



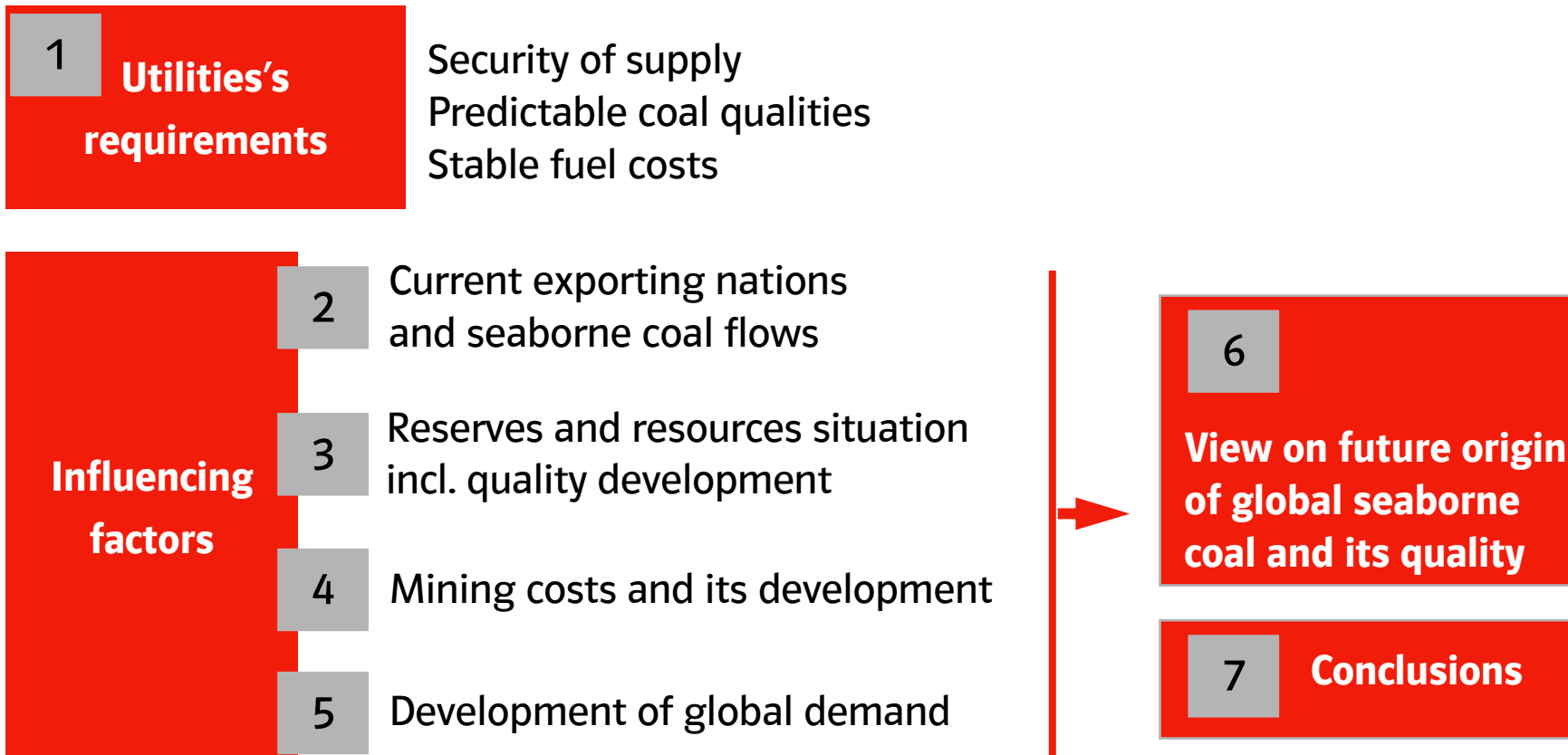
## Seaborne steam coal market dynamics and future production costs

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Resources Workshop "Long-Term Costs and Reserves of Coal, Oil, & Natural Gas"  
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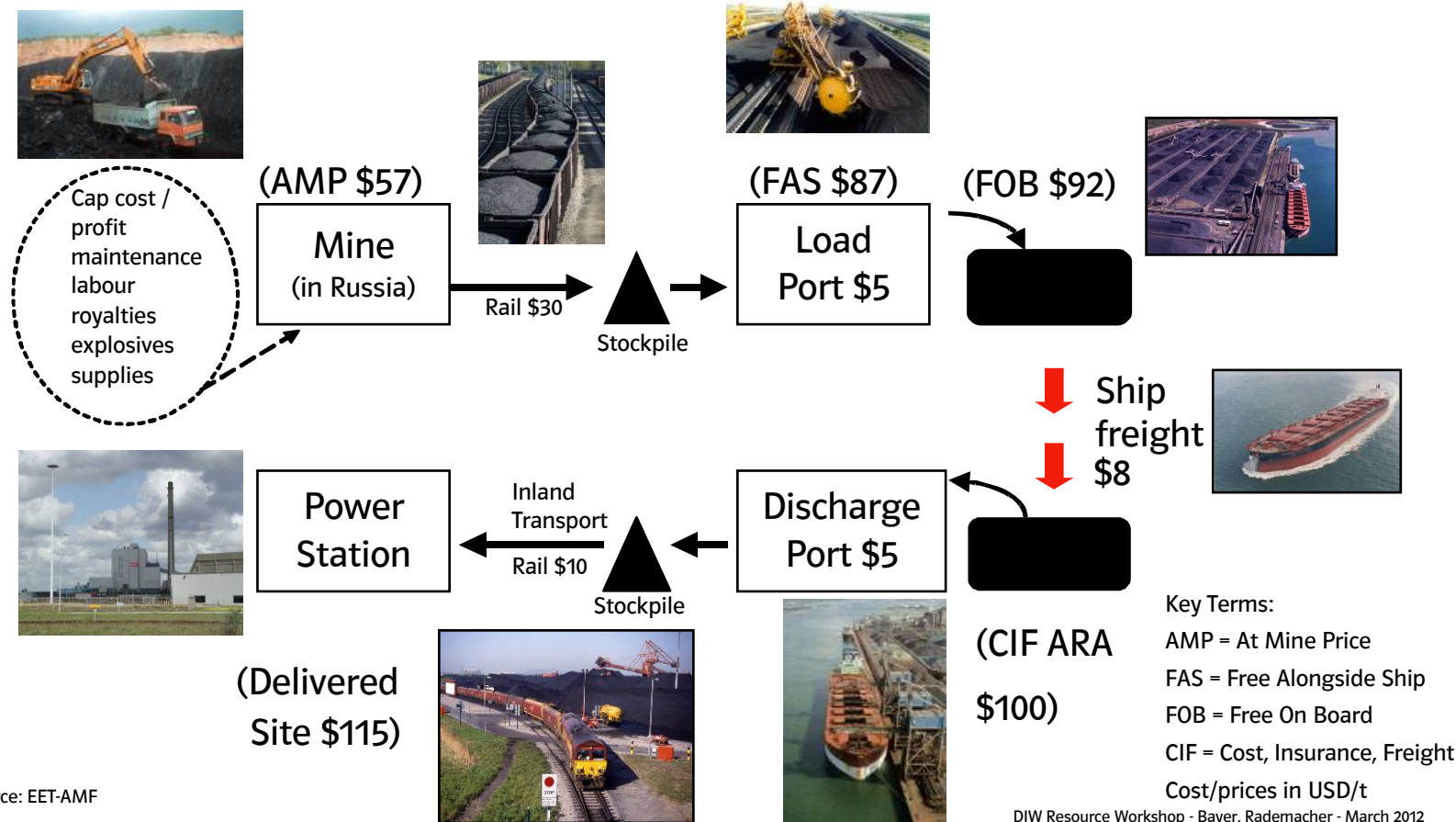
# Seaborne steam coal market dynamics and future production costs

## Agenda



Talking about seaborne coal markets means talking about a complex logistics chain with a number of input factors

**Coal Logistics Chain - Pit to Power Station - February 2012**



Source: EET-AMF

## Coal based generation is a long term business with a need for predictable input parameters like costs or quality

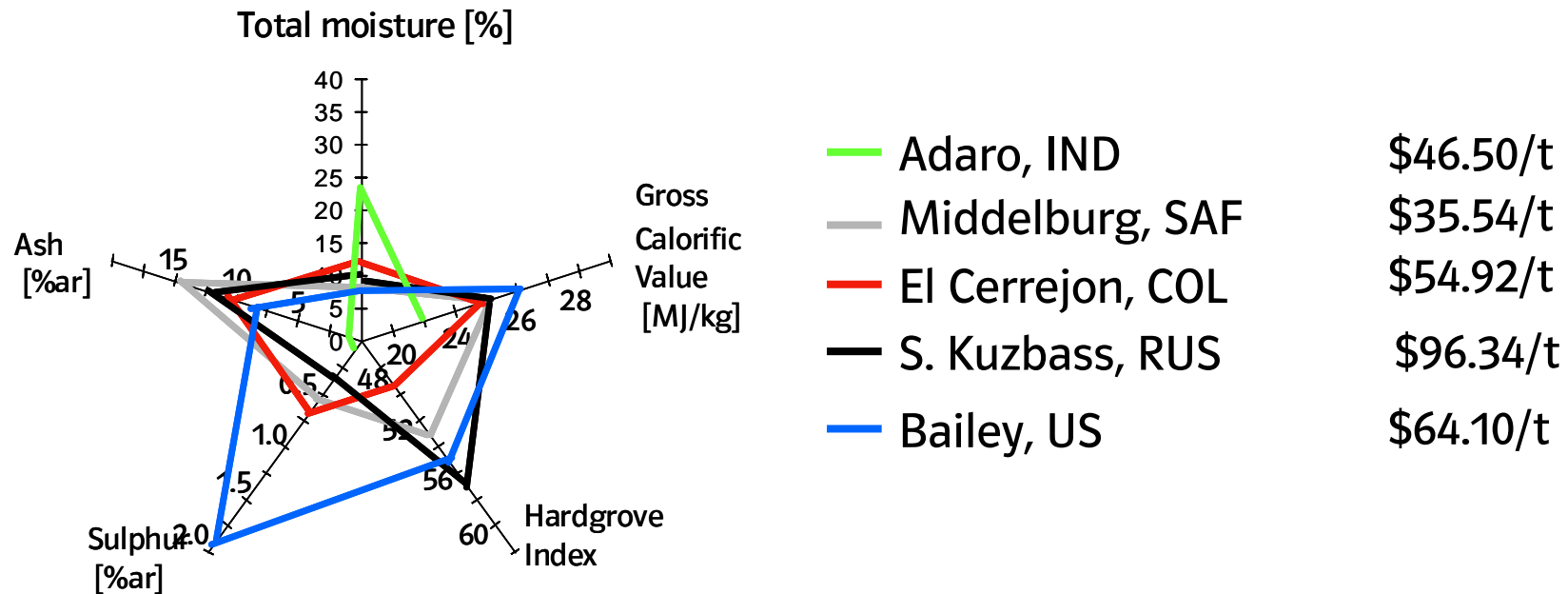
- Currently E.ON operates some 20 GW of hard coal fired power stations in Germany, Benelux, UK, Italy, Spain and France
- These thermal power plants (TPP) consume next to domestic coal approximately 17 mn t of seaborne import coal annually
- E.ON also invests in high efficiency blocks of 1.100 MW each – with 35-40 years of operational lifetime as a basis for investment decisions – and engages in new international markets like Brazil, India and Turkey
- Consequently to balance risk and optimize both existing fleet and new build, E.ON has to be assured of security of supply and predictable coal qualities, as well as, understanding the fundamental mining cost base and future trends



E.ON Kraftwerke's global coal database models major exporting nations on a mine/project basis (capacities and costs)

# Physical coal is not homogeneous like financial benchmarks

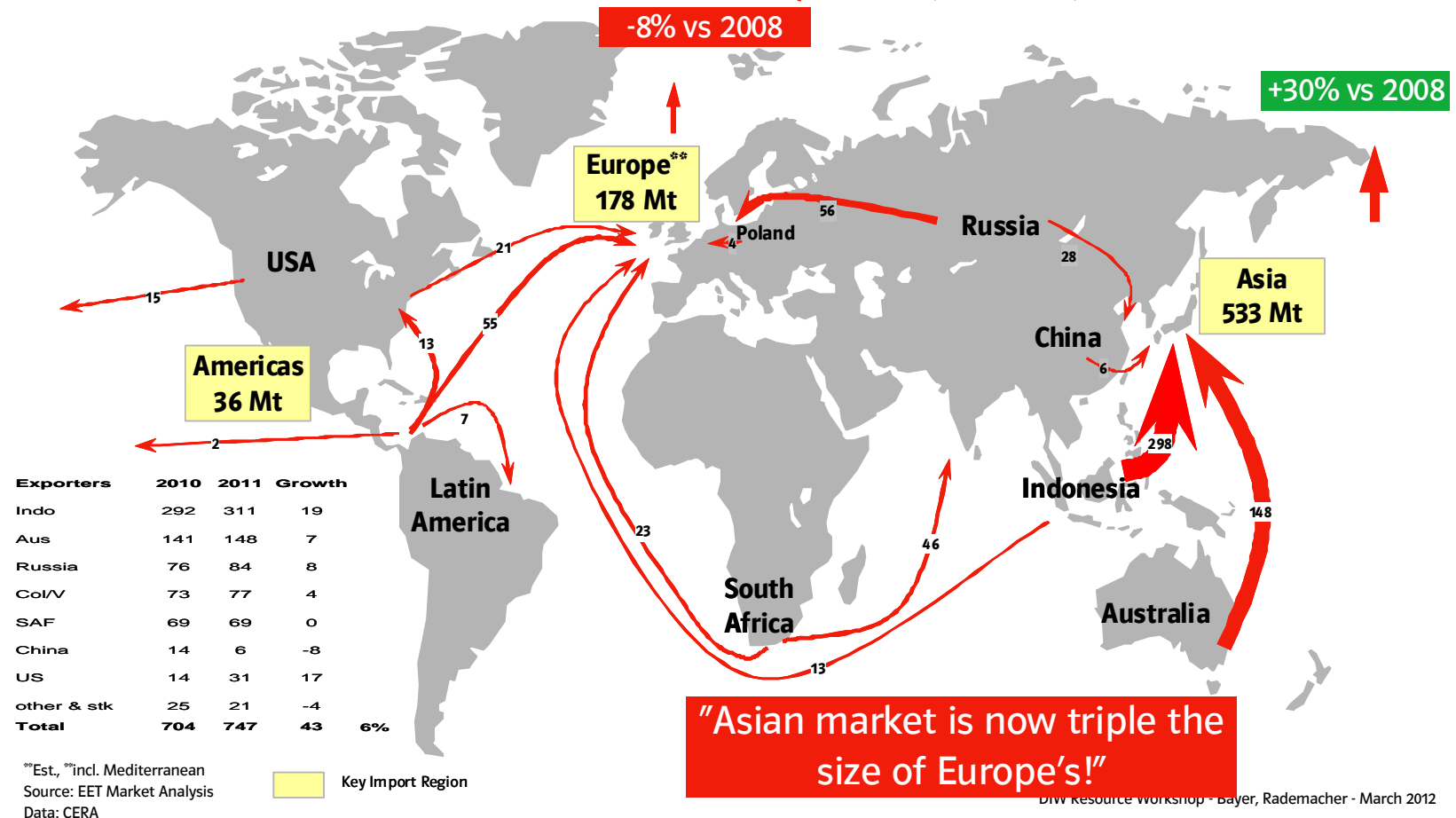
## Variations in import coal specs & Est. Production Costs to Export Port (2012)



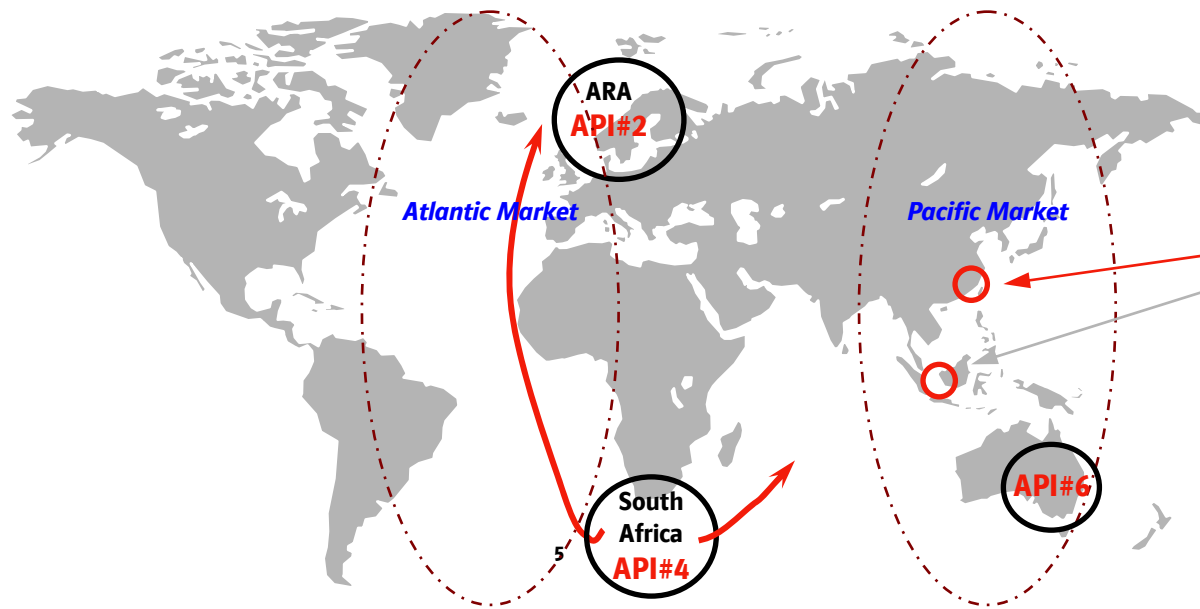
- Each coal plant can take a spectrum of coal qualities
- The wider the band and plant flexibility, the lower fuel and generation costs, though impact on plant efficiency
- Low grade and off-spec coals offer opportunity for lower prices for plants in blends

Seaborne trade makes up just some 1/7 of global production – therefore E.ON model focused on export nations

Main seaborne trade flows in hard coal, 2011\* (747 mt)



# Financial markets follow rising Pacific physical trade



### New Coal Swaps 2011/12

South Chinese CFR:  
steam coal FOB 5500 kcal/kg NAR

Indonesian Sub-Bituminous  
Steam coal FOB 4,900 kcal/kg NAR

### Future?

interest in off-spec coal qualities  
grows from price sensitive  
Utilities  
(high sulphur, low energy, petcoke?)

### European Standard Trading Products (est. 2001)

- API#2: Steam coal ARA range (North Western Europe), 6.000kcal/kg, ACPRS standard quality (Coal cargoes from Australia, Colombia, Poland, Russia or South Africa)
- API#4: Steam coal South Africa, Richards Bay coal terminal, 6.000kcal/kg
- API#6: Steam Coal Australia, Newcastle terminal 6000kcal/kg, 1%S

### Traded European Utility Spread (es. 2004)

- Clean dark spread CDS: Price difference between coal (including CO2) and power

## Ongoing supply issues for utilities increase fuel risk

### **Infrastructure Bottlenecks delay new mine capacity and exports**

- Sufficient number of mine projects & expansions in planning across globe
- Port expansions are underway in existing exporters; missing in new mining countries
- Largest hindrance is in inland rail infrastructure due to high cost of investments and permitting difficulties

### **Quality Management a growing challenge with global share of lower grade coals on the rise**

- Indonesian sub-bituminous dominates exports to China and in India
- NSW Australia exports of high ash off-spec coal increasing
- South African suppliers seeing off-spec export market as a viable option
- High sulphur US cargoes offer high spot discounts in the market

### **Growing government intervention to manage local coal reserves & resources delays investment**

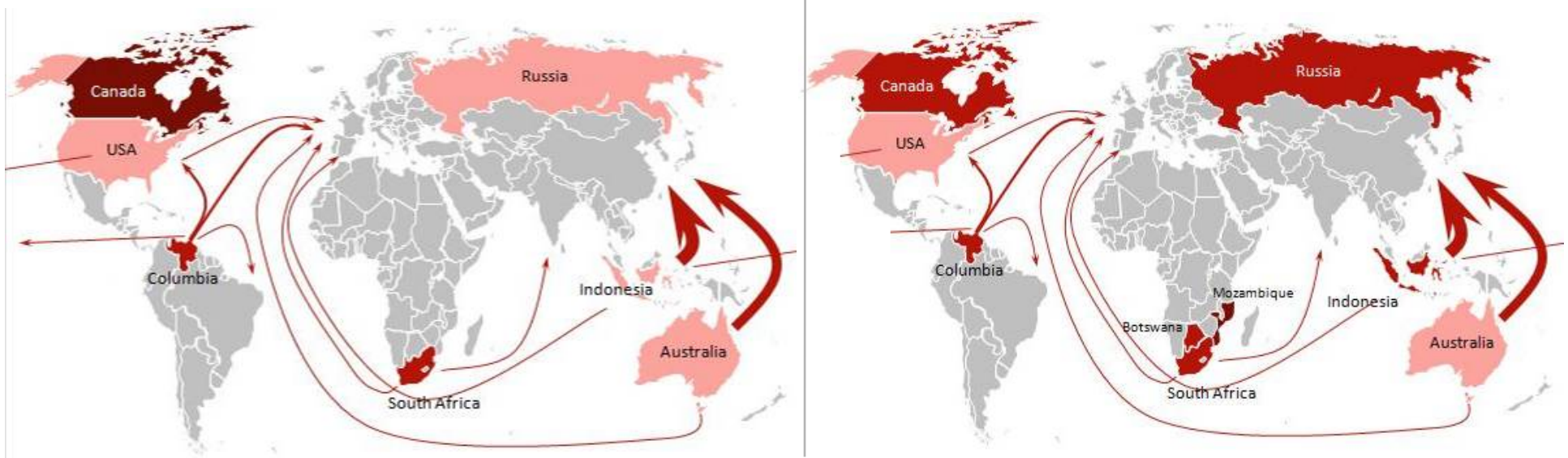
- Indonesia moving to secure domestic supplies; plans to limit foreign ownership of mines
- Nationalisation in South Africa mining sector a possibility
- Australia's Resource Tax could return;
- Increasing difficulties in permitting (USA, Australia)



E.ON analysis shows that coal market will become less competitive in mid-term – any impact on consumers?

2010

2015

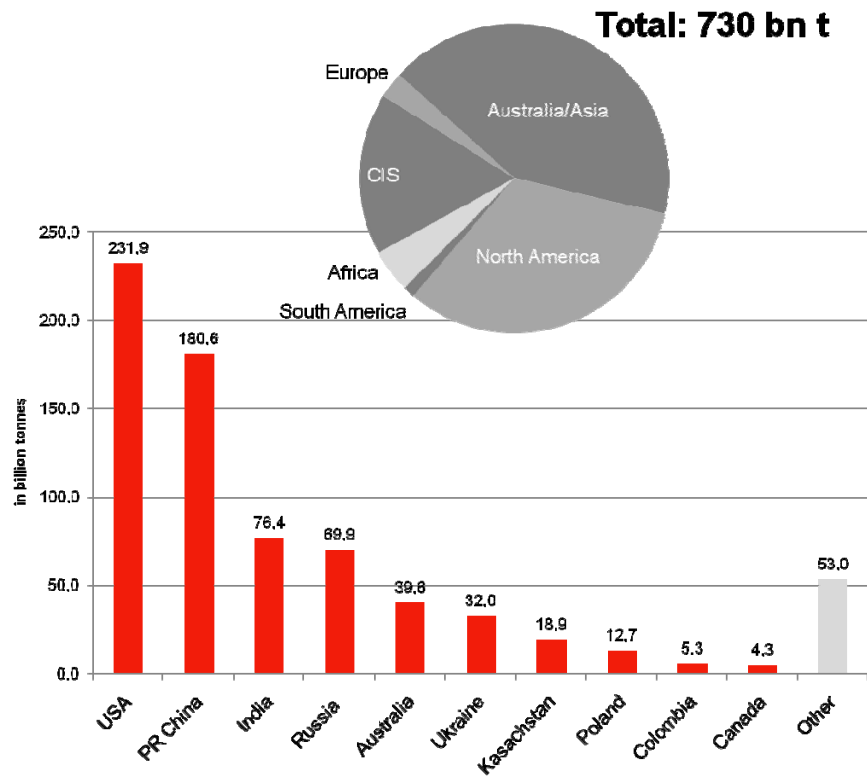


■ High market concentration    ■ Moderate market concentration    ■ No concentration    ■ High competition

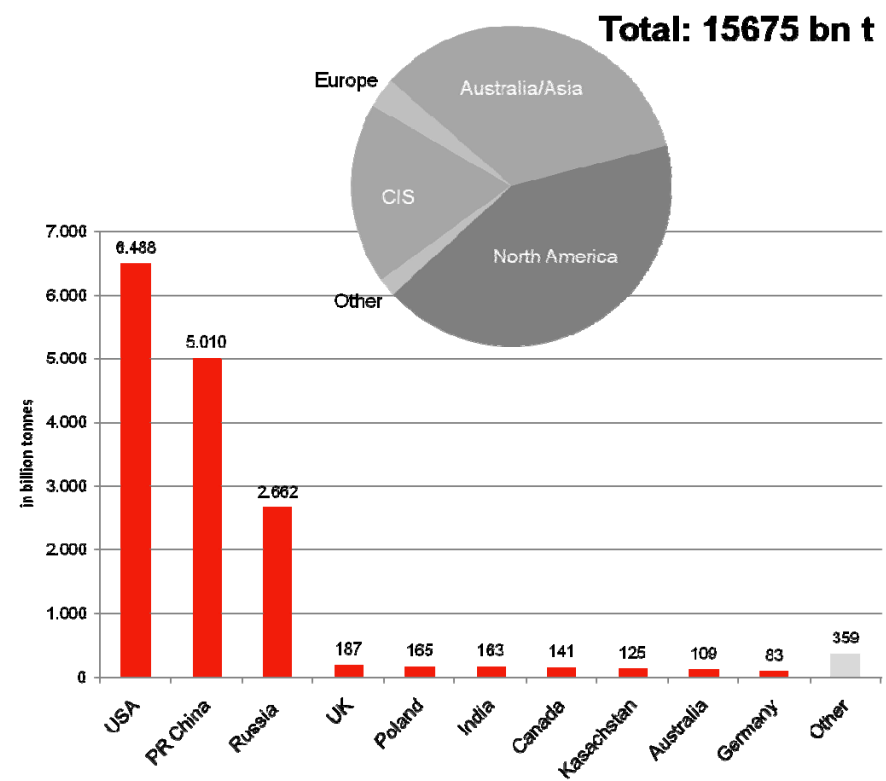
- The share of "free coal" in the market, not controlled by utilities, state or steel companies is falling
- Market trend is for miners to become "integrated" controlling supply chain or utilities to take a direct share in mining projects at home and abroad (ex. MPX, Chinese)
- Market concentration strengthens in 2015 versus 2010 increasing supply risks
- New supply regions will be strongly concentrated (e.g. Mozambique)

BGR puts geological coal reserves at approx. 750 bn t globally - exceeding 100 years current annual demand

Coal reserves



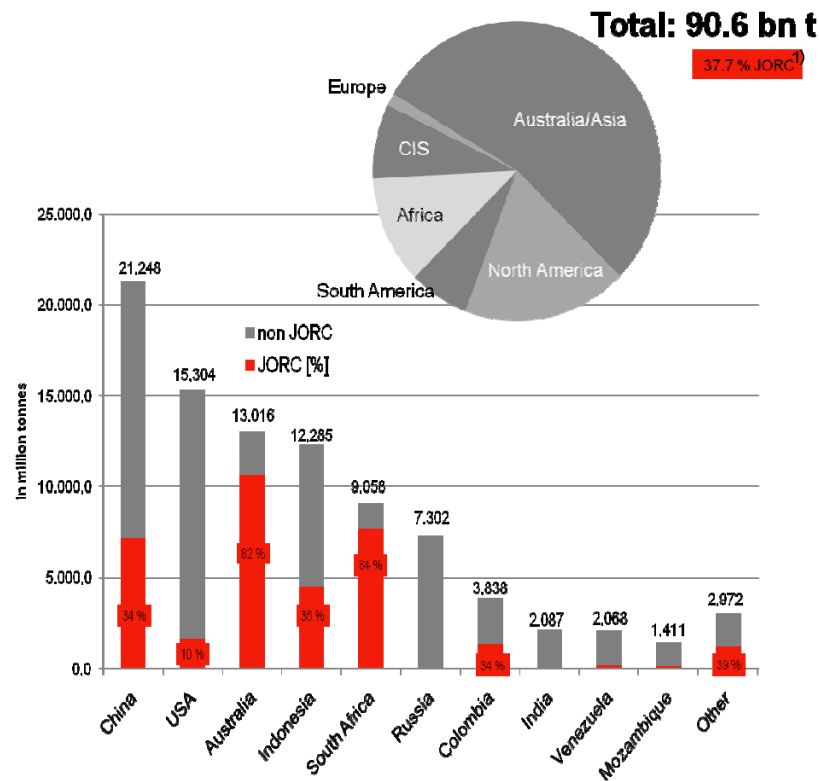
Coal resources



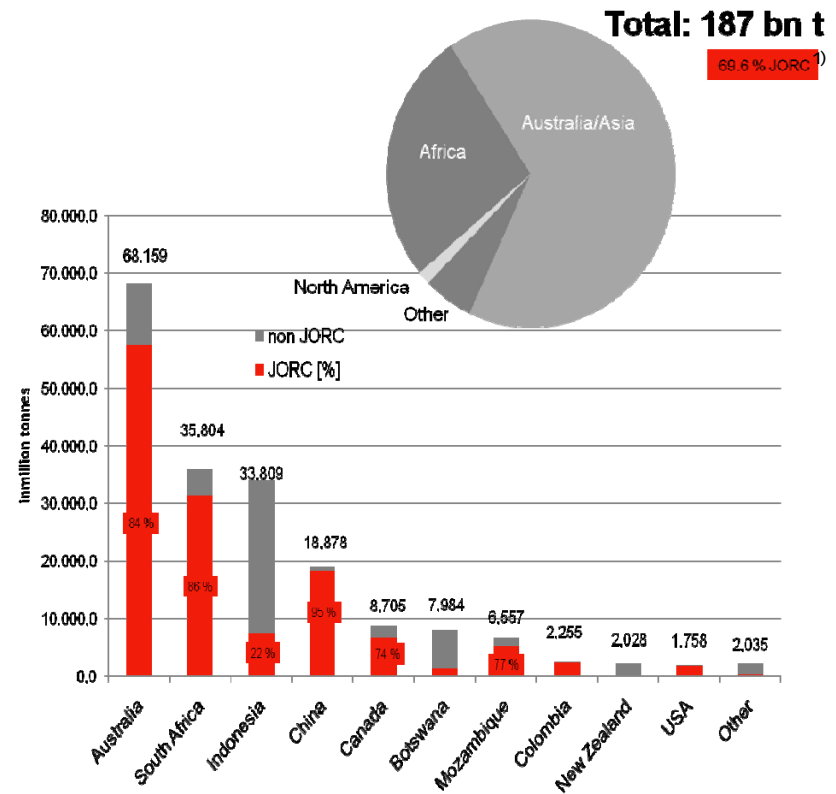
Source: Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), 2009

Coming from a mine's perspective, E.ON has identified specific reserves at mines/projects of almost 100 bn t

Coal reserves



Coal resources

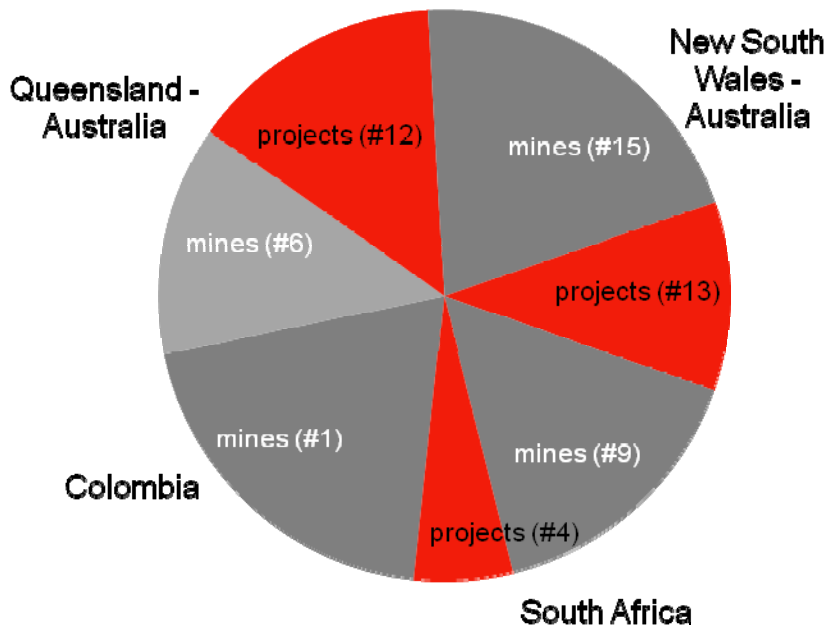


1) Code for Reporting of Mineral Resources and Ore Reserves  
Source: E.ON Kraftwerke GmbH internal research

E.g. E.ON reviews exporting mine/project portfolio of companies like Xstrata to forecast future volumes & qualities

**Xstrata coal reserves**

Σ 4 bn t (JORC certified)



- Xstrata is a globally active mining company with 32 active mines and 30+ green & brownfield projects in the pipeline
- Annual production sums up to some 90 mn t – theoretical lifetime of reserves close to 45 years
- Additionally approx 20 bn of resources identified
- E.ON Kraftwerke allocates dedicated coal types/brands to mines/projects to be able to forecast future coal quality (besides capacities & costs)

Hence, core of E.ON model is the constant tracking of new projects/investments and running mines incl. expansions

**Explanation of methodology for supply (1/4)**

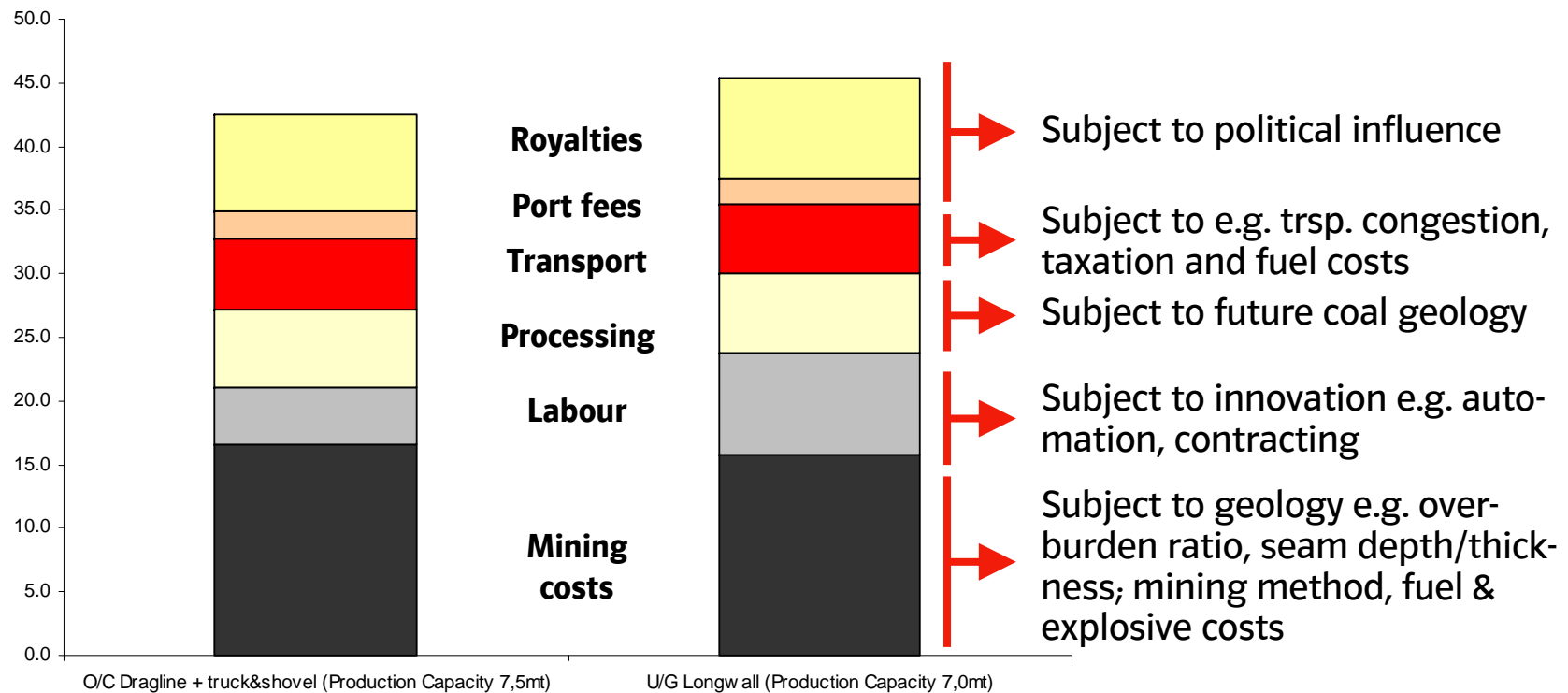
- 1 Create a list of existing export mines and potential mining projects based on AME database and E.ON proprietary information collected over 10+ years to identify potential mining capacity to cover demand needs over the LTP period
- 2 For each mine, identify the start of production, annual saleable production and years of future potential production based on provable reserves / saleable production), incl. information on qualities if available

Mine	Country	State	Type	Status	EKW-Status	Start of Production	Saleable Production	Reserves in 2008	Reserves	Report of Reserves
						[year]	[mt]	[mt]	[mt]	[year]
Abel U/G	Australia	New South Wales	U/G	Production		2008	3,0	60,0	60,0	2005

\*for missing data, assumptions made based on similar mines and historical data

FOB cost positions for opencast and underground operations vary significantly – impacting future development

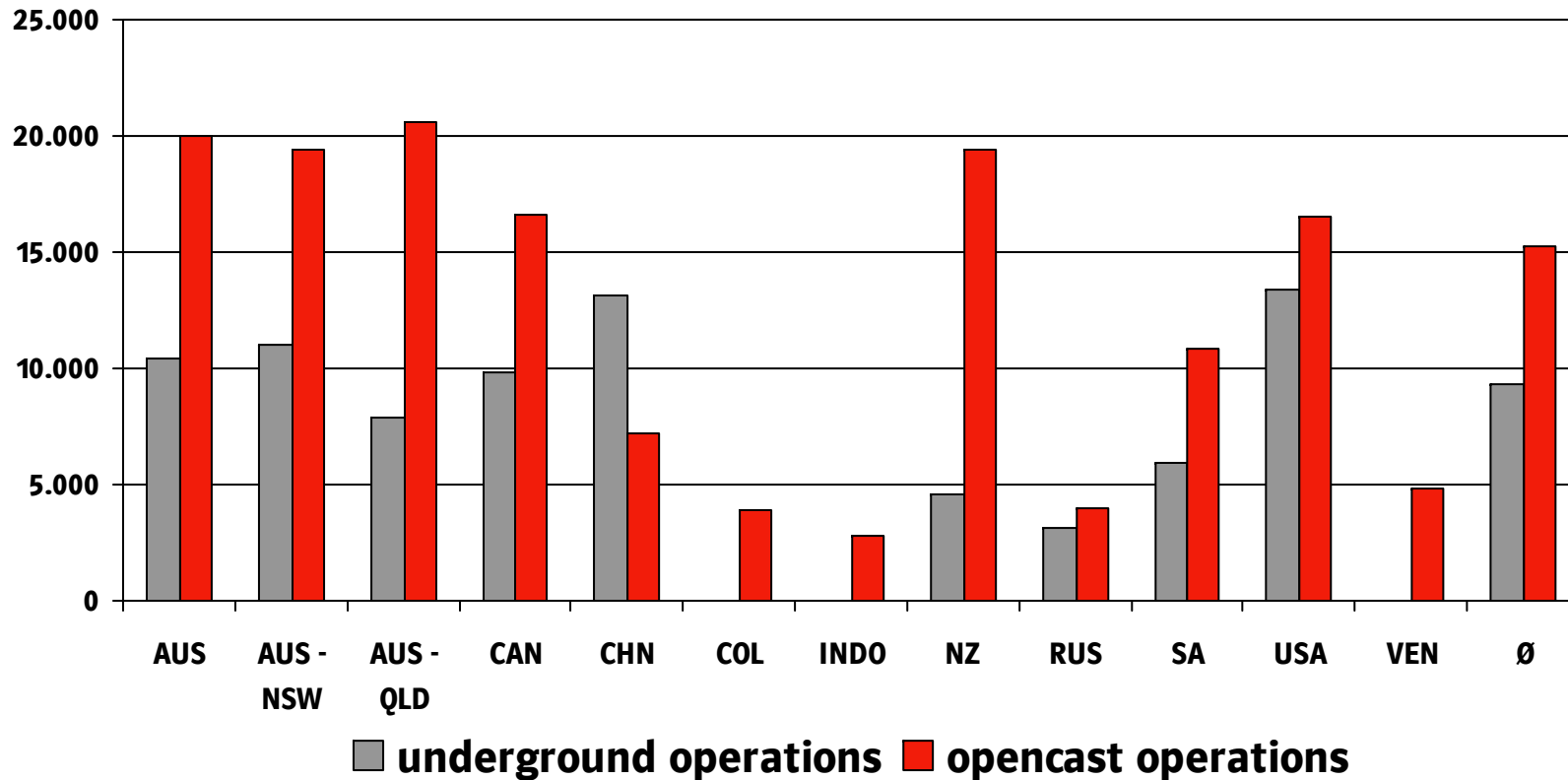
**Free on board (FOB) cash costs New South Wales [USD/t]**



Source: E.ON Kraftwerke GmbH internal research

Generic costs model e.g. allows for allocation of productivity ranges to mine types in certain mining countries

**Productivity [t per FTE year] for mine types and countries <sup>1)</sup>**



1) 172 mines in total analyzed

## Generic cost model developed incorporating oil component

### General distinction between cash costs

- Initial AME set forms a sufficient sample for various kind of mining countries and technologies – sample testing for prominent mines and OEM suppliers by E.ON done to cross-check accuracy of data
- E.ON expert knowledge distinguishes between general inflation related cost items of coal extraction and oil related cash costs
- Main mining costs rooted in fueling excavators like trucks as well as explosives in open pit mining operations are exposed to trends in oil price (truck employment in coal and overburden haulage)
- Ratio between excavated coal and overburden is essential in this respect
- On top; transportation costs are evaluated for respective mines as rail carriage by diesel fuel trains has to be incorporated in comparison to electrified systems line in SAF or to Indonesian barge transportation



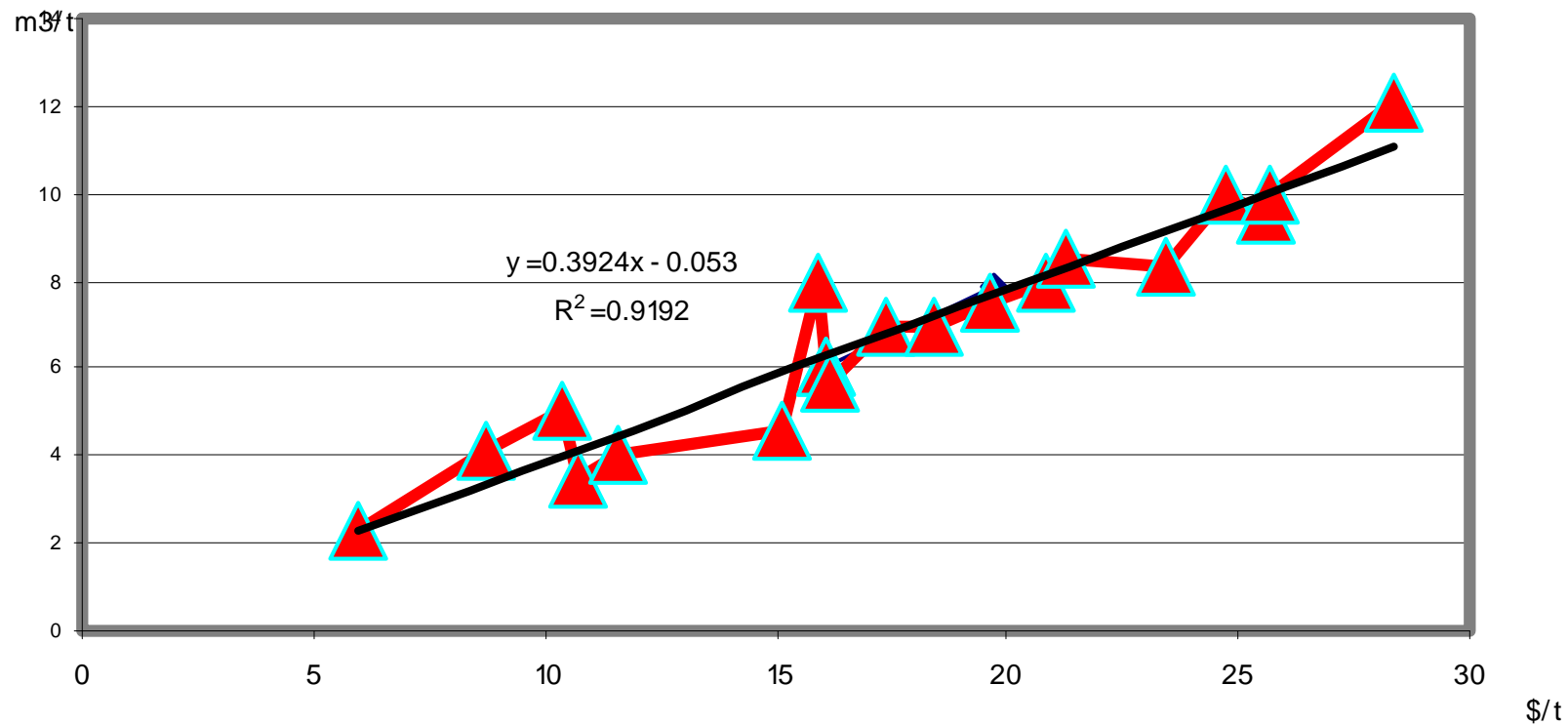
Fundamentally, oil correlation of mining costs only relevant for basis mining expenses and transportation costs to ports

**FOB cash cost item**

	<b>Oil correlation</b>	<b>Comments</b>
Labour costs	X	<ul style="list-style-type: none"> <li>Mine type and country specific labor costs on US\$/t basis</li> </ul>
Mining costs	✓	<ul style="list-style-type: none"> <li>Depending on mine type (opencast vs. underground), overburden:coal ratio (O:C) and technology (truck &amp; shovel vs. dragline)</li> </ul>
Processing costs	X	<ul style="list-style-type: none"> <li>Coal type and reserve specifics</li> </ul>
Royalties	X	<ul style="list-style-type: none"> <li>Country/state specific royalty charges</li> </ul>
Transportation costs	✓	<ul style="list-style-type: none"> <li>Depending on transportation to export harbors via train (diesel vs. electricity), truck or barge</li> </ul>
Port costs	X	<ul style="list-style-type: none"> <li>Port specific handling costs</li> </ul>

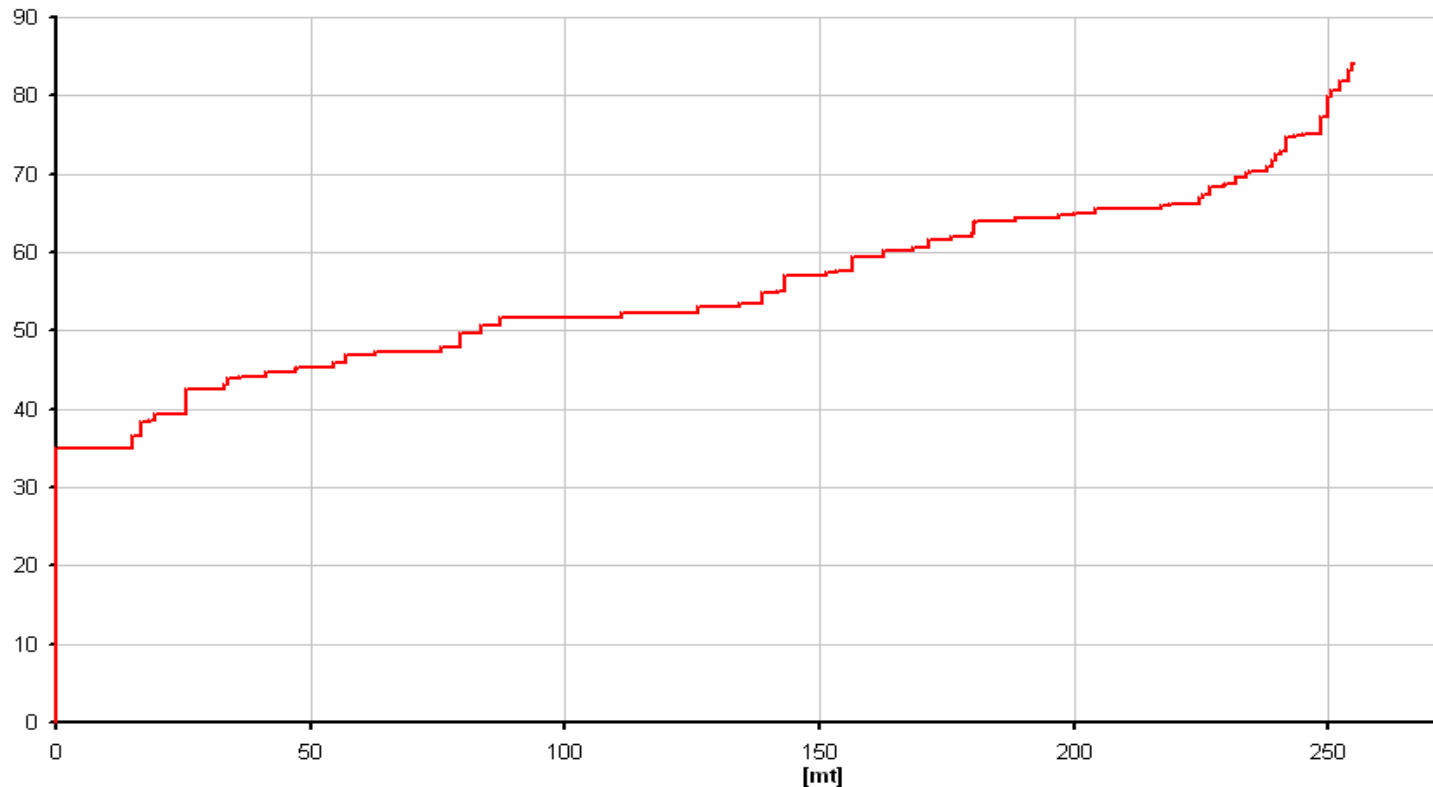
Future generic mine cost model incorporates mining specific characteristics

**Mining costs in relation to O:C ratio (Indonesia T&S)**



When looking at producers cash costs, e.g. Australian merit order depicts large bandwidth of miner's cost base

**Free on board (FOB) cash costs [USD/t]**



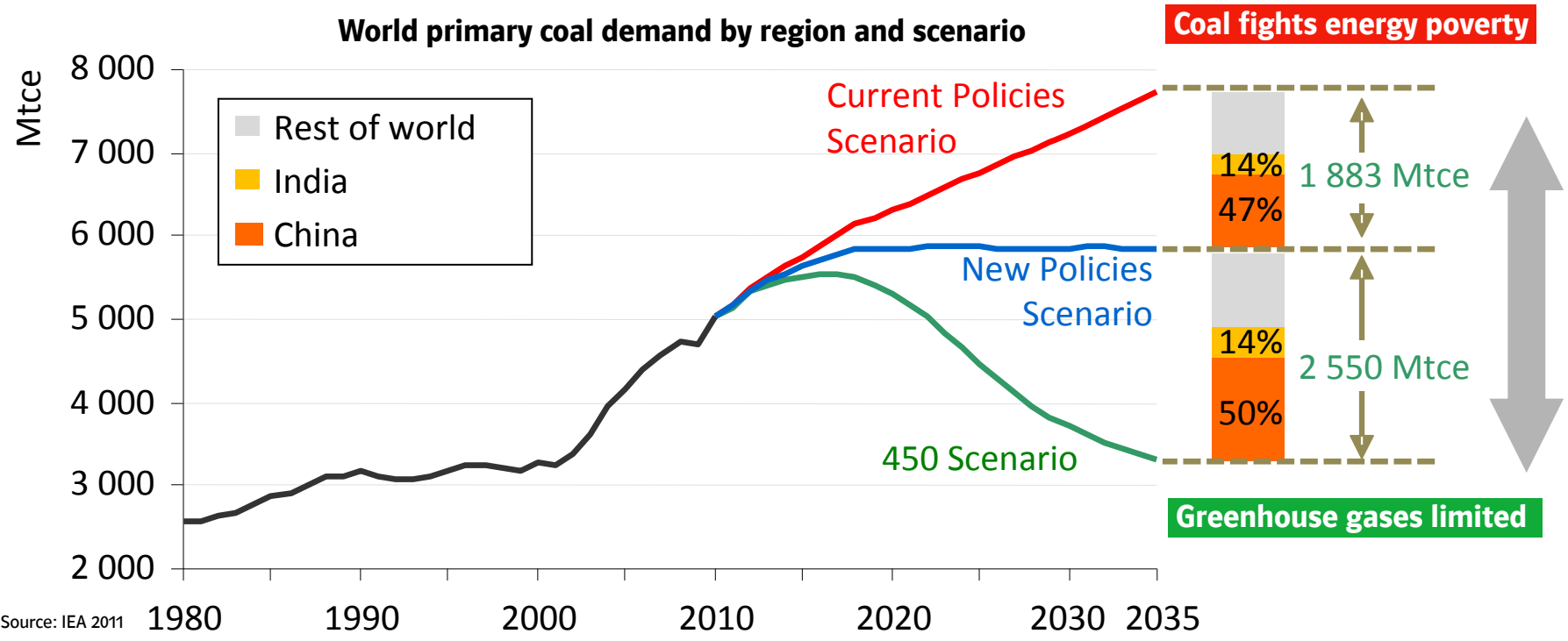
Source: E.ON Kraftwerke GmbH internal research

Assumptions on cost development combined with production generate country specific merit order supply curves

### Explanation of methodology for supply (2/4)

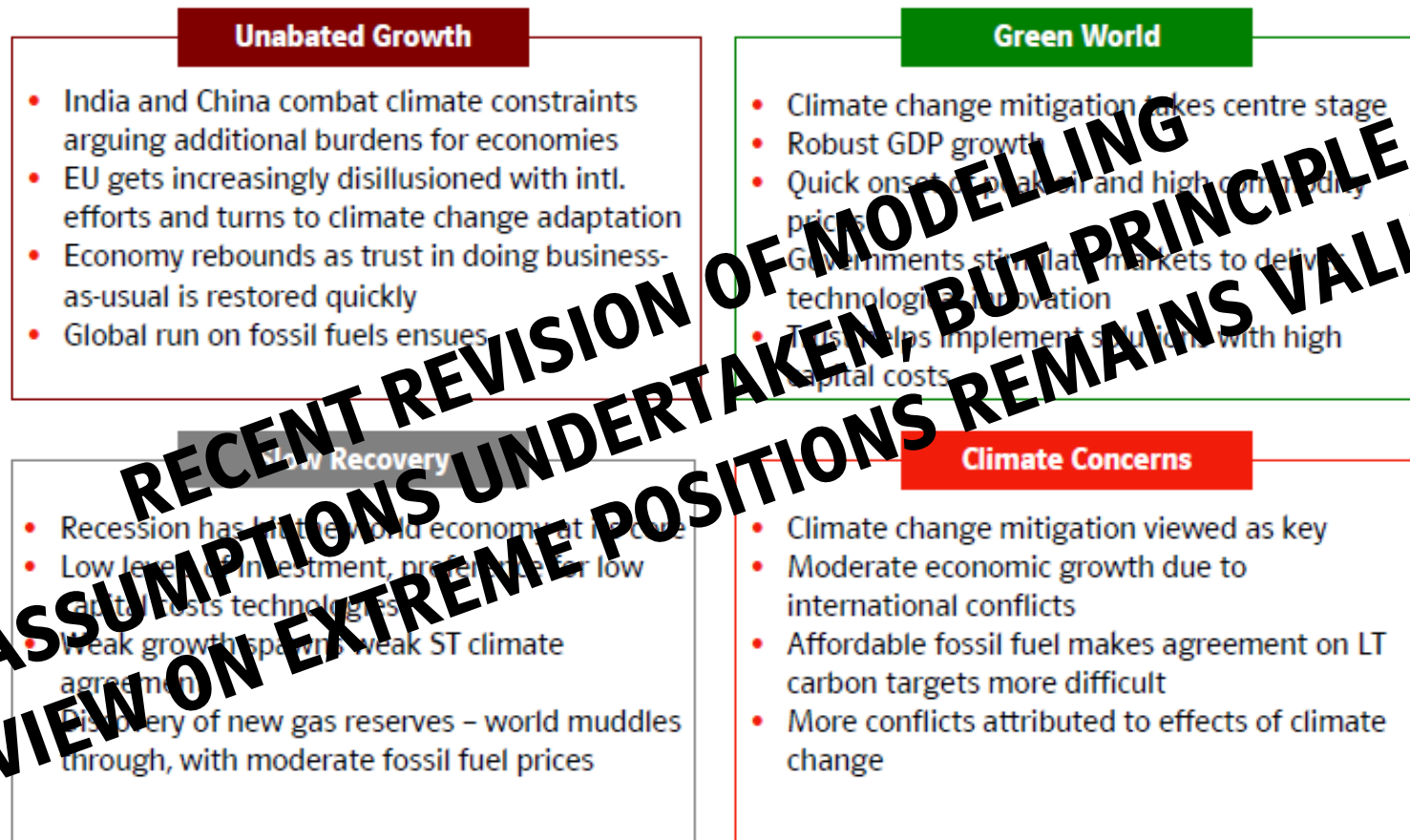
- 3a** For each mine, assign an estimated production cost (USD/t) based on historical mine specific production costs (where available) or the clustering of similar mines (type / region) for mines with no cost information
- 3b** Estimate the impact of oil price on production costs for open cast mines to fit in with E.ON oil scenarios
- 3c** Adjust the fixed cost component of production cost curves for E.ON inflation assumptions to 2030
- 4** Create a merit order supply curve for global export production capacity weighting the total available annual mining capacity (mntpa) by production price (USD/t FOB) for each of the years in the sample

In current situation coal is at a crossroads – demand to rise til 2020, but post?



Coal demand is set to slow – just how much depends critically on government energy & environmental policies, especially in China

A look into crystal ball – E.ON positions itself for the future by using detailed scenarios, also effecting coal models



Source: E.ON Investor Relation Information, 2009

Production volumes are adjusted in terms of active mines in case a 15-20% capacity safety margin is not yet covered

**Explanation of methodology for supply (3/4)**

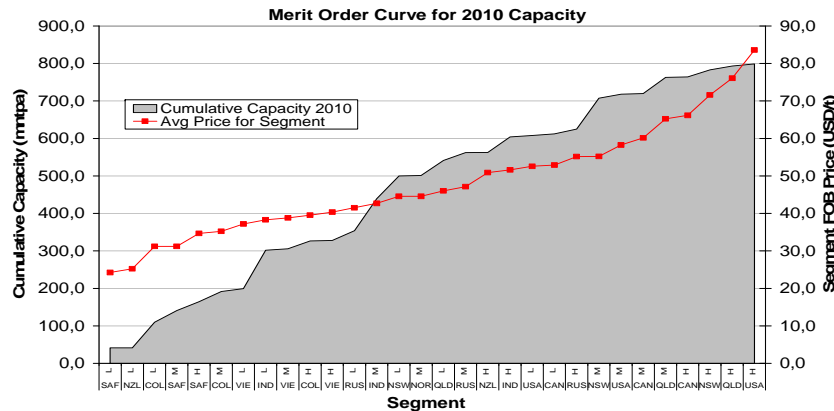
- 5** Evaluate needed demand for seaborne coal capacity with the available merit order supply curve for each year to make certain enough capacity is available  
 Available supply capacity should exceed demand scenario by at least **+15-20%** to assure adequate supplies and minimize price volatility due to seasonality, constraints, mining outages, weather, transport problems etc.

20xx			20xx			20xx						
Region	Production [mt]	Demand [mt]	Region	Region	Production [mt]	Demand [mt]	Region	Region	Production [mt]	Demand [mt]		
Australia - New South Wa	141,2	194,0	Europe	Australia - Ne	<b>interna</b>	<b>interna</b>	Europe	Australia - New S	<b>interna</b>	<b>interna</b>		
Australia - Queensland	74,1	346,0	Pacific	Australia - Qu			Pacific	Australia - Queer				
Canada	7,8	8,4	Mexico	Canada			Mexico	Canada				
China	0,0	7,0	Asia	China			Asia	China				
Columbia	91,6	0,0	Africa & Middle E	Columbia			Africa & Midd	Columbia				
Indonesia	22,2	12,6	Brazil	Indonesia			Brazil	Indonesia				
Mozambique	0,0	0,0	Russia and Frie	Mozambique			Russia and F	Mozambique				
New Zealand	1,5			New Zealand				New Zealand				
Norway	2,5			Norway				Norway				
Russia	59,9			Russia				Russia				
South Africa	82,9			South Africa				South Africa				
USA	19,7			USA				USA				
Vietnam	0,0			Vietnam				Vietnam				
Venezuela	12,0			Venezuela				Venezuela				
<b>Total</b>	<b>727,0</b>	<b>638,0</b>		<b>830,1</b>			<b>690,7</b>				<b>1067,1</b>	<b>813,1</b>
<b>Relationship</b>	<b>114%</b>			<b>120%</b>							<b>131%</b>	

Merit orders are matched in GAMS model with demand points and freight assumptions to determine volume flows

**Explanation of methodology for supply (4/4)**

- 6 Evaluate what production cost (FOB) is needed from the merit order curve to suffice global demand in each scenario. We have now identified the coal export sources. These results are reviewed and optimised using the freight costs in the GAMS model.



**Outcome:**

- Scenario
- Slow Recovery
- Green World
- Climate Concerns
- Unabated Growth

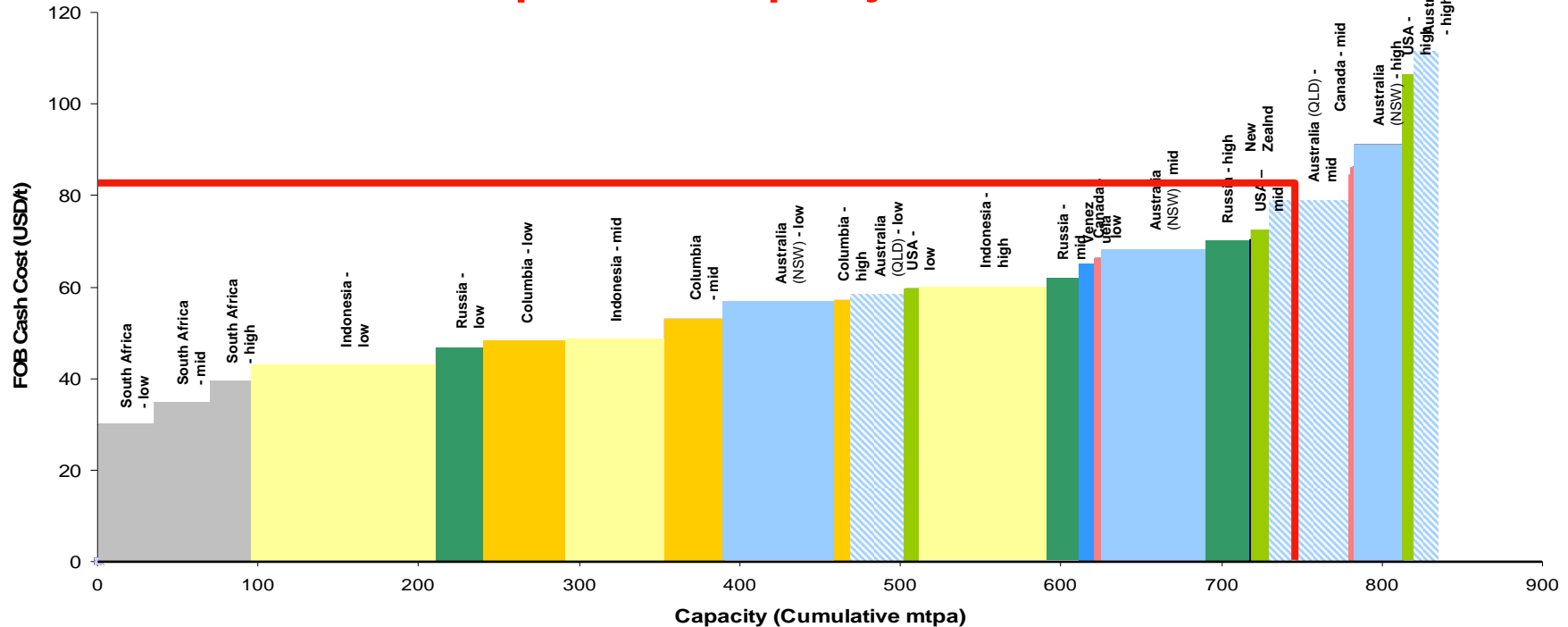
2010 Demand Levels			Source
Demand	+20%	FOB	
625	750		D - M
651			NSW - H
		71,6	NSW - H
		83,6	USA - H

**ILLUSTRATIVE**



E.ON forecasts conclude that sufficient steam coal capacity is available, if the coal chain functions efficiently

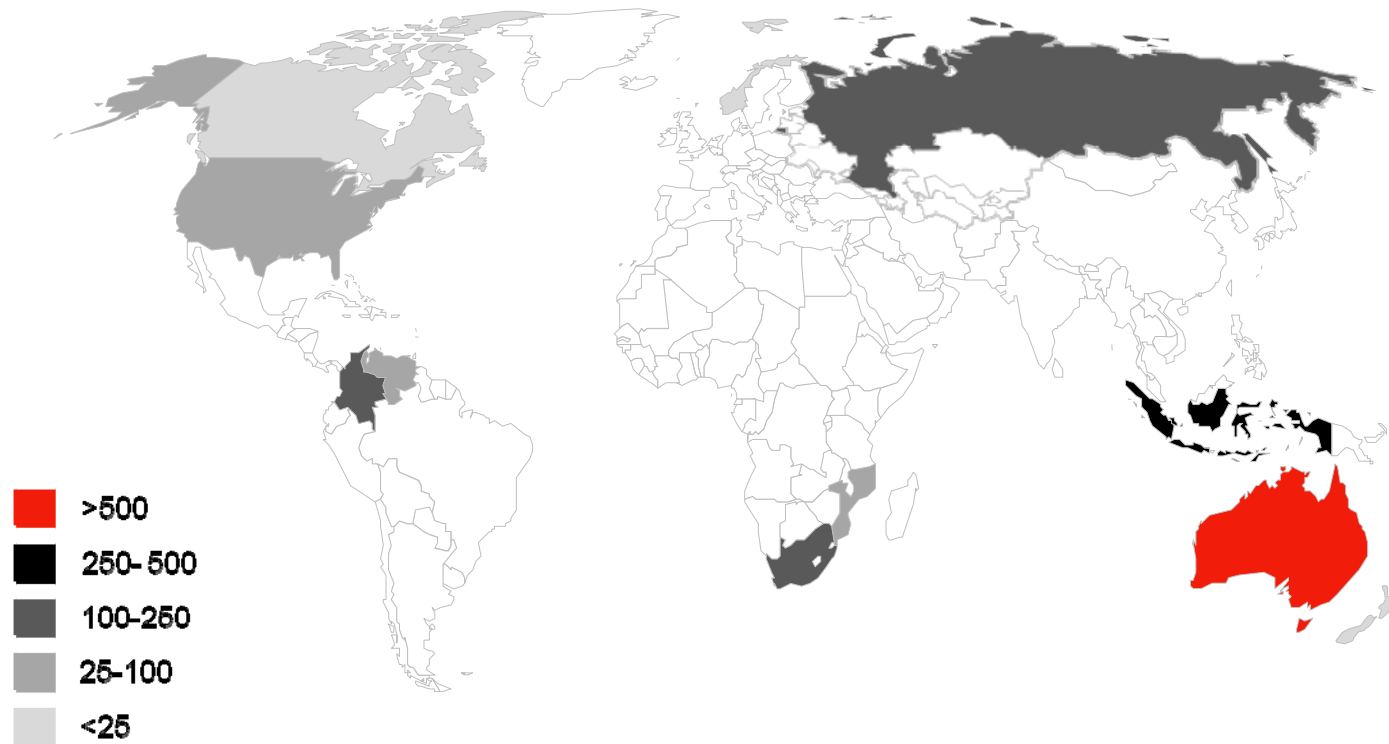
**Merit Order Curve for Export Mine Capacity in 2010/11**



- Actual plant costs must add freight, handling surcharges and a mark-up

With seaborne coal demand above 1 bn t in 2030, E.ON model predicts stable supply situation with usual suspects

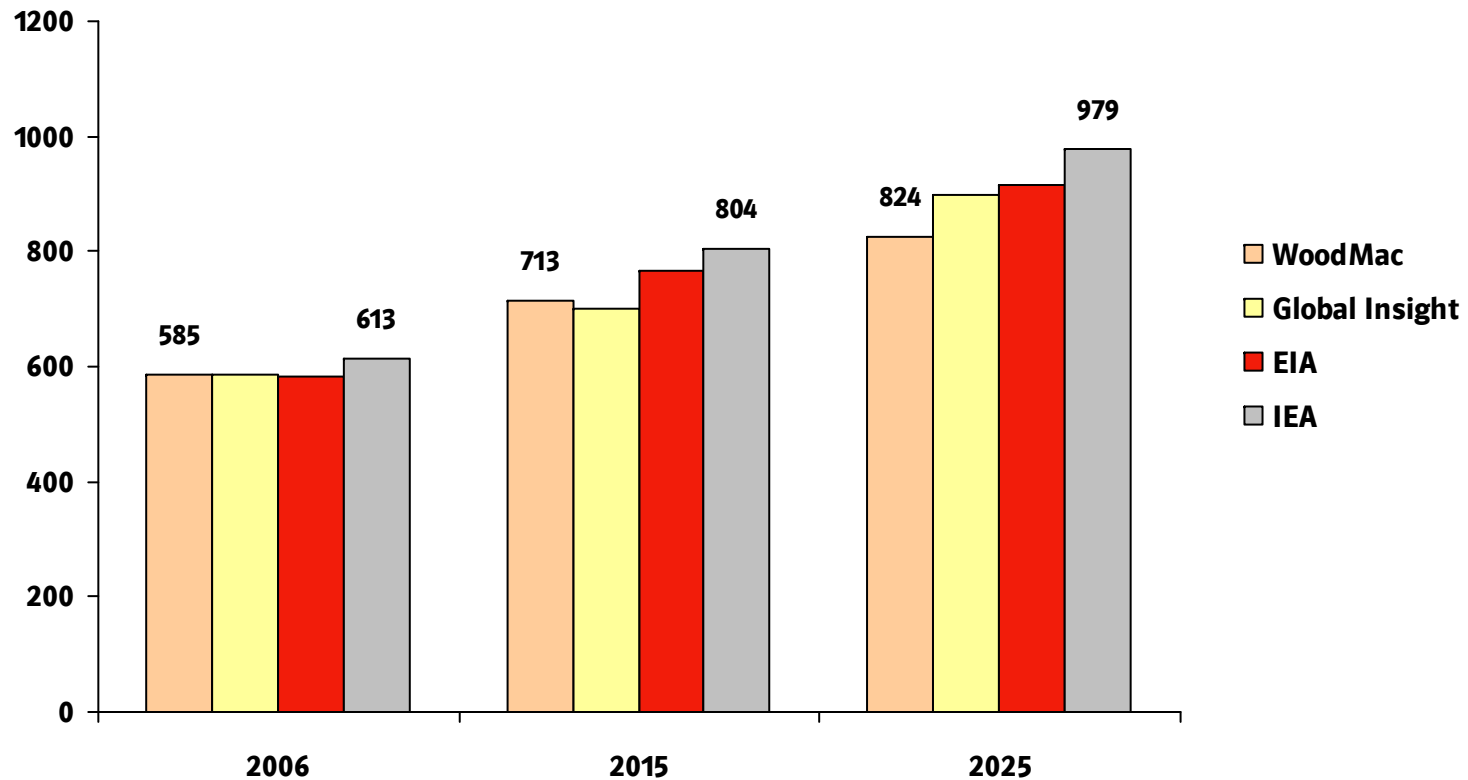
**World seaborne coal supply 2030 in mn t<sup>1)</sup>**



1) Assuming specific scenario based on EKW mine based supply model  
 Source: E.ON Kraftwerke GmbH internal research

The magnitude is line with other experts which also expect thermal coal export markets to grow significantly in the future

**Development of steam coal exports (Mio t)**



Source: Various forecasts

Consequently no significant change in European coal import mix expected with somehow predictable qualities

### Where will European coal imports come from?

- As majority of demand growth Asia centered – Australia, Indonesia and Mozambique will supply this area with seaborne thermal coal
- South African coal exports will most likely shift direction towards India rather than to European consumers
- Consequently Columbian and Russian coal are seen as the natural suppliers for EU thermal power stations in the future
- US will remain swing supplier, gas squeezes coal domestically and increases export capacity
- Norway and Venezuela will make up only small remainder of import coals
- Fundamentally cost mining cash costs are not expected to rise significantly above today's levels given moderate oil prices (incl. freight rates) and current taxation/royalty schemes
- Given the origin of future imports, quality bands for European utilities are not likely to deviate substantially from today, but quality mix means this will be premium coal qualities and = higher prices.

Fundamental coal data on mine by mine and project basis becomes more difficult - modelling also challenging

### Challenges for coal modeling

- Difficulties in procuring data are becoming a real issue
  - Fewer sources of information available in the market from coal experts/consultants
  - Movement towards information summarized at country level; mine level information limited
  - Information on coal qualities by producer / mine not in public realm
  - Quality of data for some large exporters (Indonesia, Russia) poor
- Optimisation modelling difficulties
  - Theoretically, a mark-up function for market premium possible; quantitatively, no successful proven approach for traded market
  - Measuring capacity availability / utilization means having a view of mine production capacity, inland transport and port capacity as restriction