

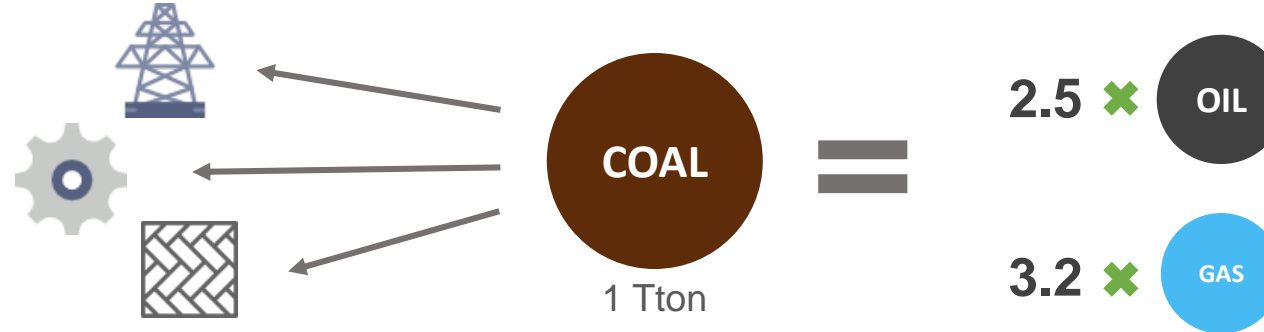


Innovation in coal mining

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Higman, B., McKittrick E., Active coal mining at Two Bull Ridge, Ground Truth Trekking, photograph, viewed December 2016
http://www.groundtruthtrekking.org/photo/active-coal-mining-at-two-bull-ridge_3/

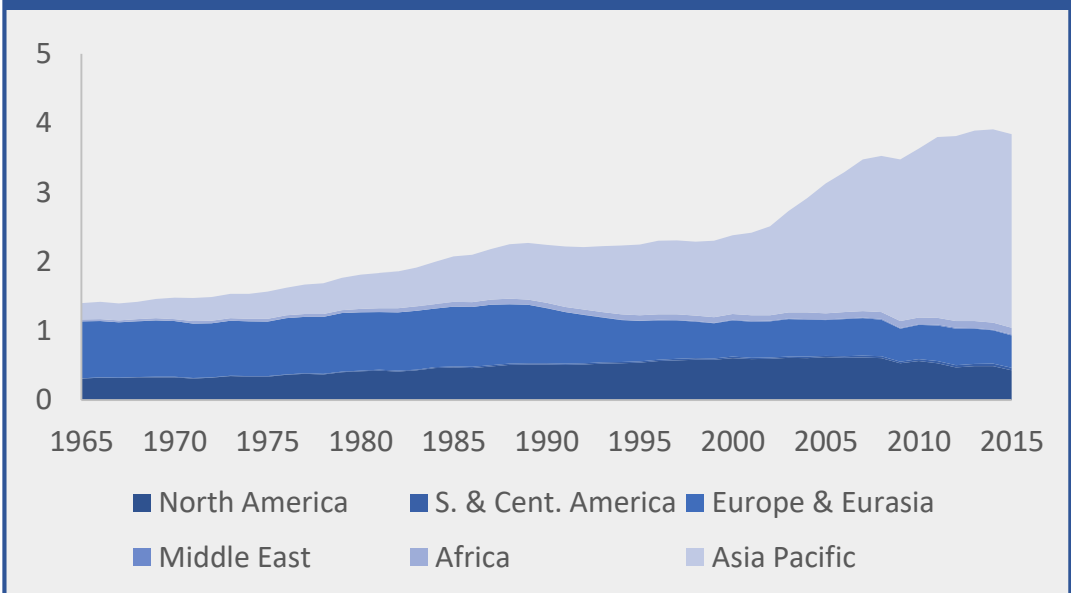
Coal plays a vital role in global economy



Coal industry is undergoing significant changes

- Asia is driving growth of coal production
- Consumption in Europe is declining due to switch to unconventional energy resources
- Energy security concerns force development of domestic resources and alternative energy
- Coking coal will sustain high demand, while thermal might lose its share

Global coal consumption, Billion TOE (BP, 2015)



Innovations in coal mining are mostly of incremental type

Coal companies' technology development:

- Mining companies utilize adaptor strategy
- Effect from economy of scale is diminishing
- In-house R&D expenditure account for 4-8 % of revenues and has been decreasing

Recent innovations:

- Since 1990 a few radical innovations occurred: long haul extraction, continuous mining, draglines and some other
- Incremental innovations increased efficiency and intensity of operations

Economy of scale in mining – Haul trucks

Over the period of 35 years, haul trucks have increased in size by **10 times**, at the same time the cost of the haulage has decreased by **72 %**



1970

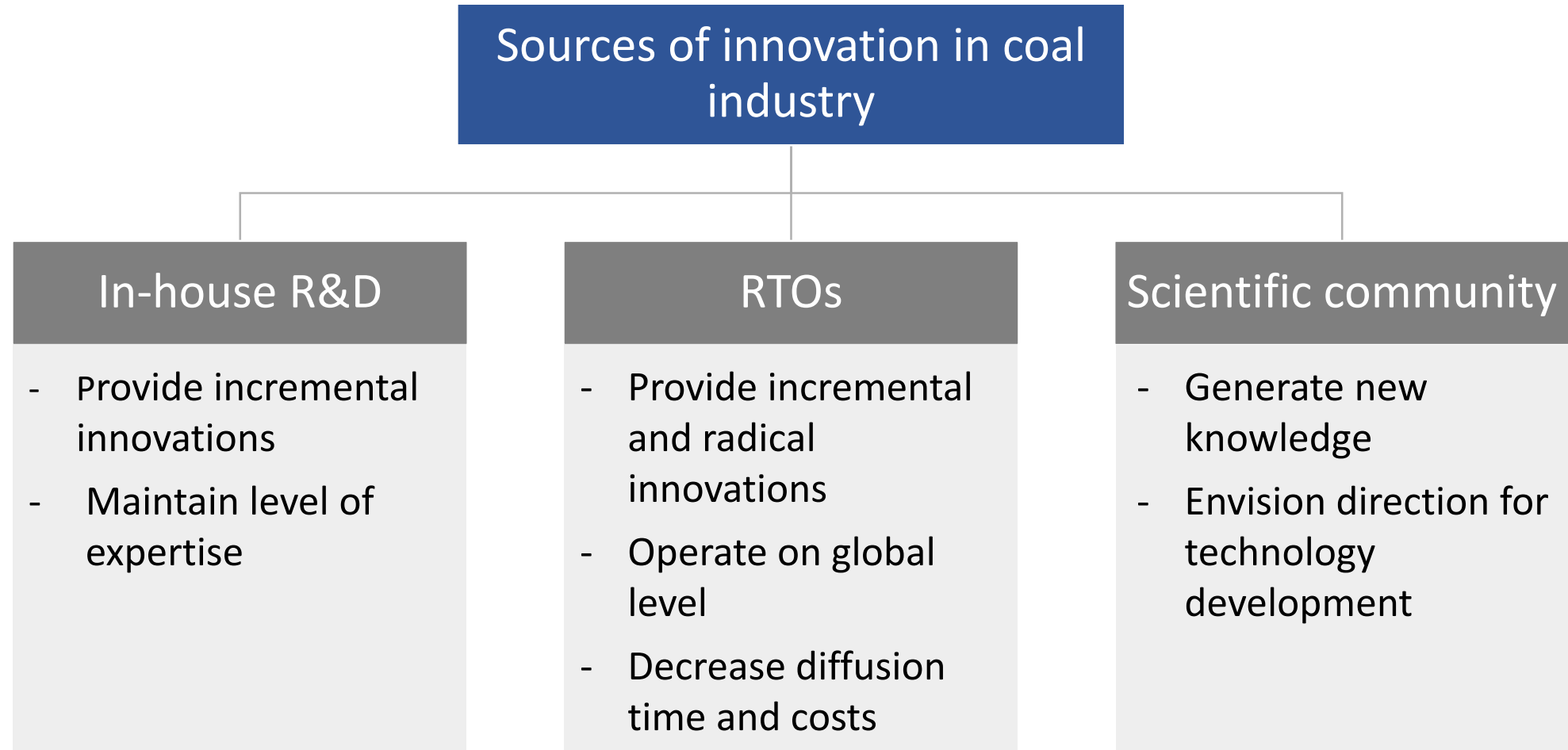


1990



2005

Cooperation with RTOs advances technology development in coal mining



Innovation in coal mining is driven by strengthening regulations and market growth

To continue growing, coal mining has to:

- Comply with emerging Health, Safety and Environmental regulations
- Increase efficiency and productivity of processes

Spheres that are targeted for changes

- Extraction
- Processing
- Supply chain
- Utilization (power plants)
- Waste recycle

Technologies that enable changes

- Sensing technologies & Internet of Things – will allow remote, real-time monitoring, diagnostics and prognostics
- Automation of machinery – will allow remote control of the processes without direct human intervention
- Combination of processes – synergetic effect will increase efficiency

Example of innovation in mining – Rio Tinto open pit mining

Rio Tinto owns Pilabara iron ore mine in Western Australia

- Launched first projects on automation of mining in 2008
- Introduced fully automated operations with driverless haul trucks and trains
- Remotely controls operations from Perth 1300 km away
- Delivers ore at 450 km distance of with driverless trains

Core technologies utilized:

- Sensing technologies
- Satellite communications
- Artificial intelligence
- Robotics

All of the technologies can be transferred to coal mining processes



Example of innovation in coal processing and utilization – Polygeneration plants

Polygeneration plants are **under development** in Australia, China, Japan, Europe, Canada and the USA

Polygeneration plants produce

- Electricity
- At least one of the chemical products: hydrogen, SNG, ammonia, methanol, dimethyl ether and other liquids from the syngas

Efficiency is greatly increased due to:

- Supply network redesign
- Synergetic effects
- Waste and emissions capture, reuse and recycle

Summary

- Coal industry has a big influence on local and global economy
- The future of coal mining relies on innovation activity for increase of efficiency and regulations compliance
- The industry has witnessed mostly incremental innovations recently; radical a rare
- Significant role in generating innovations is being undertaken by RTOs that enable rapid changes due to technology transfer and faster diffusion
- Current innovations are directed at all processes in coal supply chain: from mining to utilization

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