Global Energy Policy - Section 001

Impacts of Technology on Resources

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Executive Summary

Beyond the supercycle experienced by the five key commodities – thermal coal, crude oil, natural gas, copper and iron ore – technology plays a prominent role in affecting their demand and supply, as well as in motivating the development of renewables, which serve as substitution of conventional energy sources. This paper focuses on the impacts of technology on resources from various perspectives and concludes that the trajectory of energy transition calls for more awareness.

Supercycle 2003-2015

"Supercycle" is a commodity price boom and bust cycle. Commodity price movements are important in determining national trade, exchange rate, employment, income and inflation.

Since the prices of energy resources on commodity market are continuously fluctuating, this price volatility has been one of the most important industry's hallmarks. In this paper, five energy commodities' prices are mainly focused: Coal, oil, iron ore, natural gas and copper.

Figure 1 shows resource expenditures from 1900 and the two supercycles ever since, of which the 2003–2015 one was exceptional. Before it began in 2003, expenditures on mineral resources globally amounted to $1.2 trillion, about 3 percent of the world's GDP. Just ten years later, the world was spending more than $4 trillion annually on mineral resources, or 6.2 percent of global GDP. Even during the recession in advanced economies following the 2008 financial crisis, spending on resources barely eased. But from 2013, the prices of resources plummeted for a long period of time.

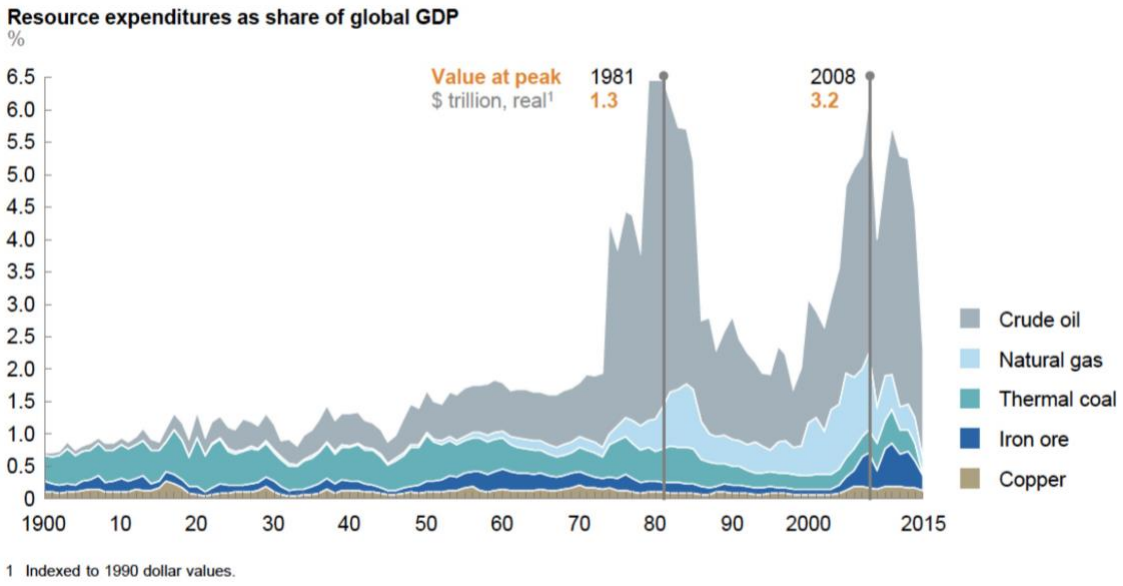

Figure 1. Resource expenditures as share of global GDP
Source: Rystad Energy; BP statistical review of world energy, 2015; World Bank; The Madison Project; USGS; McKinsey Global Institute analysis

This supercycle was caused by emerging economy growth as well as the dramatic change of China's demand. China's demand for energy resources increased a lot and then rapidly decreased due to its economy structure transition. However, it is recognized by most public that the key factor underlying this growth is technology. Technology is reshaping resources by bringing deep impacts on both producers and consumers, as well as by promoting renewables.

Technology impact on demand

As more technology become integrated in our homes, transportation and business, it has changed the energy landscape from demand perspectives. MGI's 2011 "resource revolution" report estimated that energy efficiency could reduce demand (moderate case) by more than 20% by 2030. And if technology is adopted to its full potential (technology acceleration case) a further 10% reduction could be achieved. These changes are mainly driven by increased technology adoption including automation, advanced analytics and internet of things.

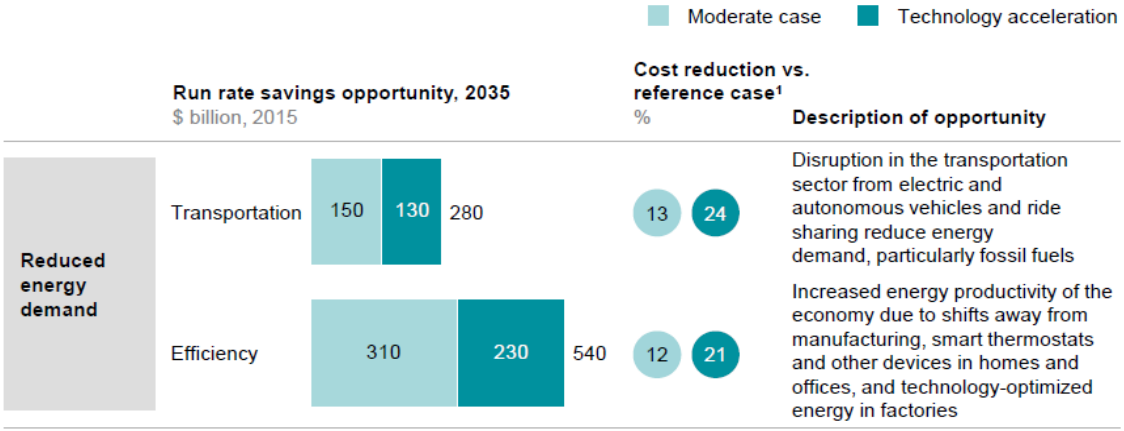

Figure 2. Technology will create opportunities for increased productivity
Source: McKinsey Global Institute analysis

These three technology trends increase public's awareness of energy usage and reduce energy consumption gradually. First, disruption in technology such as autonomous vehicles is reducing demand in transportation. Falling costs of electric vehicles, increasing use of ride sharing and the rise of autonomous vehicles are altogether changing driving behavior and therefore fundamentally changing energy consumption. These would lead to second-order effects for the resource sector as well. Reduced sale of vehicles made from steel and other infrastructure materials leads to less wear on roads. Land requirement will also be reduced and thus increase the development of housing. Moreover, technologies are also improving engine performance such as friction reduction and engine downsizing, which could reduce fuel consumption by trucks and aircrafts.

Second, in industrial settings, the combination of advanced sensors and analytics could reduce energy demand by 10 to 30 percent. For example, algorithms improvement in manufacturing robots is shown to

improve energy consumption efficiency by around 20 percent and a chemical company can reduce energy consumption by 10 to 20 percent if using improved sensors and modelling techniques.

Third, smart control systems and internet of things technology could boost adoption of more efficient devices in home. Smart control systems can automatically control energy usage when users enter or leave buildings to achieve 20 to 30 percent of energy savings. As technology gain wider adoption, information from different devices will be input into a central app, which will function as an energy audit and connects consumers with providers of installation or replacement services, and will likely to change consumers behaviors and therefore reduce energy consumption.

As a result, in moderate technology case, a reduction in consumption of fossil fuels of 140 million terajoules is expected, while in technology accelerated case, consumption of fossil fuels will decline by an additional 100 million terajoules.

Technology impact on supply

On the supply side, resource producers could benefit from a significant increase in technology-enabled productivity.

Now the challenges faced by resource producers are a significant productivity challenge, particularly as reserves become more difficult to access, and a long-term decline in overall productivity. This is where technologies come in. Technology has delivered productivity gains in the past, for example when oil faced the threat of hitting peak supply, by opening up access to new reserves. Today once again, technological progress could play a key role in lifting the resource sector productivity.

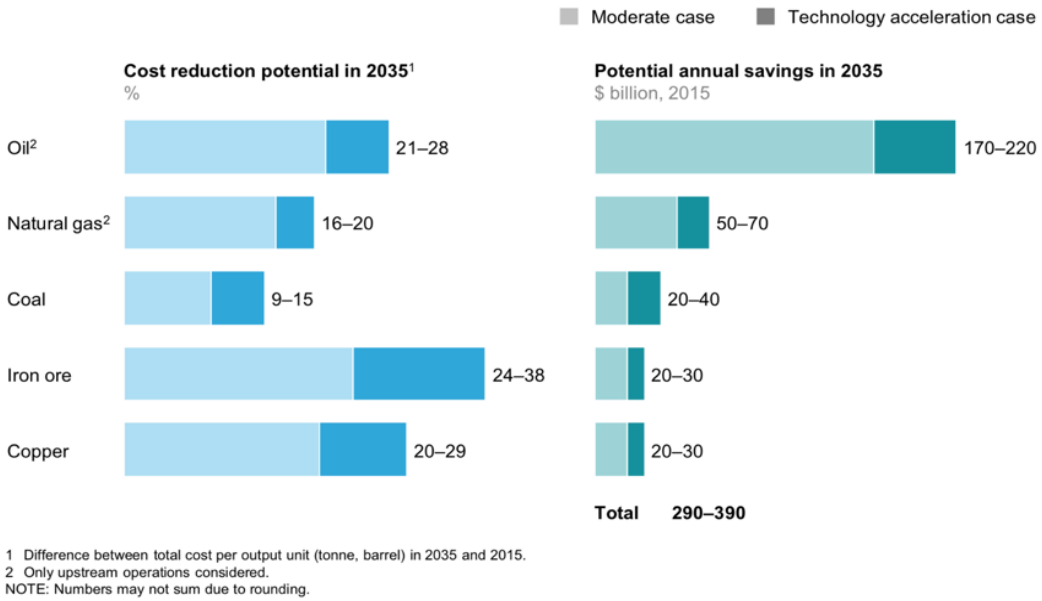

Figure 3. Technology could unlock up to $400 billion in annual value for resource producers by 2035
Source: McKinsey Global Institute analysis

Adoption and adaption of existing technologies could substantially increase the productivity of the oil and gas and mining sectors, with gains in technology acceleration scenario ranging between almost 20 percent for coal and more than 60 percent for iron ore. In all, there productivity improvements could unlock between $290 billion and $390 billion in annual value for resource producers in 2035.

There will be large scale applications of technologies. Each sector has specific technologies with specific uses that will help bring about a productivity boost. In oil and gas, technology can make the workplace safer and more productive. For example, on-site drones and robots take over dangerous activities on platforms and in fields (e.g., maintenance and inspections), it can reduce costs and improve safety. In mining, automation and analytics can transform production. For example, autonomous vehicles like trucks and drillers will result in less downtime and greater reliability through continuous operations. New technologies are also likely to benefit utilities. For example, sensors and real-time data analytics across assets allow for by-the-minute adjustments to maximize power generation efficiency, e.g., communication to adjust to changes in wind conditions automatically.

Renewables empowered by technology

Since 2013, renewable generation continues strong growth, outpacing fossil fuel and taking share of the market. Post 2020, cost of renewables becomes competitive with marginal cost of fossil fuels in most regions, accelerating transition. Post 2035, the trend continues. As substitute of traditional energy, potential 36% share of power generation by renewables in 2035, up from 4% today, which means renewable energy becomes more available. Technology can affect renewable energy from following benefits and obstacles.

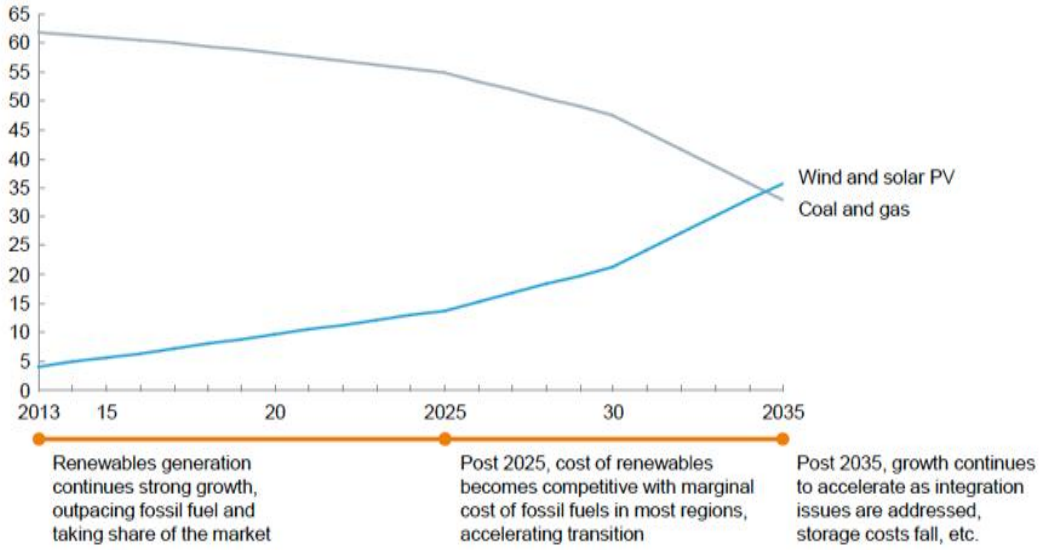

Figure 4. Global power generation mix (% of total generation)
Source: McKinsey Global Institute analysis

First benefit: Technological advances will continue to bring down the cost of renewable energies such as solar and wind, as well as the cost of storing them. Renewable energy usage has been rising rapidly as

costs have fallen. Since 2001, total solar generation worldwide has grown by 50 percent annually, while wind power generation has been growing at an annual rate of 24 percent. But, Costs have been falling sharply with widespread deployment of the technology; new solar power plants being contracted today are being bid at below $0.03 per kilowatt hour (kWh)—about one-tenth of the cost of solar plants just six years ago. This will hand renewables a greater role in the global economy's energy mix.

Efforts are also under way to reduce material costs by creating less waste, for example with kerfless wafers, which require no saw to cut a silicon wafer off a large ingot, and to extend the lifetime of the equipment. Soft costs associated with installing panels and turbines are likely to continue falling too.

Second benefit: Technology improve renewable energy efficiency a lot. Renewables are not only substituting for fossil fuels, but also reduce overall demand for energy, as they do not incur the heat losses associated with fossil fuel power generation.

Besides benefits, there are some obstacles we still need to overcome in the future. Storage is one notable challenge: it could be a key enabler of growth, but it has limitations, including capital investment, which needs to increase by about 47 percent over the next 20 years to hit penetration levels.

Another challenge is scaling the industry and ensuring that players in the supply chain receive adequate returns to warrant investment. The industry has shown that it can grow very rapidly if there is a driver for supply expansion. Recent research has highlighted that the industry needs a margin exceeding 15 percent to grow at 19 percent per year. However, supply expansions continue in the face of low prices, indicating that the industry is continuing to find ways to lower costs and increase profitability to warrant new investment. The industry will also have to overcome the challenges of training a large and geographically disparate labor force to enable cost reductions. Engineering, procurement, and construction firms that are able to standardize the installation process and create effective training programs will be most affected.

Correlation between commodities

The impacts of technology vary among these five resources, as a result of which their correlations alter significantly. As predicted by McKinsey, the year of 2015 has been the watershed in correlations between commodities' demands – before 2015, demands for the five commodities were increasing in a highly positively correlated way; while after 2015, each commodity is expected follow dramatically different demand curve, resulting in muted demand for these resources as a whole.

Copper demand is expected to continue increasing for the next few decades, as copper can be used for a wide range of purposes in modern economy, from electronics to infrastructure, in spite of increase in substitutions. On the contrary, iron ore could experience a decline in demand as the recycling rates of steel increase and the steel demand growth slows down. The similar decline is also faced by coal. Although coal has been dominant resource in electricity generation for a long time, its leading role is challenged by natural gas as well as other renewable resources under growing environmental concerns. Technology, which could drive down costs in renewable power generation, further undermines coal

demand. In terms of oil and natural gas, as the world is focusing on transitioning from fossil fuels to more environmentally friendly energy, their demands are expected to fall. Technology could exacerbate this decline by improving energy efficiency.

With projected the demands of these five commodities, further projection in prices can be conducted. In the meantime, examining the projection with real-world data is essential. Figure 5 shows prices changes of these key commodities within the last five years. According to these charts, all of these five resources have experienced a price recovery from low points. The most dramatic one is coal price, which have been expected to decrease with the adoption of technology, has actually increased and reaches a surprisingly high level recently. Iron ore and oil are facing similar situations, though less significant than coal.

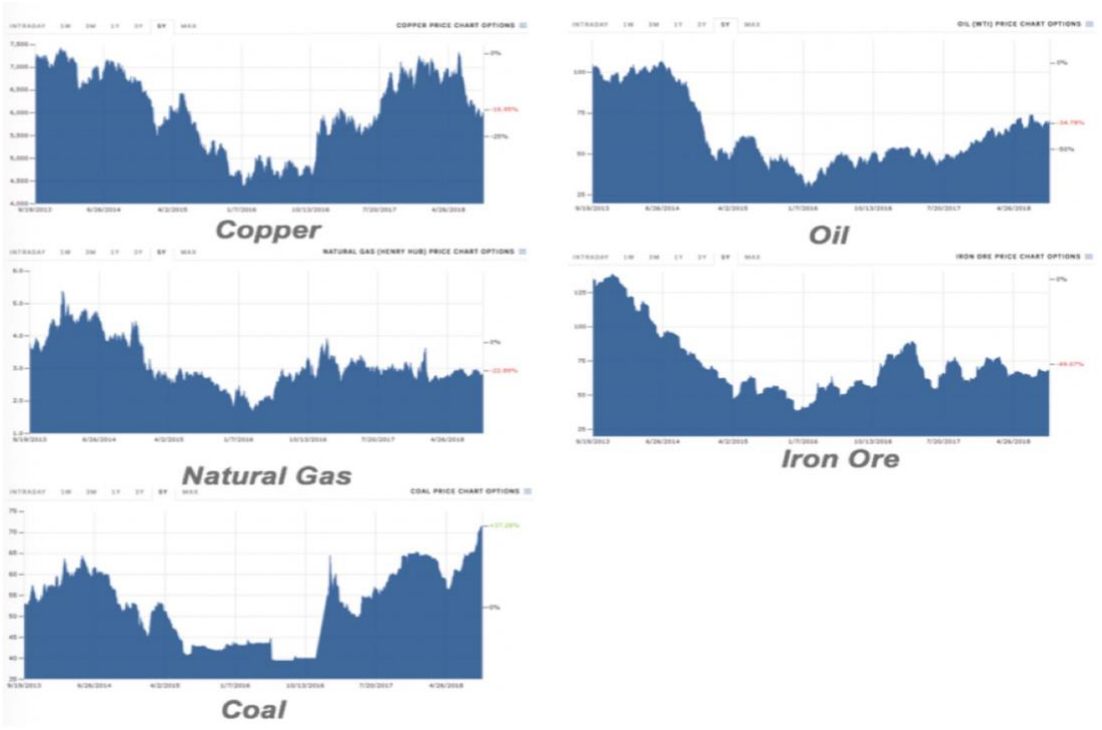

Figure 5. Prices of Copper, Natural Gas, Coal, Oil, Iron Ore 2013-2018
Source: Market Insider

Conclusion

Difference between projection and real-world data serve as a reminder that, the energy transition is a long process with ups and downs. From the perspective of technology adoption, changes in commodities demand, supply as well as renewables development can be projected. However, more factors need to be taken into consideration, just as the case of 2017 that, with two steps forward in energy transition, one step back worth more awareness.

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