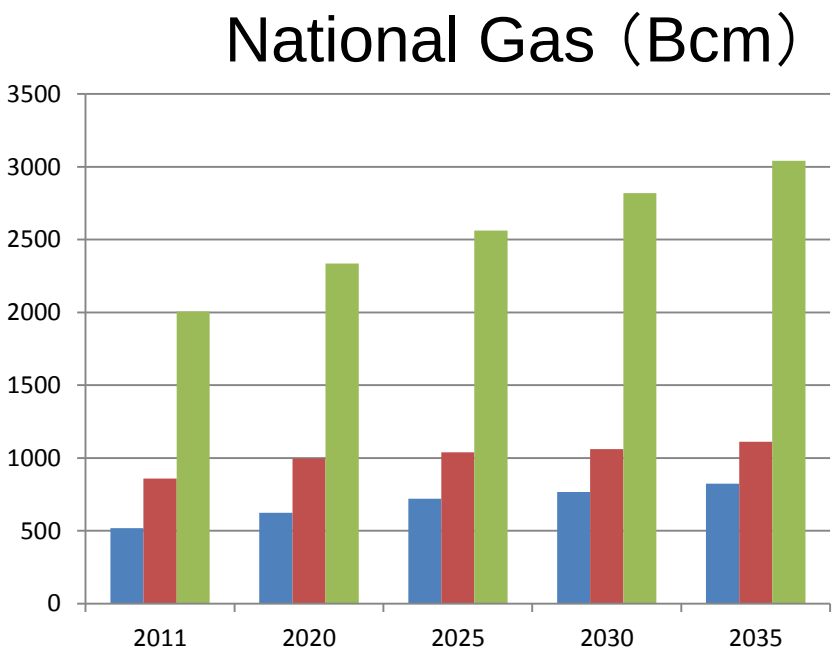
Oil production in U.S. (mainly tight oil) and Brazil (Deep-water) will increase until 2025. However, growth of world oil still depends on Middle East in the long run.

Source: IEA

World Energy Supply: *Three Middle Easts*

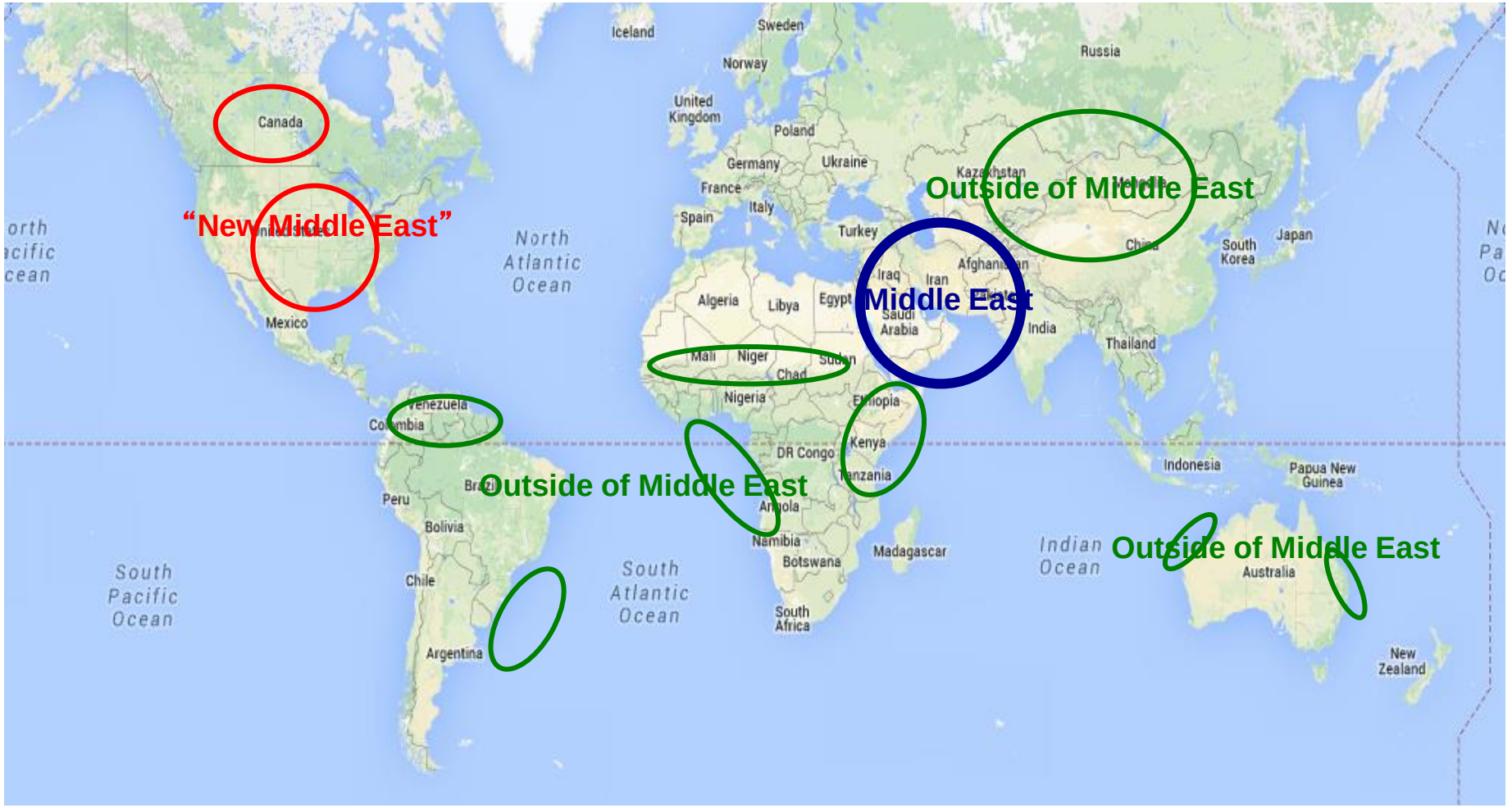
- Segmented world oil & gas supply…
- The Middle East, “New Middle East” and outside of Middle East



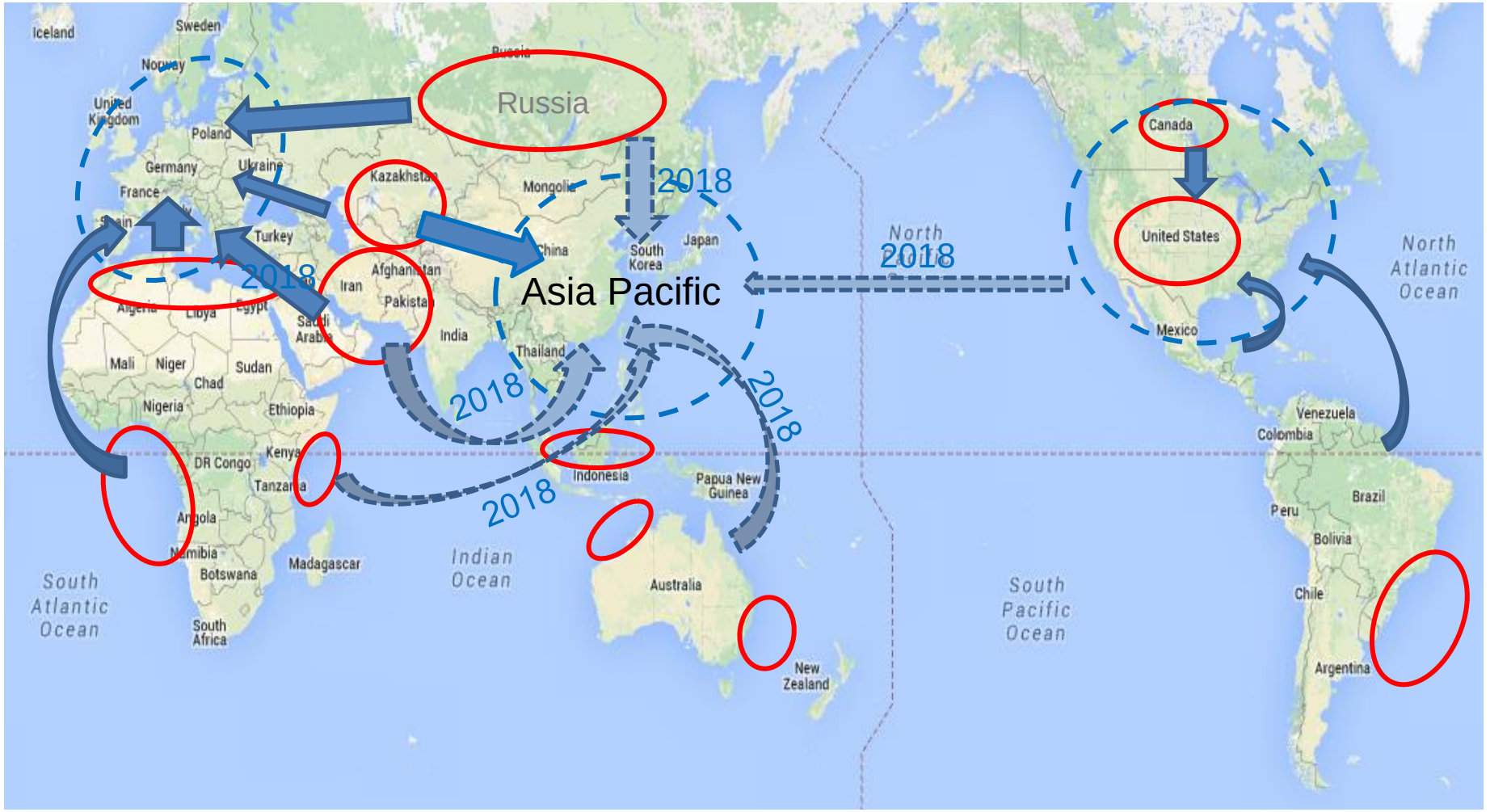


Source: IEA

Polycentric Supplies while eastbound demand



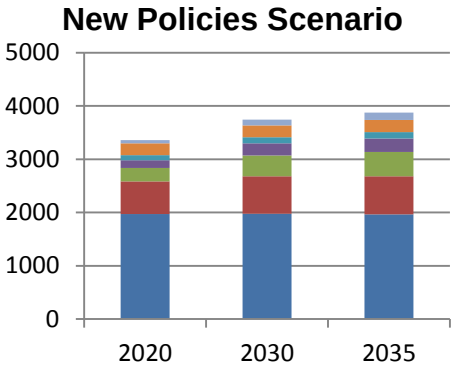
Polycentric Gas Supplies and New Trade Patterns

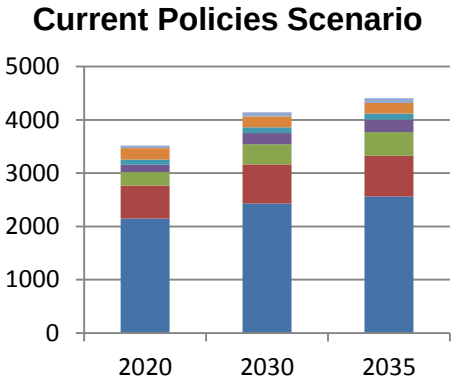


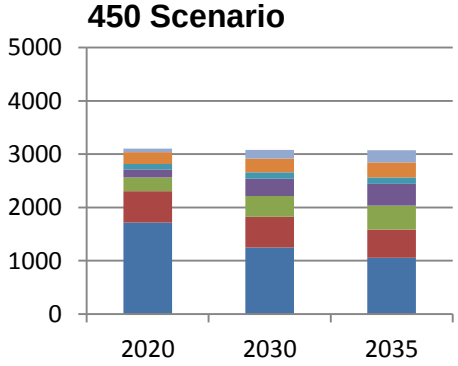
2. Demand

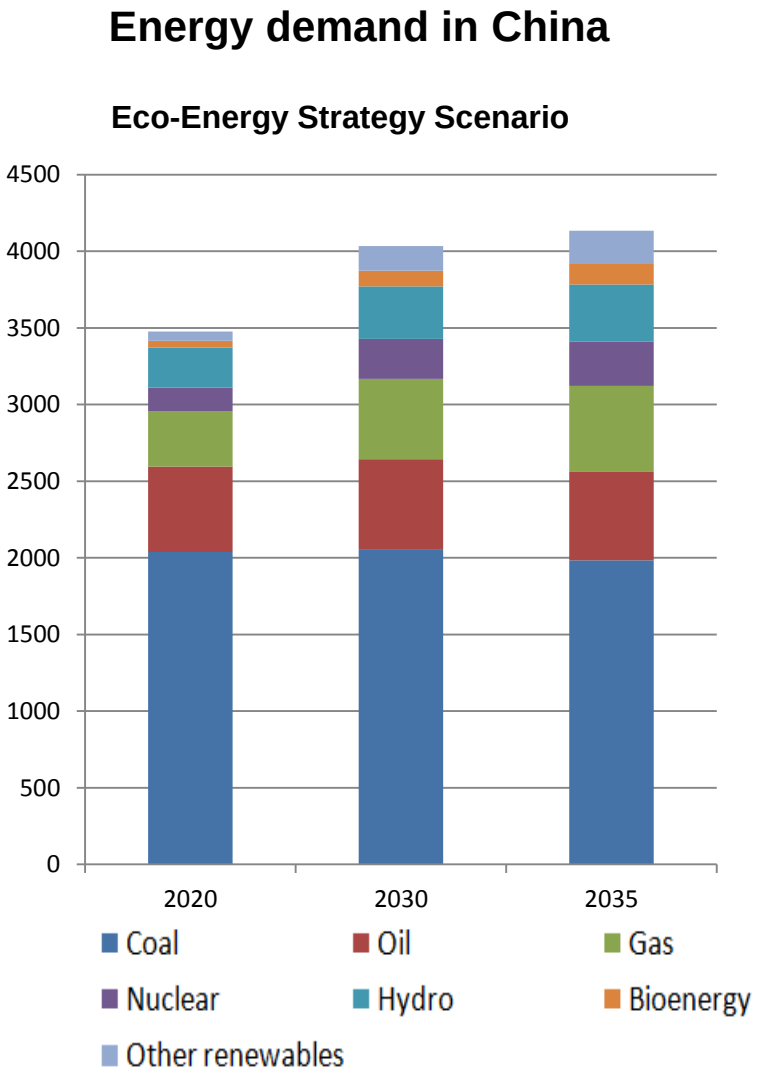
- Energy consumption in China will grow at rate of 2.23 percent in the outlook period (2011-2035), higher than the IEA's growth rate of 1.9 percent under its new policy scenario (CPS)
- Energy production in China will grow at 1.97 percent, higher than the IEA's growth rate of 1.4 percent.
- Consequently, China will be in a higher position leading the world energy growth, both in demand and supply at large. A greater impact on the world energy industry, world economy, and geopolitics will be widely felt onward worldwide, esp. in the course of its new four drives mentioned above.
- Energy Dependency in China and Energy Independency in the US have been collectively re-drawing the world energy system and landscape.

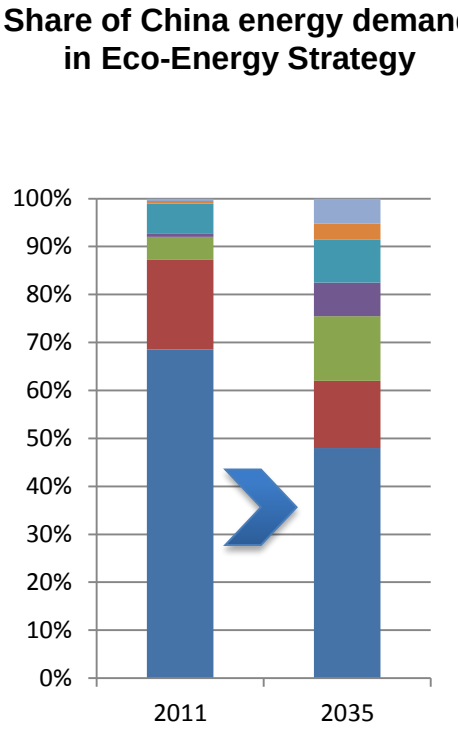
Coal reduction is key to curb demand in China







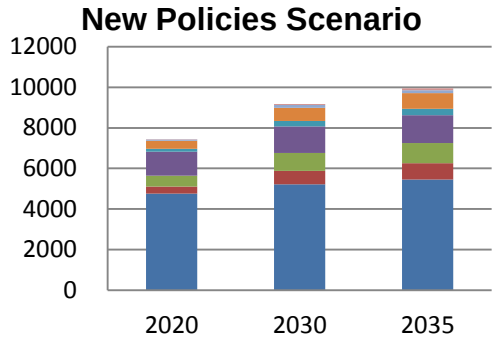


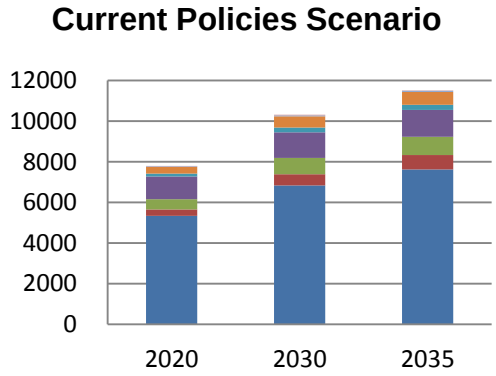


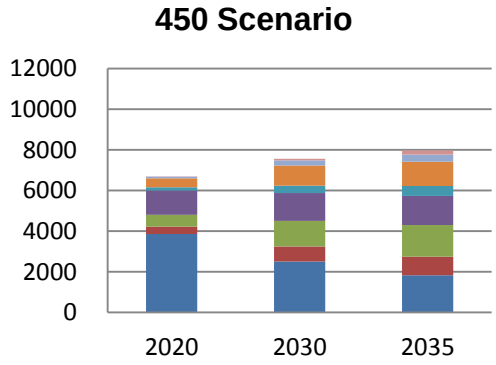
Unit: Mtoe
Sources: IEA; IWEP

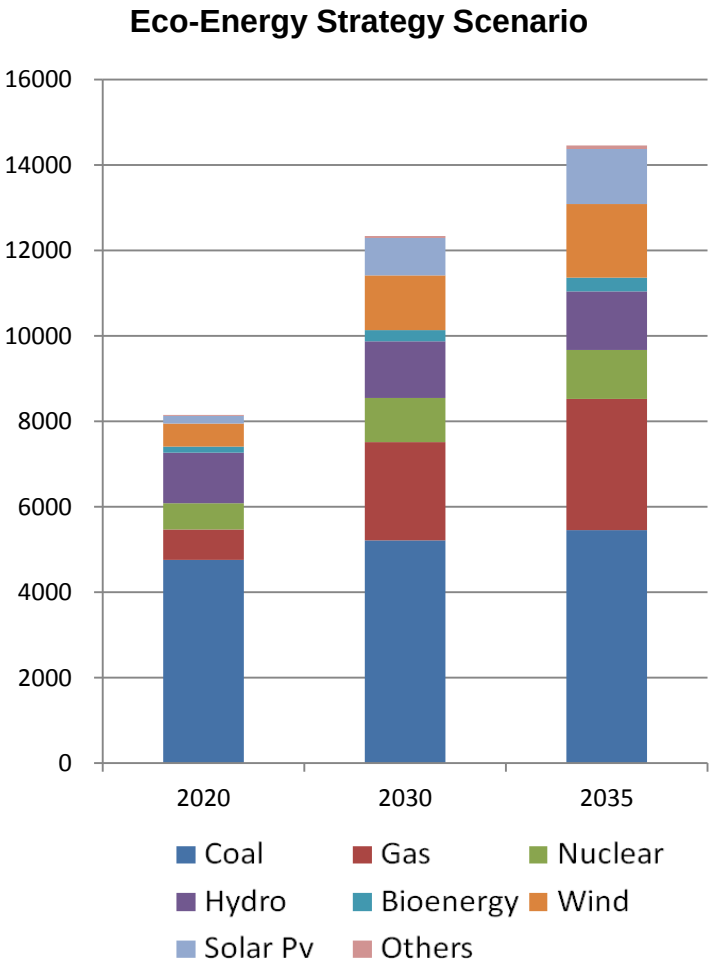
Optimizing Electricity Mix is one of core issues

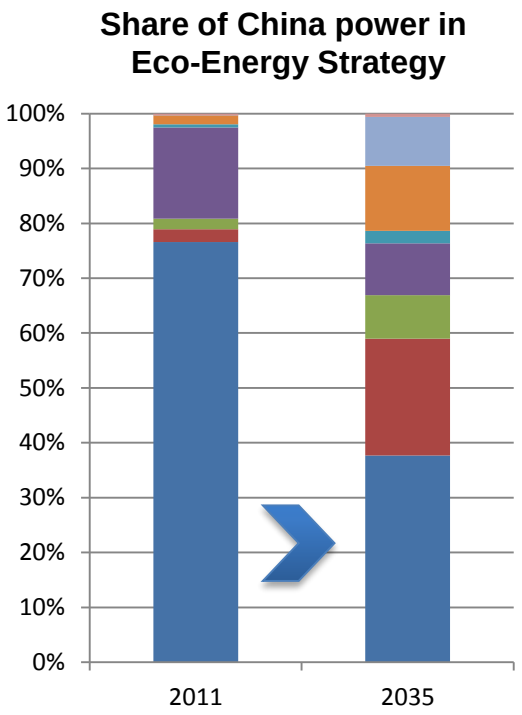
Power generation in China







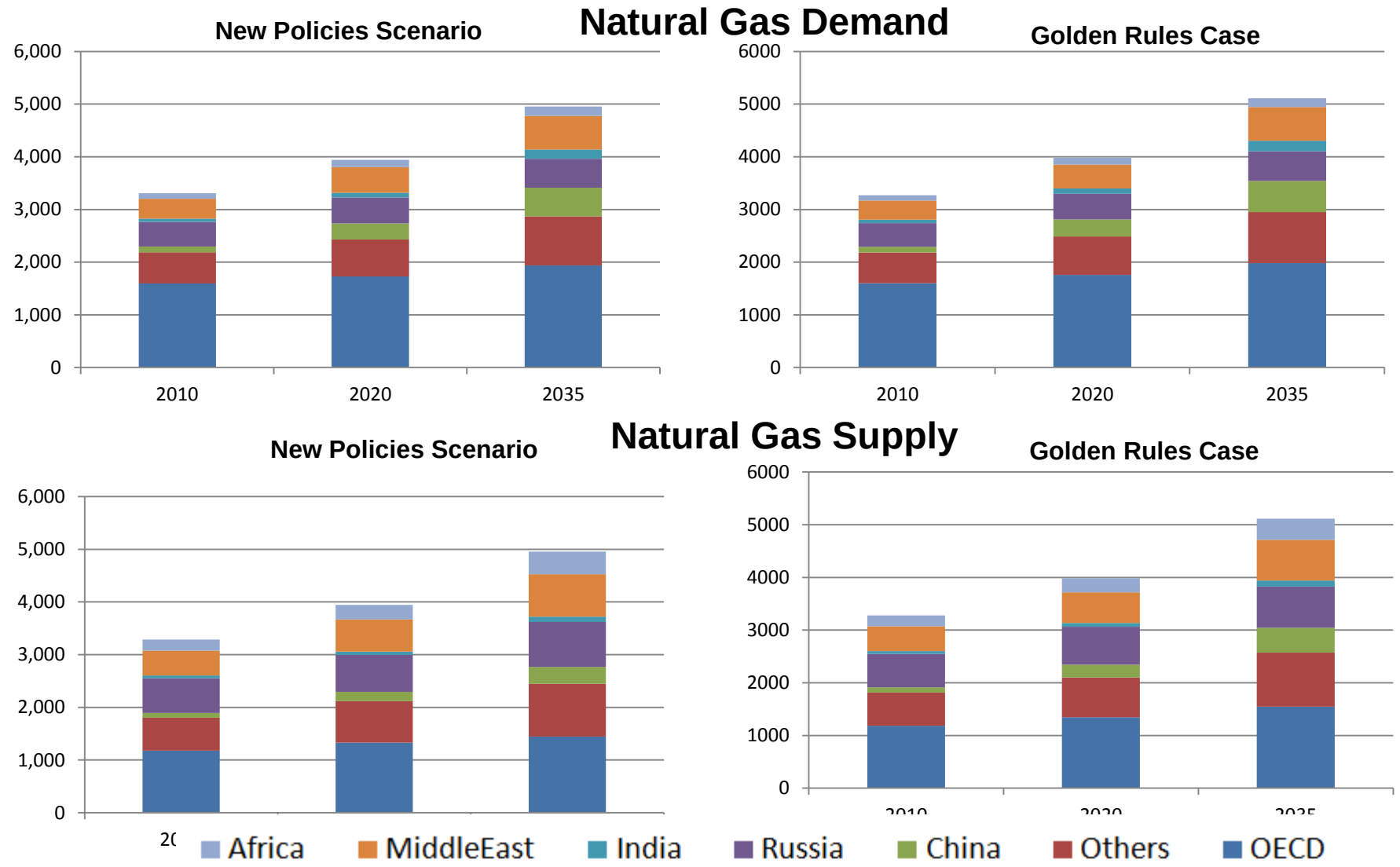




Unit: TWh
Sources: IEA; IWEP

3. Gas, we are approaching Golden Age of Gas

bcm

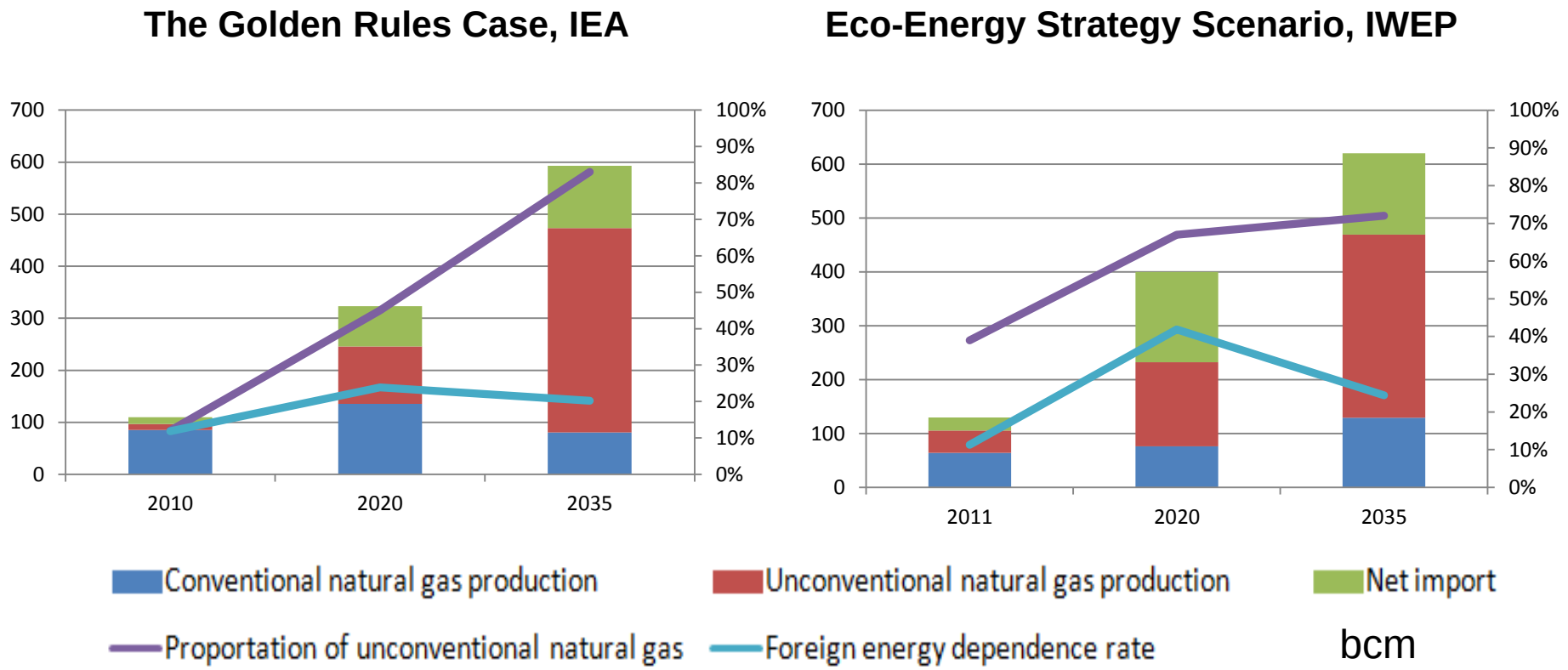


Source: IEA

China's Gas Profile

- We estimate natural gas demand in China in 2035 at 558 MTOE (620.4 bcm) under EES rather than 455 MTOE under IEA's NPS
- Natural gas sector in China is stepping into its Golden Age and will be so in the years after 2020, 2025 through 2035 featured by rapid increase in output. The key evidences behind the gas boom are: unconventional gas will be an engine of the increase in gas production into 2035 while conventional gas has reached its peak output in 2015-2020 and will witness its decline thereafter in our outlook period.
- Therefore, how to stimulate the sub-sector in China is critical to its hydrocarbon industry policy makers and could be an issue for its upcoming industrial reform, accordingly.

Gas Supply and Unconventional Rate



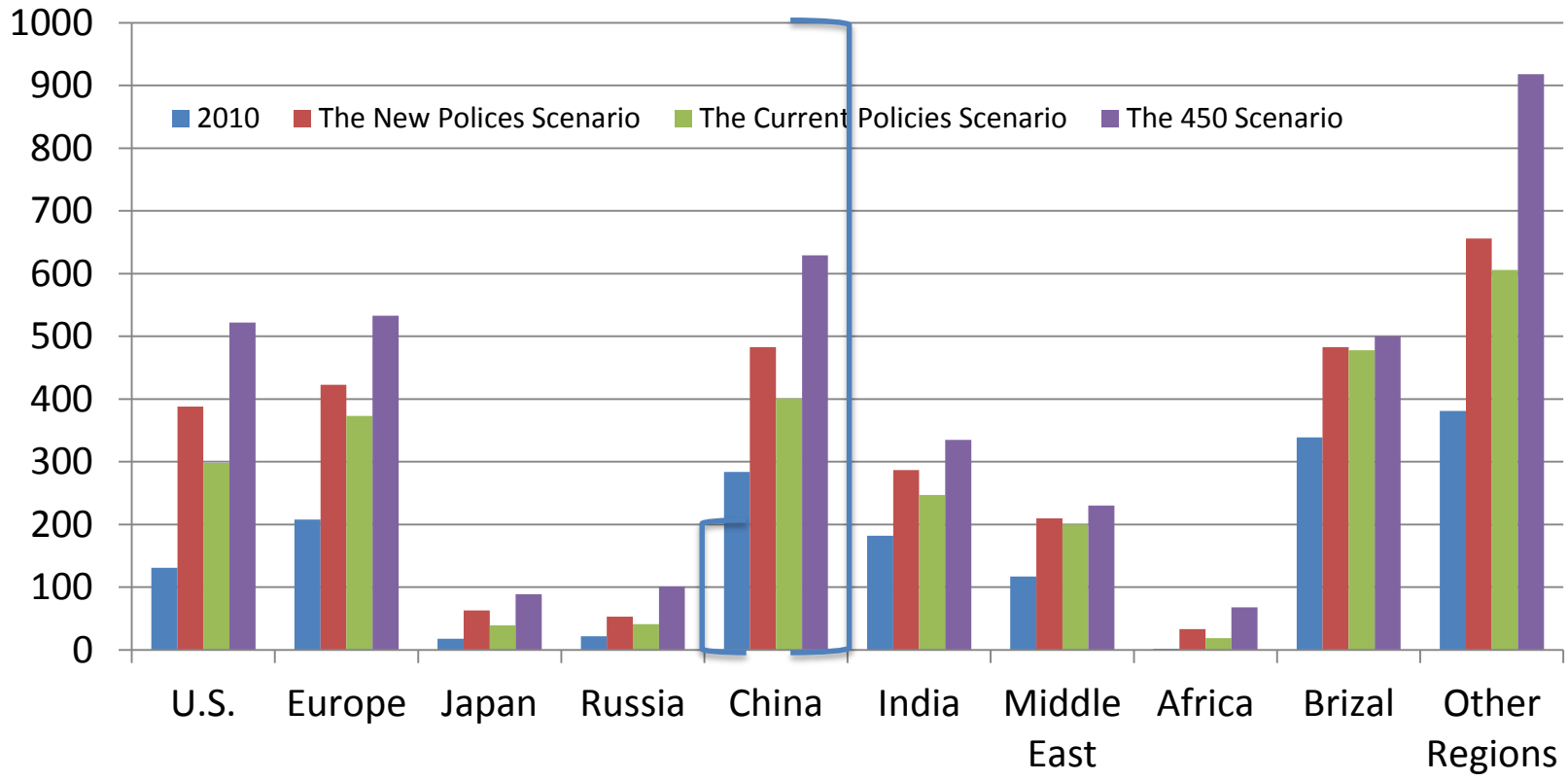
Source: IEA, IWEP

China's Gas Boom is Subject to Reform

- Shale gas production remains at its nascent time, although it has larger resources potential than that in the U.S. statistically. It is less possible to reach its said output targets 60-100 bcm by 2020 in China.
- No fast development could result any time soon. By contrast, tight gas and coal bed methane would take lead based on their sizable production combined and ever-enhanced technologies employed.
- There are a set of questions to be answered in terms of development pattern for the sub-sector, policy issues and environmental concerns over the possible unconventional gas boom.

4. Renewables

Renewable Energy Demand Growth by Region and Scenario, IEA

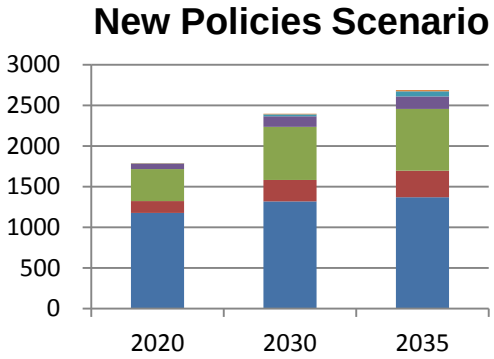


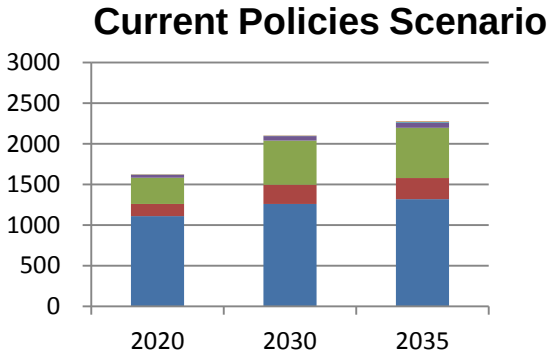
Source: IEA

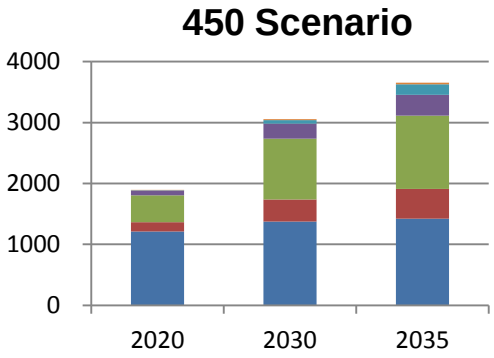
4. Renewables: 24.5 by 2020?

- We predict that non-fossil fuel energy demand in China will increase up to **15 percent in 2020 and 24.5 percent (higher than that of oil) in 2035 from current below 10 percent.**
- Hydro-energy will be growing steadily while nuclear energy will resume its momentum under strictest safety circumstances.
- New renewables (solar, wind and bio-energy combined) will gain their fastest growth momentum above 100 percent, as their current capacity at home remains small in its entirety.
- This trajectories are supported by renewables law in 2006, Five Year Plan in 2012 and four plans in details. Policy incentives are designed and applied.
- More importantly, a big market potential at home can be tapped if taking into account of A Plan for Actions against Atmosphere Pollution in 2013.

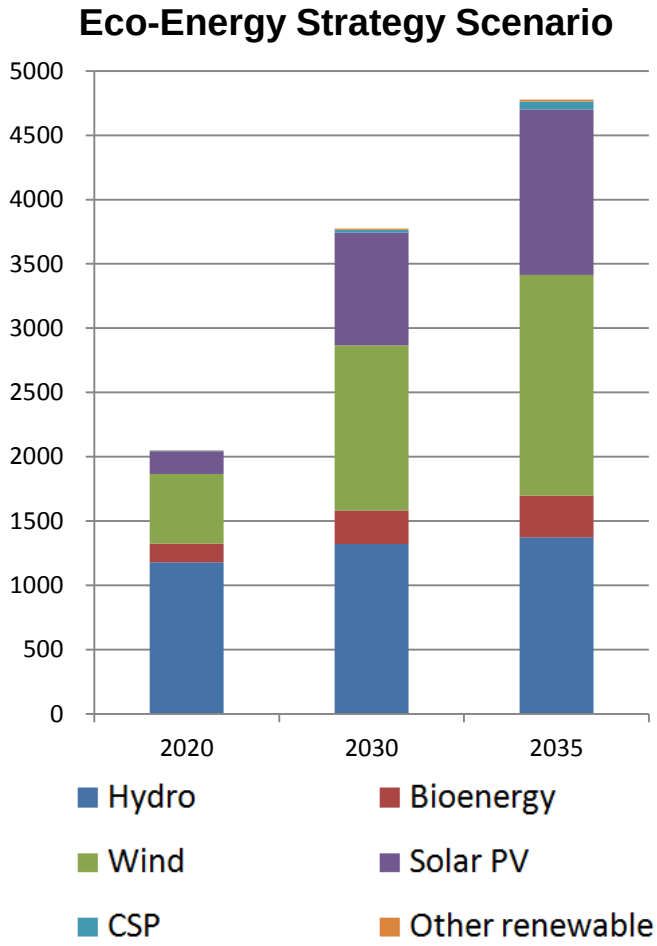
Electricity Generated by Renewables in China

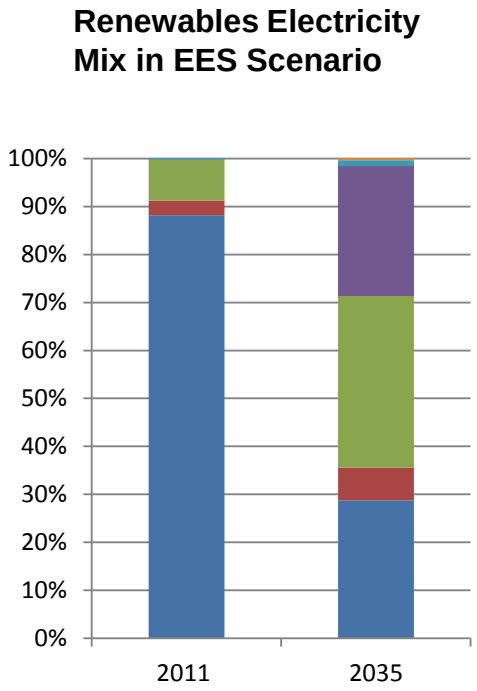






Outlook of power generated by renewables in China





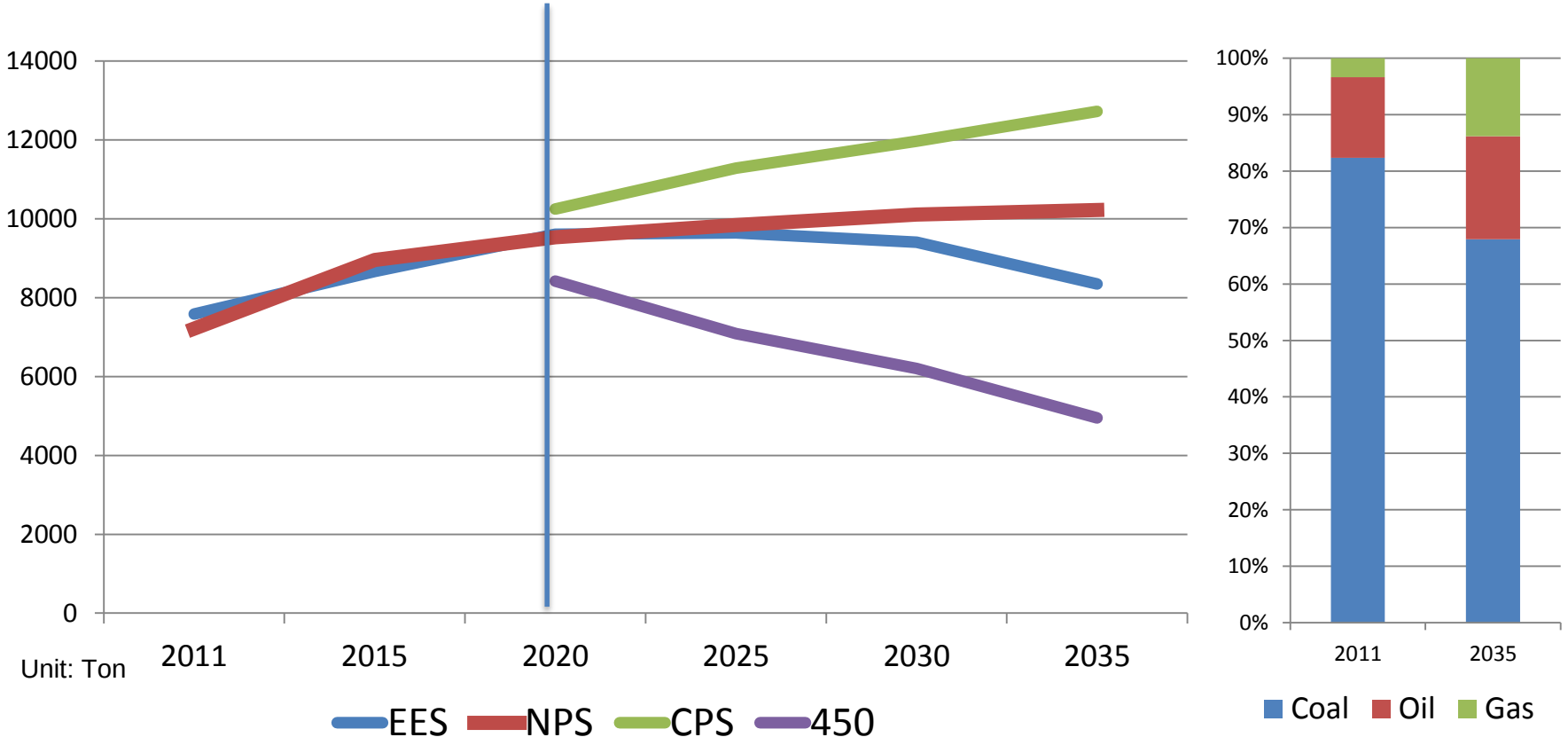
Unit: TWh
Sources: IEA; IWEP

5. Emission

- It is a fact that different types of energy mix lead to different impacts of carbon emission on the eco-system and global warming.
- The IEA's 450 scenario aims to curb global warming with temperature increase within 2 ° C while its NPS and CPS will come with results 3.6 ° C and 5.3 ° C temperature increase.
- Our EES is designed as a better scenario than the IEA's NPS but worse one than the 450 scenario. CO^2 emission growth from coal consumption in our outlook period will be negative 0.4 percent, at much lower rate than IEA NPS in both 2030 and 2035. As a result, Chinese contribution under the EES will obviously improve the environment and global warming concern within 2-4 ° C by 2050.

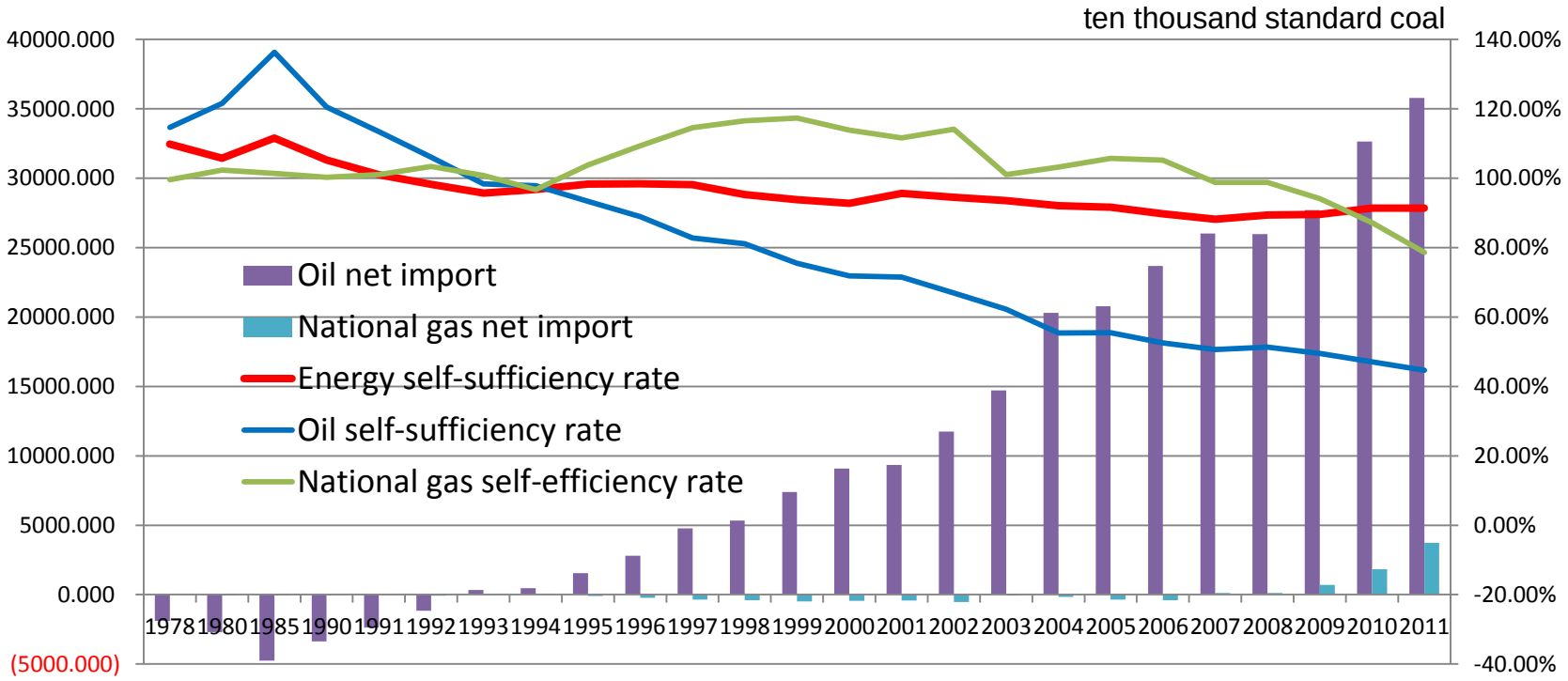
Scenario Comparison of CO2 Emission

Carbon Emission Outlook in China



Source: WECO-13, IWEP

6. Dependency/Self sufficiency



Source: National Bureau of Statistics, PRC

- China's foreign energy dependency will increase to 11 percent in 2015 and 26 percent in 2020 from current 9 percent, and could stabilized thereafter and possibly decline to 15 percent in 2035.
- Oil dependency will increase to 60 percent in 2015, 65 percent in 2030 and 68 percent in 2035 from the 55 percent in 2011 while foreign natural gas dependency will be 35 percent in 2015, 40 percent in 2020 before declining to 24 percent in 2035.
- All above-mentioned dependencies, lower than those by the IEA, will push the country to expand its energy outreach regionally and globally, and bilateral and multilateral.

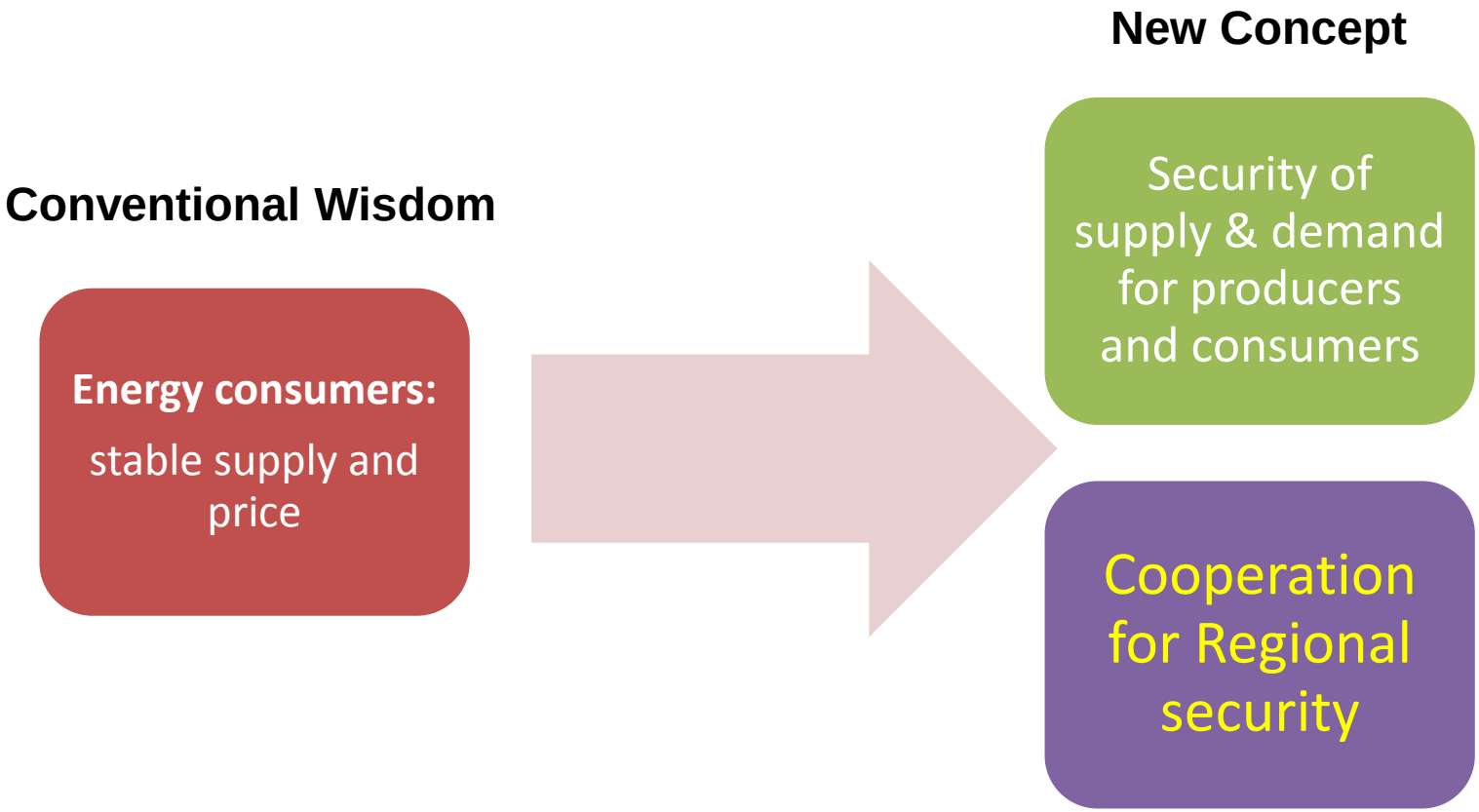
Strategic Measures to Address Dependency

- Enhance domestic supply, energy efficiency, energy saving, recycling, and productivity
- Going abroad for resources and win-win prospects under new campaign entitled Land Silk Road and Marine Silk Road
- Expand cooperation with developed world not only for resources and win-win but for best practices and better governance.
- Get ready to deal with existing issues and underlying issues, regionally and globally in terms of supply and demand management, investments and trading, risk management, and global issues such as climate changes

7. Energy Security, a special focus

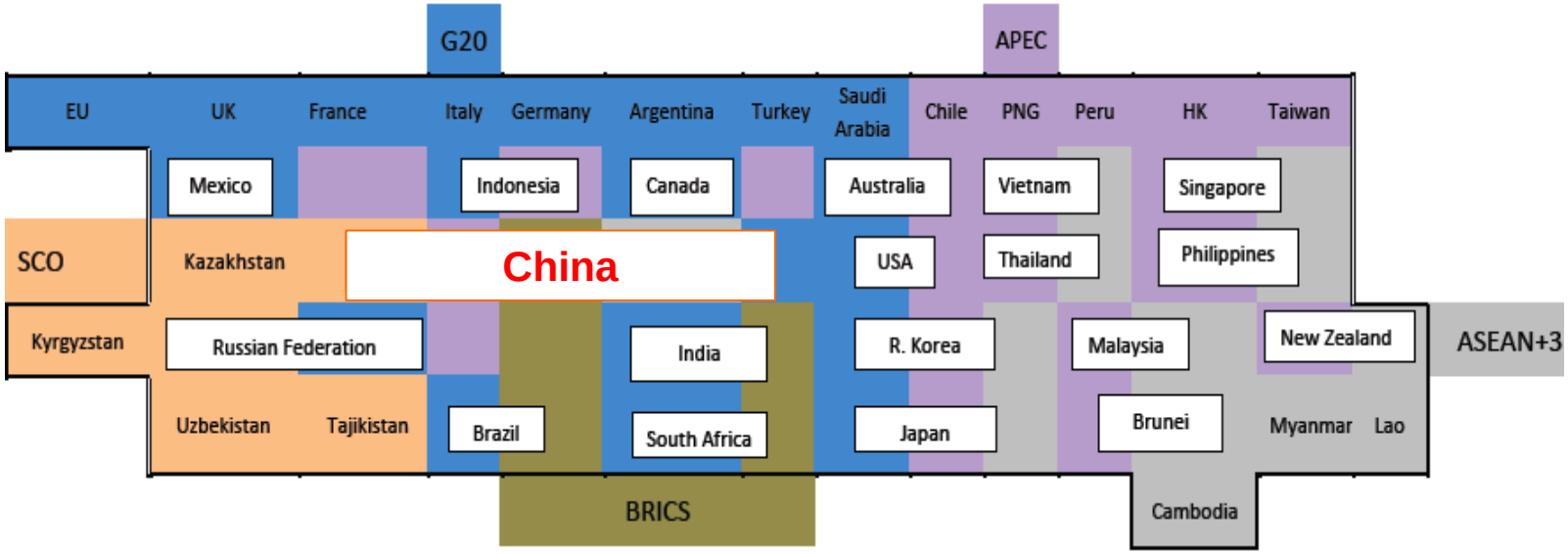
- In our report. An evolving concept on the energy security was discussed, covering security of (1) demand, (2) supply and (3) cooperation at both regional level and global one.
- Such an energy security was furthermore explored at a bilateral level by taking Sino-Russian hydrocarbon ties as an example. A multilateral level review was done by examining Chinese attitudes towards the regional and global energy governance.

A Concept Shift on Energy Security



8. Interactions

- Active engagements and open dialogues with all stakeholders are required as a responsible party. Energy Club, IEA Alliance, G20, Energy BRICS, and IEF. In 2014, we believe, the country will play its bigger role in APEC Meeting in Beijing.
- New visionary diplomacy entitled Silk Road Economic Zone and 21st century's Marine Silk Road are endorsed by the new leadership.
- However, China's cooperation capabilities remain in lower level because of lack of a set of infrastructural and logistic settings such as required institutions, staffing, rules education, and information sharing



Conclusions

1. We are facing an interesting time and witness unprecedented changes in our energy landscape including fundamental profile, energy mix, trade pattern, etc.
2. Upcoming energy revolution in China will be featured by rebalancing of energy sources: coal reduced sharply down to 48% in 2035, gas increased to the similar percentage to oil around 14, renewables 24%.
3. Gas is new star together with renewables
4. COs emission will decrease at lower rate than the IEA.
5. The year 2018 or 2020 will be watershed or milestone
6. *Is China really getting ready to address these issues?*

Is China really get ready? My answer is mixed

- Top leadership and strategy: *Yes with some concerns*
- Policy review: *Under way*
- Market competition (wind and solar): *Y/N*
- Technologies (CCS): *Ongoing*
- Public awareness (public hearings): *Y/N*
- Institutional arrangements (NGOs): *No*
- Rules (soft ones): *Y/N*
- Data sharing (strategic reserves etc.): *Down rated*
- Education (staffing): *Down rated*
- Openness and localized supports (less Beijing focused): *Not ready*

Policy Recommendation (1)

Curb energy consumption by energy efficiency for sustainability

1. Curb energy demand growth in 2014: 3.88 billion standard tones for energy (3.2% upward) and could peak at 4.1 bn by 2020, electricity generation 572 TWh (7%), 3.8 billion tone for coal (1.6%), 510 MT for oil (1.8%), 193 bcm for gas (14.5%).
2. Increasing energy efficiency: energy use per GDP unit down to 0.71 standard tones. Energy consumption elasticity: 0.43 while power consumption elasticity: 0.93.
3. Enhancing energy-saving and efficiency by a set of policy incentives and technology innovations covering wastes utilization, embedded energy.

Policy Recommendation (2)

Optimize energy mix for emission reduction

1. Reduce coal share down to 65% in 2014 while promoting efficient and clean utilization: IGCC vs. USPG; Coal2Gas, Coal2Oil
2. Shift from co-development "both oil and gas sector" to the one "increasing gas while stabilizing oil" with intent to increase gas share up to 6.5% in 2014.
3. Ultra-high Voltage Transmission and smarter grid
4. Promote the development of renewable energy including wind and solar energy based on market mechanisms instead of interference with intent to increase share up to over 10%.

Policy Recommendation (3)

Enhance energy security system at home and abroad

1. Increase domestic supplies remain its priorities: unconventional, deep-water, and deep exploration on land
2. Domestic responsibility: public policy dimensions, social responsibility
3. International expansion: trade, investment, cooperation mechanisms
4. International cooperation on global agendas (governance, security, sustainability and climate)
5. Compatible Infrastructure (rules, educations, institutions, data sharing, local supports)

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- Is the author of Petro-Dragon's Rise, what it means for China and the World (English, European Press, 2002) and Energy Black Swan: Global Games for Hydrocarbon Resources and Chinese Options (in Chinese, 2011) along with numerous writing and speeches on energy investment, corporate strategy and governance, and geopolitics of energy in both Chinese and English.
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