ANALYSIS OF THE POTENTIAL COAL PRODUCTION PEAK IN CHINA AND INDIA: IMPACT ON INTERNATIONAL TRADE IN GAS AND COAL

Arkhipov Nikolay, Mironova Irina

Energy research institute Russian Academy of Sciences

Antalya, Turkey

May 25, 2015

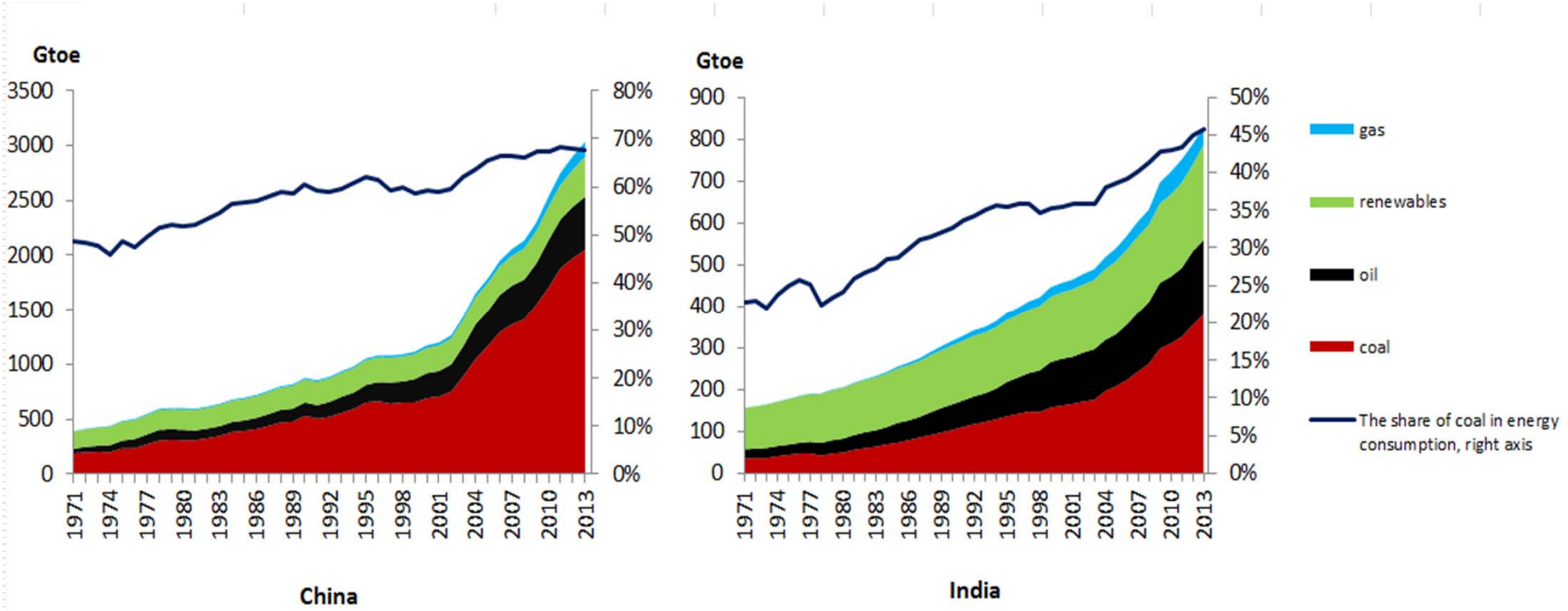
- Objectives
- Background
- Methodology
- Results
- Discussion

Objectives

- The main tasks are to determine with the use of economic modelling:
  - Whether peaks of production in China and India can be reached and what are the conditions for such developments;
  - Whether and to what extent coal production peaks in China and India have an impact on the international coal trade (trade volume, trade geographic movements, price levels);
  - Whether and to what extent coal production peaks in China and India have an impact on the international gas trade (trade volume, trade geographic movements, price levels);
  - What would be the impact of the above discussed developments on key world coal suppliers;
  - What would be the impact of the above discussed developments on key world gas suppliers.

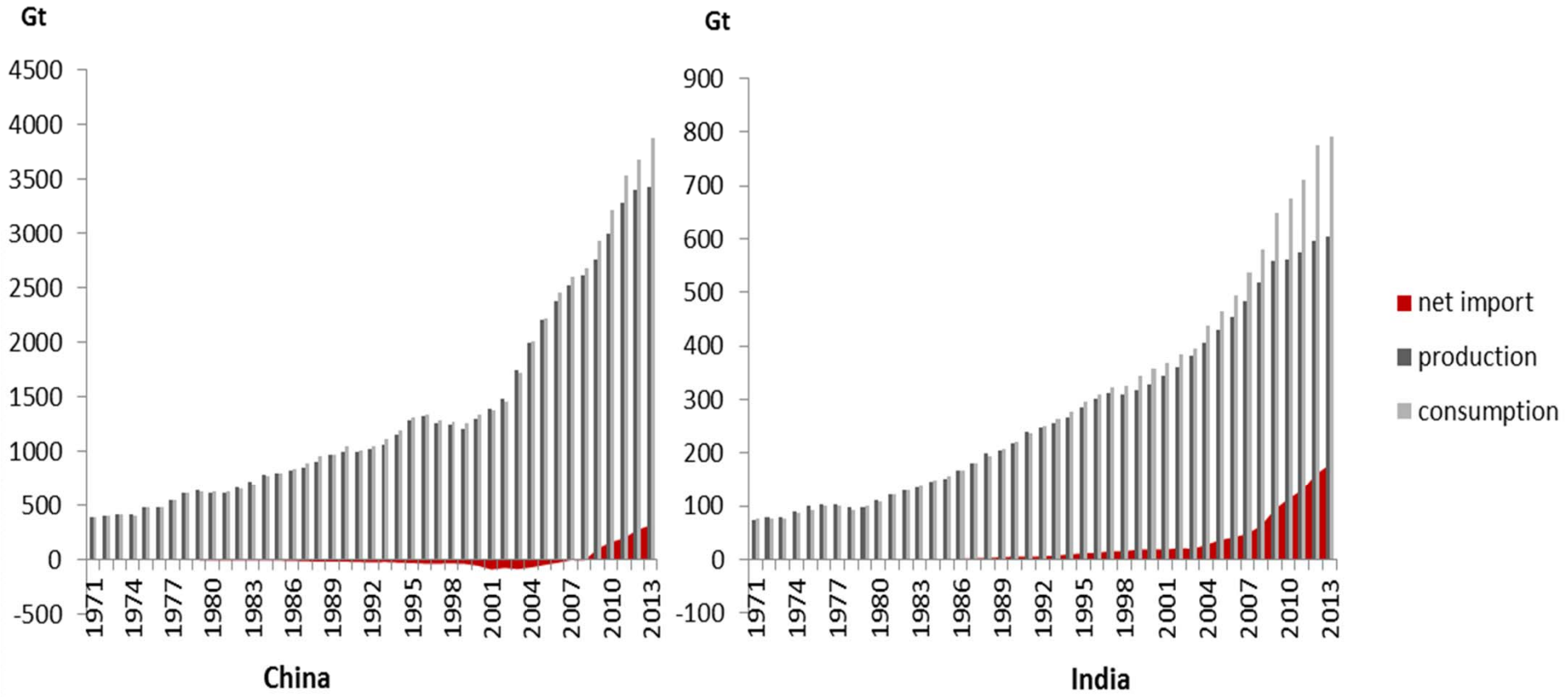
- Objectives
- Background
- Methodology
- Results
- Discussion

The energy balance of China and India and the share of coal in the balances



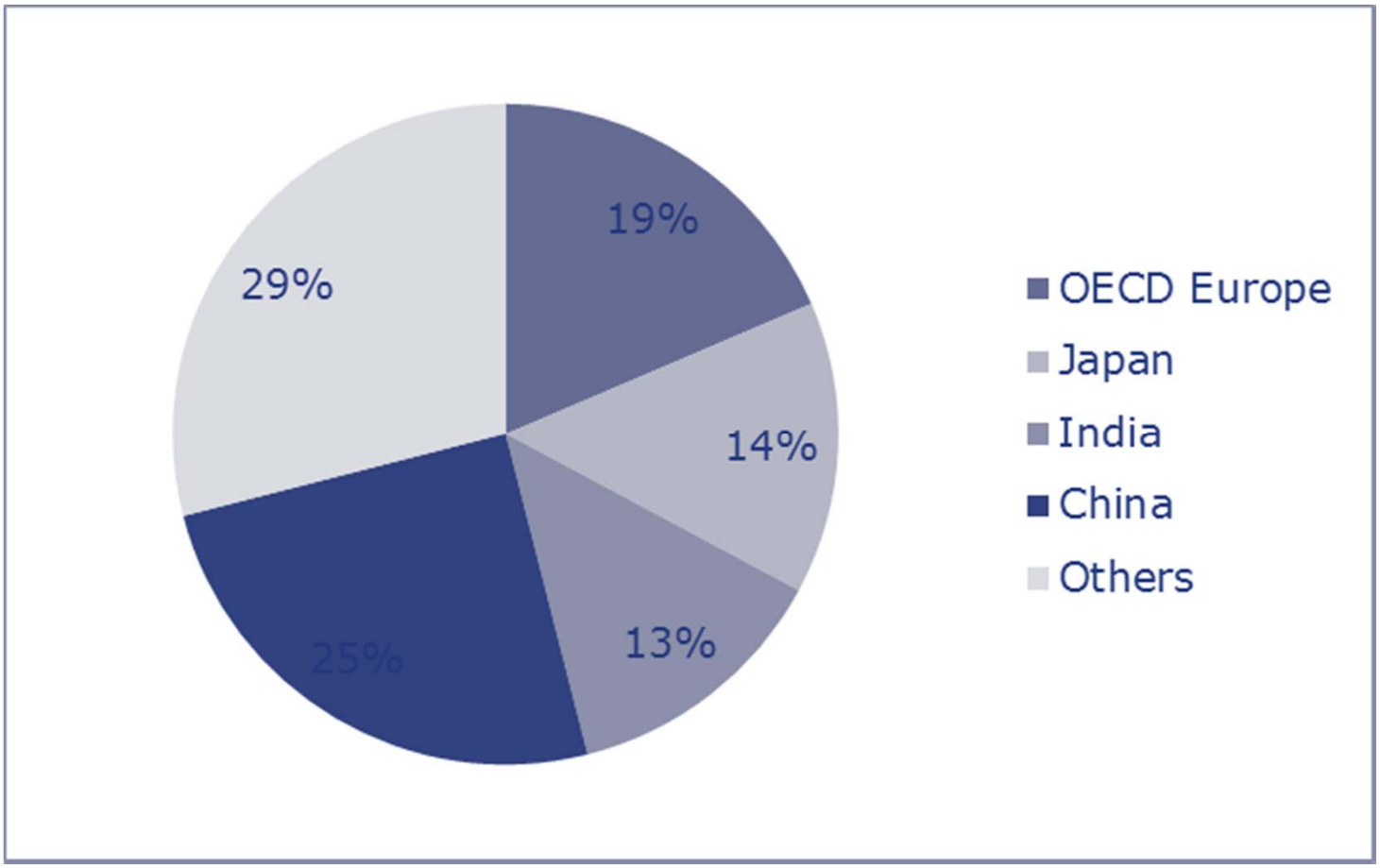
Coal is the basis of energy balances of China and India, and its share has grown rapidly over last decade

Production, consumption and coal import in China and India



The growth rate of consumption exceeds rate of production so the import needs of coal are increasing

The share of China and India in world coal import



Total share of China and India in total world coal import is almost 40%

- Objectives
- Background
- Methodology
- Results
- Discussion

The SCANER complex

- Optimization, econometric analysis, balance approach
- Modules:
  - module for the development of scenarios of external conditions;
  - module for global energy forecasts;
  - module for forecasting the socio-economic development of Russia and its regions;
  - module for forecasting energy consumption and development of fuel and energy balances;
  - electric power sector module;
  - oil and oil refining industry module;
  - gas industry module;
  - coal industry module

Building the forecast

1. A) forecasted indicators of GDP, population and B) forecasts for energy intensity, electricity intensity, oil intensity of GDP and per capita energy, electricity and oil consumption is inputted in order to receive **demand for primary energy, electricity, and liquid fuels**
2. **Demand for oil, renewables (RES) and nuclear energy** is subtracted from the primary energy demand – this is done within the balance module, and renewables and nuclear modules.
3. Forecasts of oil, natural gas and coal are transferred to resource modules, which provide with outputs of **production volumes, trade flows and prices forecasts** for oil, gas and coal respectively.

Explanation step 2

$$D_{forecast} = D_{linear\ trend} \pm Adjustment + DSR$$

where:

$D_{forecast}$	Forecasted demand for RES / nuclear
$D_{linear\ trend}$	Bases on linear trend forecasted demand for RES / nuclear
$Adjustment$	Adjustments accounting for country's energy policy
DSR	Demand side response from world gas model (the demand which has to be met by gas rather than renewables due to economic efficiency)

$$D_{coal,gas} = D_{prim.en.} - D_{oil} - D_{RES} - D_{Nuc.}$$

where:

$D_{coal,gas}$	Demand for coal and natural gas
$D_{prim.en.}$	Demand for primary energy
D_{oil}	Oil demand
D_{RES}	Demand for renewables
$D_{Nuc.}$	Demand for nuclear energy

Explanation step 3

Target function of the coal module uses volumes of production and transport as arguments (master variables)

$$f(x) = \sum_{field} C_{prod} + \sum_{rail} C_{transp:rail} + \sum_{marine} C_{transp:marine}$$

where:

$\sum_{field} C_{prod}$	cumulative costs of coal production per each node
$\sum_{rail} C_{transp:rail}$	cumulative costs of coal transportation by railways
$\sum_{marine} C_{transp:marine}$	cumulative costs of coal transportation by sea routes

Cumulative costs are counted by multiplying incremental costs (USD per tonne) with volume (tonnes)

$$\sum_{field} C_{prod} = \sum_{field} P_{prod} \times Q_{prod}$$

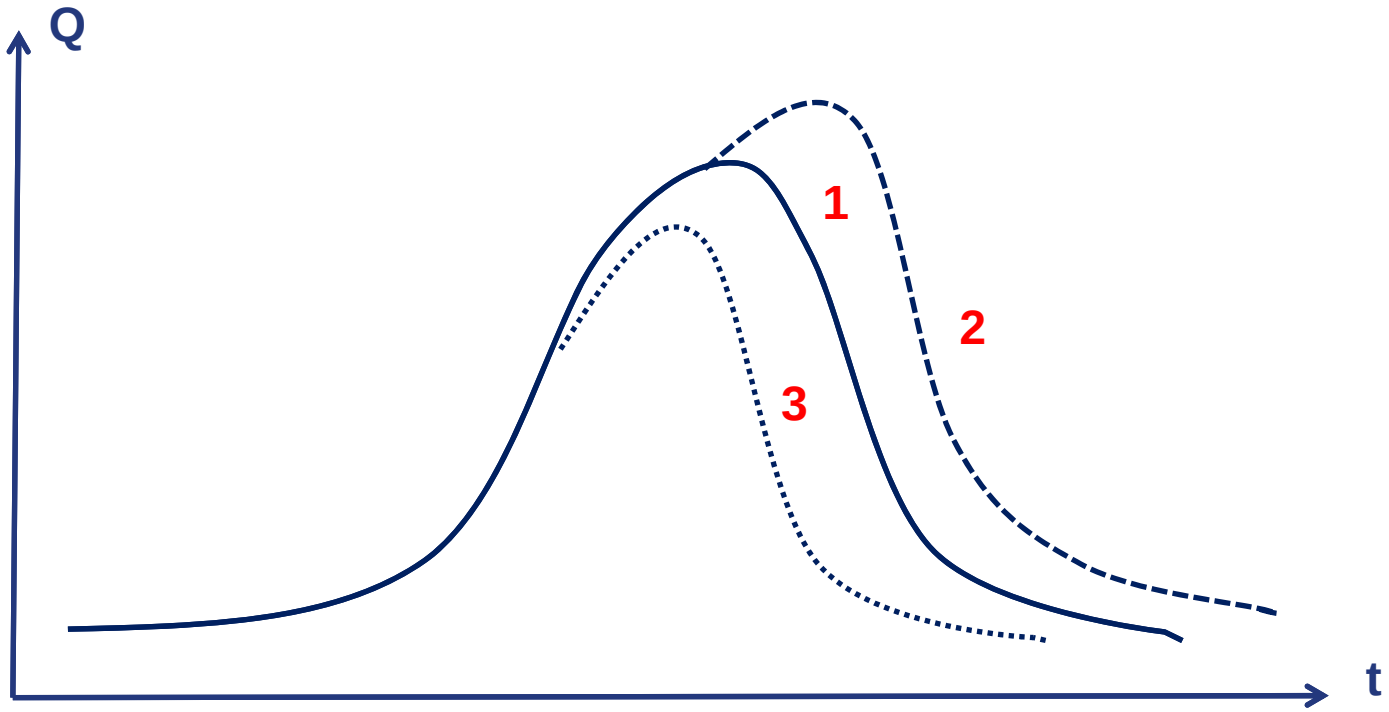
$$\sum_{rail} C_{rail} = \sum_{rail} P_{rail} \times Q_{rail}$$

$$\sum_{marine} C_{marine} = \sum_{marine} P_{marine} \times Q_{marine}$$

where:

P_{prod}	Cost of production per each field (price)
P_{rail}, P_{marine}	Respective costs of transportation (tariffs)
Q_{prod}, Q_{rail}, Q_{marine}	Respective volumes of production and transportation (limited by inftrastructure capacity and production limitations.)

Coal Peak: explained by Hubbert curve



1 - Curve Hubbert taking into account the resources and current production of coal

2 - The offset of Hubbert curve to up and right under the improvements of technical factors and rising of coal price

3 - The offset of Hubbert curve to down and left under the falling of coal price and tightening environmental requirements

- Objectives
- Background
- Methodology
- Results
- Discussion

Peak production of coal in China

Source	Projected year of peak production	Total recoverable reserves
12 th Five Year Plan for National Economic and Social Development	2020-2025	
WEO 2014	2025-2030	3,7
Wang J, Feng L, Davidsson S, Hook M, 2013	2024	4,1
Hook M, Zittel W, Schindler J, Aleklett K, 2010	2020-2025	3,1-3,3
Tao Z, Li M, 2007	2027	3,3
	2029	3,8
	2033	4,2
Lin B, Liu J, 2010	2025	3,8
	2027	3,7
Patzek T, Croft G, 2010	2011	2,8-2,9
Li M, 2008	2030	3,8
Li M, 2010	2039	6,1
(Mohr S, Evans G, 2009	2010	2,4
	2017	2,4

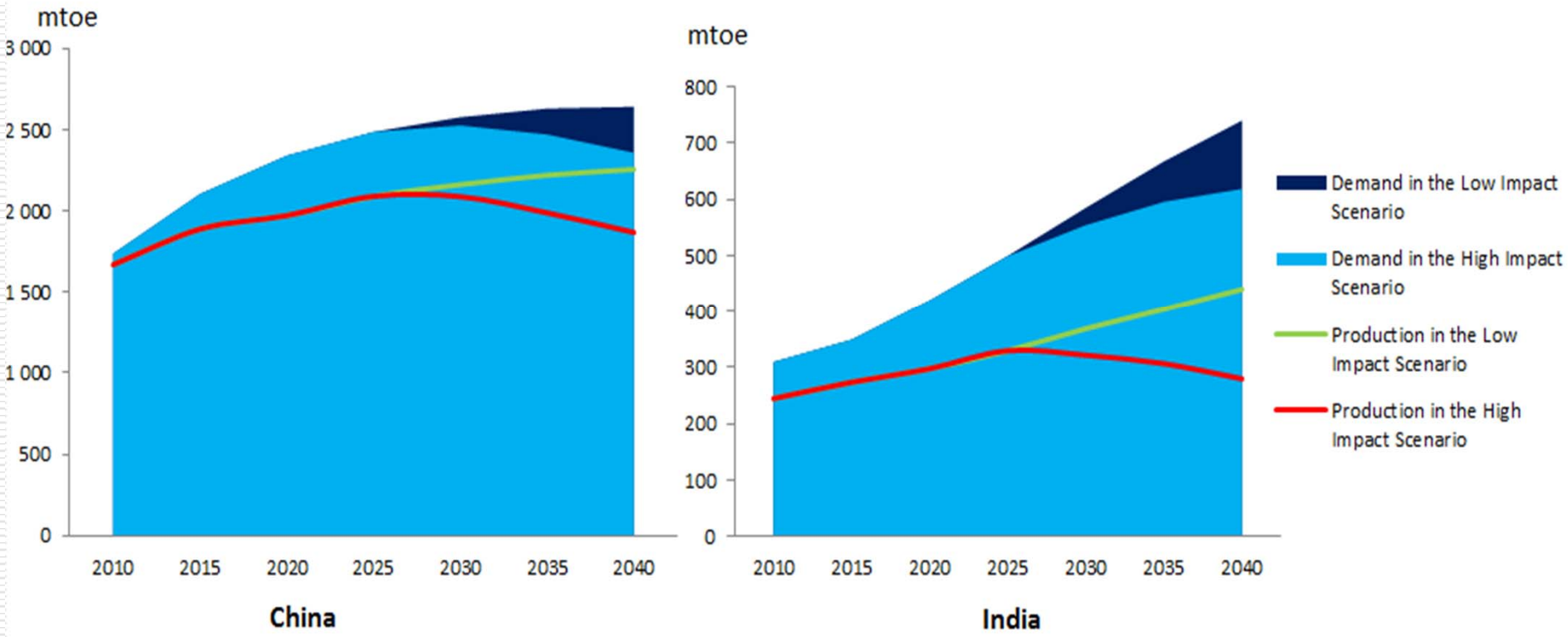
The most likely scenario for China is achieving peak of coal production around 2025 at the level of 3,7 to 4,1 million tonnes.

Peak production of coal in India

Source	Projected year of peak production	The total recoverable reserves taking into account economic viability and technological capabilities
Patzek, Croft, 2010	2011	0,7
Mohr, Evans, 2009	2032	0,8
	2037	0,9
	2038	1
Hook et al., 2010	2020-2040	1
	after 2040	1,5
WEO 2014	after 2040	

As a result of the production that in fact is lower than in the national plans, and in the context of growing demand with the lack of initiatives to replace coal in the fuel mix, India has all chances to become the largest world coal importer within the period up to 2040.

Comparison of production and consumption coal in Low and High Impact Scenarios



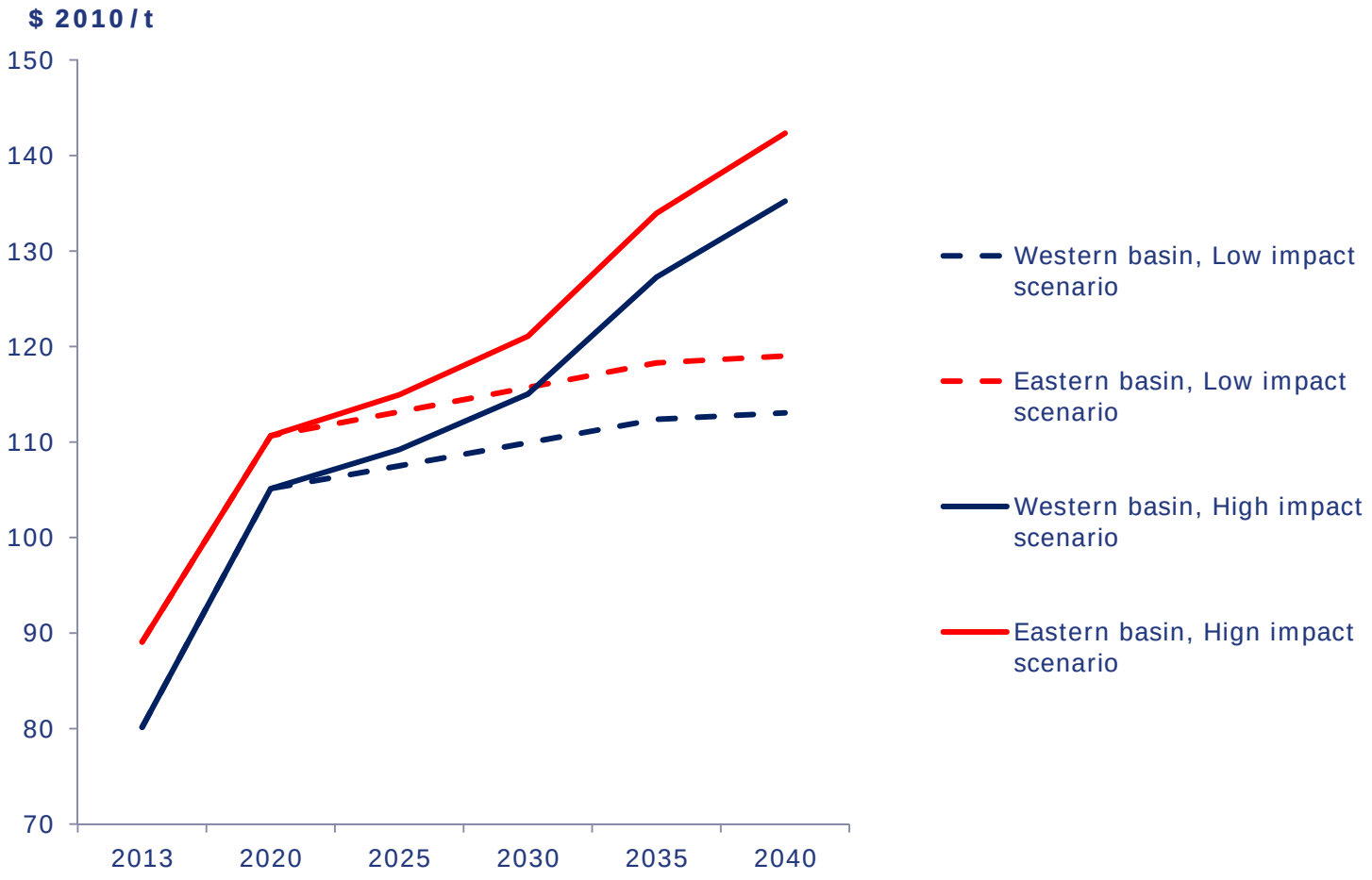
We have input the peak in coal production into the model (VS conventional approach) and received a different outlook particularly for import dependence in coal

The differences in trade flows in the Low and High impact scenarios for world markets

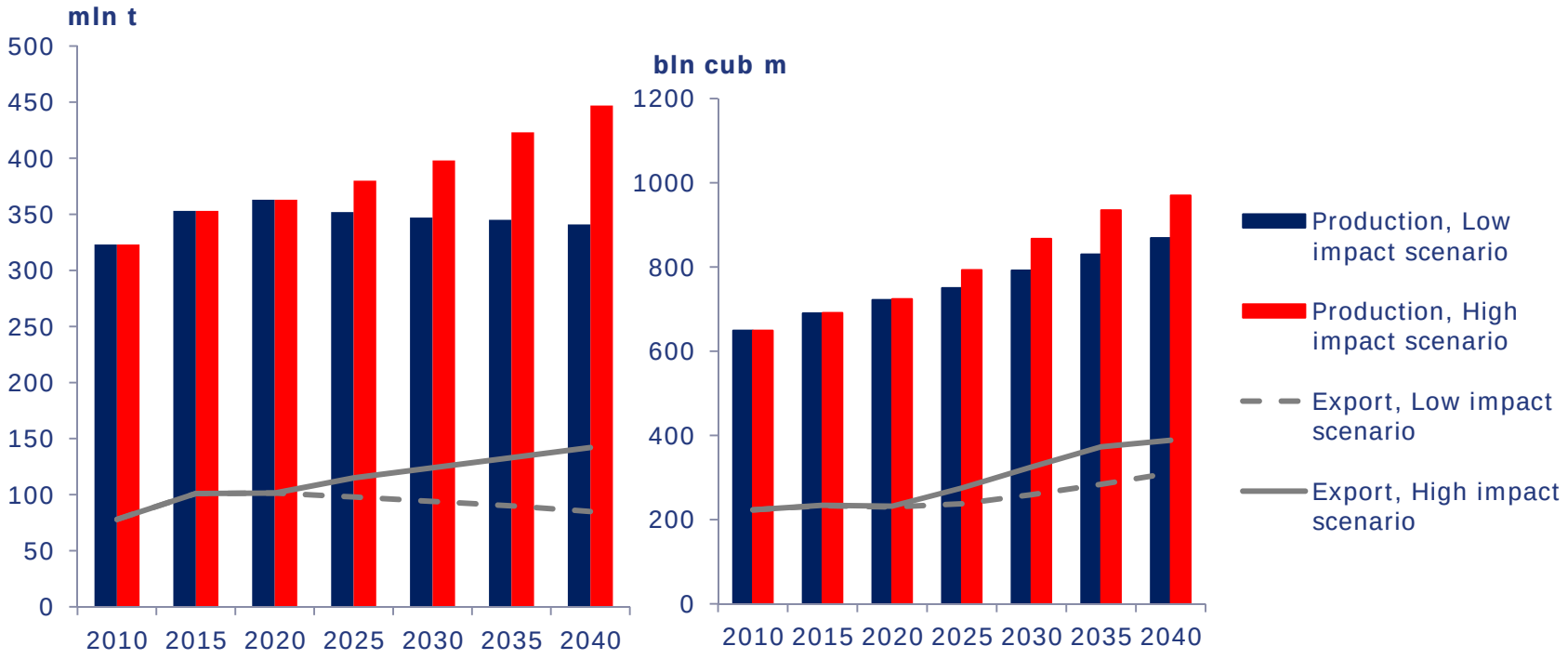
- In the High impact scenario, the energy use China and India is **above Low impact scenario** by about 148 and 66 million tonnes of oil equivalent respectively.
- In the High impact scenario China and India will **increase their imports of coal** by 210 and 65 mln tonnes respectively in comparison with the Low impact scenario.
- In the High impact scenario the needs for **gas imports** in these countries **will increase** to 200 bln cub meters, 140 and 60 bln cub meters respectively in comparison with Low Impact Scenario. Russian export rises for 80 billion cubic meters
- The **price of gas will increase** by about $ 10-15 and $ 25-30 /thousand cubic meters in the Atlantic and Pacific basin respectively in the High Impact Scenario in comparison with Low Impact Scenario
- The **price of coal will increase** by about 10% and 22% in the Atlantic and Pacific basin respectively in the High Impact Scenario in comparison with Low Impact Scenario

- Objectives
- Background
- Methodology
- Results
- Discussion

The coal price increases!



Impact on Russia?



- **High impact scenario provides Russia with opportunities: world energy balance becomes tight which is a favourable condition for suppliers.**
- **Among coal suppliers, it is Russia who has the capacity increase potential for production and export of coal (Left), but it would still be an important condition that the prices are at the high level.**
- **The High impact scenario also leads to 75% growth in gas exports in 2040 compared to 2010 levels (Right).**

Nikolay Arkhipov
nikolayarkhipov@yandex.ru

44/2 Vavilova st.
Moscow 119333
Russian Federation

+7 (499) 123-05-01
+7 (967) 097-27-56

Energy Research Institute
of the Russian Academy of Sciences