THE FUTURE OF THERMAL COAL IN POWER GENERATION

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In recent years, financial institutions – particularly banks – have been very cautious about managing the social and environmental risks in project finance, resulting in 92 financial institutions in 37 countries adopting the Equator Principles with links to their annual 'Equator Principles Financial Institutions Reporting'.

There has also been a growing concern in the investment community that being associated with thermal coal projects is not good for their business and/or their reputation. For this reason, a number of investment institutions have started to shy away from the thermal coal projects, particularly in Europe.

These reactions immediately captured the public's attention, aided by environmentalist lobby groups' and media coverages' ever-increasing campaigns on global warming. Hence, the deepening of coal's struggle to survive in the energy markets.

However, one particular aspect is commonly forgotten or conveniently overlooked when dealing with coal in the public domain: that not all coals are the same as there is a significant difference between metallurgical and thermal coals. The former is the essential component in many metallurgical applications such as steelmaking, whilst the latter is mainly used for energy generation. The environmentalist lobby does not distinguish between these two types, thus branding them as the same, which is not the case and, of course, misleads the public.

As pressures and concerns regarding climate change mount from the contemporary society, the future of coal in power generation is becoming increasingly challenging for stakeholders, such as investors, policy makers and technical professionals. It seems the writing is on the wall for thermal coal.

However, the same conclusion cannot be reached for metallurgical coal, which is still needed in large quantities in steelmaking processes worldwide, as the existing good quality deposits are rapidly depleting and not many metallurgical projects are in the pipeline to support future demands. Therefore, it is expected that metallurgical coal will still be in demand in the coming years and, due to limitations in supply, the price will gradually rise.

Reasons for thermal coal being in defence

So, why is the good, old king 'coal' in this situation for power generation? There are a number of reasons for thermal coal being at the defensive front. These reasons are briefly summarised as:

- Climate change concerns, hence the efforts of reducing CO_2 emissions in particular from coal.
- Social resistance towards coal with it being regarded as the main culprit for global warming.
- Increased competition from the renewable energy sources.
- Air quality concerns related to the air pollutants emanating from coal.
- Visual impact on the surrounding vicinities where coal mines and power plants operate.
- Waste management associated with the generation of excess power plant waste residue and issues on its handling.
- Poor investment returns on some coal operations.

Reality checks vs wishful thinking

Despite the general reluctance by the investment community to favour thermal coal in energy portfolios, there are several pressing issues that affect the global understanding on demand and supply for energy that need to be taken into consideration. These issues must not be ignored or overlooked, as they will drive the roadmap for the policy makers, investors and users in the coming decades. The alternatives for power generation have their own issues (e.g. nuclear) so investors and the public need to make some decisions essentially on the lesser of two 'evils'.

The following are some of the main issues that need to be considered.

Fact one: population increase

According to the 2015 United Nations' (UN) projections, the world population continues to grow and is projected to increase by more than 1 billion people within the next 15 years, reaching 8.5 billion in 2030, and is to increase further to 9.7 billion in 2050 and 11.2 billion by 2100 (Figure 1).[1]

A rapid population increase is anticipated in Africa, particularly in 27 countries, and this is projected to grow to 25% in 2050 and 39% by 2100, while the share residing in Asia will fall to 54% in 2050 and 44% in 2100.

In addition, between 2015 and 2050, half of the world's population growth is expected to be concentrated in nine countries: India, Nigeria, Pakistan, Democratic Republic of the Congo, Ethiopia, United Republic of Tanzania, the US, Indonesia and Uganda, listed according to the size of their contribution to the total growth.

Moreover, significant gains in life expectancy have been achieved worldwide in recent years. According to the UN figures (2015), life expectancy at birth rose by three years between 2000 - 2005 and 2010 - 2015 globally, that is from 67 to 70 years.

Furthermore, there is always unexpected population movement between countries due to wars, ethnic conflict, famine or natural disasters, which can easily skew the projections as is being seen in the Syrian, Iraqi, Yemeni and Myanmar conflicts, and inevitable consequences on host countries trying to accommodate, provide power and feed refugees fleeing the disaster zones.

The 10 largest populated countries in the world currently include Nigeria, Bangladesh, China, India, Indonesia, and Pakistan, Brazil Mexico, the US and Russian Federation.

Population growth has always been a challenging issue for policy makers, but one particular challenge is the concentration of population growth in the poorest countries that will make it harder for those governments to eradicate poverty and inequality, deal with food shortages and malnutrition, and provide education services and health systems whilst providing and improving other fundamental services.

However, these issues resulting from population growth are also a challenge to any country, rich or poor, when it comes with a price tag.

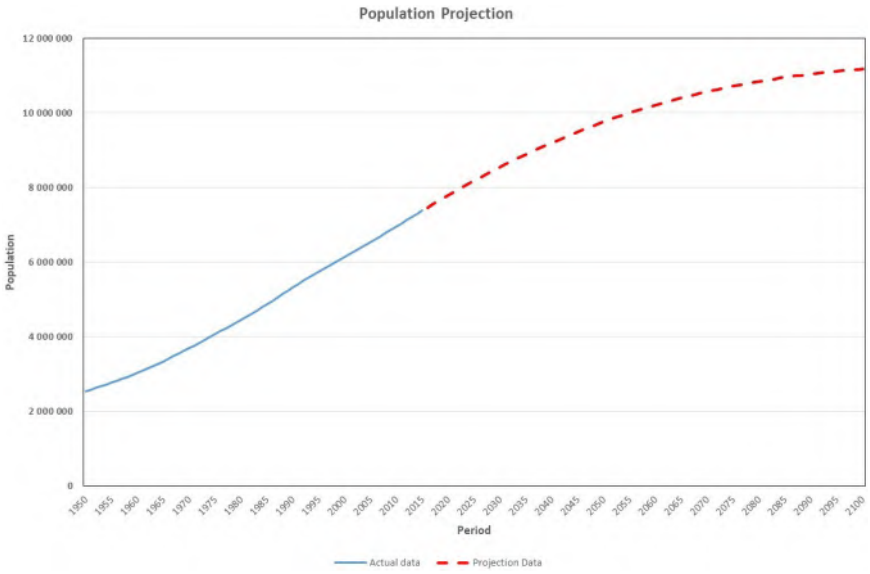

Figure 1. Average annual rate of population change by major area. Source: United Nations, Department of Economic and Social Affairs, Population Division, 'World Population Prospects: The 2015 Revision', New York, 2015.

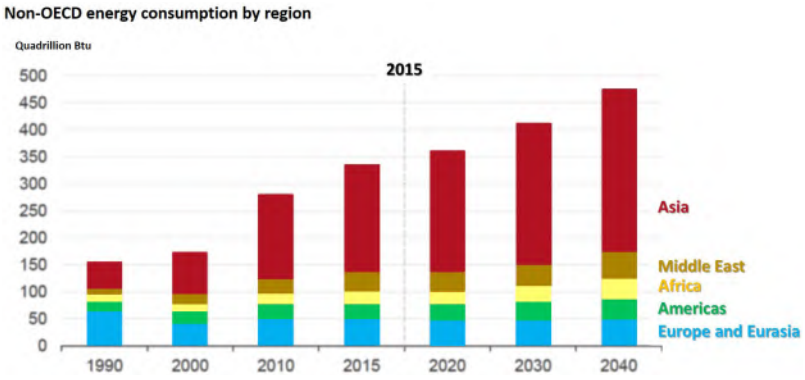

Figure 2. Energy consumption by region. Source: Energy Outlook 2017 by US Energy Information Administrative.

Fact two: energy demand

It is an indisputable fact that economic development in any society is dependent on the availability of affordable energy. As the world population steadily increases in every part of the globe from 2.5 billion to the current level – 7.5 billion since 1950 – the demand for goods and services also come under pressure to deliver to both local and international markets in an efficient and steady manner.

Energy demand is evident in all levels of society, from industrial to domestic consumption. The same is also true in terms of consumer products; power is required at multiple levels in the manufacture of equipment and for fast moving consumer goods.

The disproportionate growth rate in economies coupled with the increased demand for basic services, particularly in Africa and Asia, has accelerated the demand for energy requirements in these countries in the last few decades (Figure 2).

This means that additional goods and services need to be produced and provided to this growing population in the coming decades, leading to further growth in economic activity. However, this will still be challenged by relatively underdeveloped energy infrastructures, and large rural populations could constrain growth in energy consumption in many countries.

The thirst for technology has further exasperated an already difficult situation with heavy industrial machinery and equipment, cars, ships, building materials, computers, mobile phones and other electrical equipment all requiring power to be manufactured, maintained and operated. As developing nations 'develop', the energy demand increases, putting further pressure on power generation.

Even the energy storage in the form of Li/Co/Ni battery revolution still needs generating the energy in the first place.

Fact three: global shift in industrial development and economic growth

Europe and the US have always been, and to some extend still are, the power engine of the world economy. However, towards the end of 20th century, the world has seen a significant transformation in economic activity towards the newly developed economies, hence the development of the acronym 'BRICS' (Brazil, Russia, India, China and South Africa), originally proposed by Jim O'Neill of Goldman Sachs.

On almost every scale, BRICS is the largest entity on the global stage since it comprises over 25% of the world's land coverage and 40% of the world's population, and includes a combined GDP (purchasing power parity [PPP]) of US$20 trillion. These countries, particularly China and India, are still the champions of economic growth globally since they are not only providing goods, services and raw material for their vast domestic market, but also for the rest of the world.

These new economies have succeeded in meeting the increasing demands for goods and services worldwide through the increased investment in their own economies.

In addition to the BRICS countries, new players were recently added into the list by the original proposer, hence the creation of the new acronyms: 'MINT' and 'Next Eleven'.

MINT comprises Mexico, Indonesia, Nigeria and Turkey, whilst the Next Eleven comprises of the MINT countries, as well as Bangladesh, Egypt, Iran, Pakistan, the Philippines, South Korea and Vietnam. The Next Eleven countries comprise an area of 10 million km^2 while having a combined population of 1.46 billion with a combined nominal GDP of

US$6.5 trillion. In terms of PPP, their GDP reached US$15.5 trillion.

It is inevitable that the excess capital generated through the economies of the BRICS, MINT and the Next Eleven countries will also dominate where the next investment decisions will be made when it comes to power generation.

The capital may not be easily available from the western-based economies on some 'controversial energy sources' such as coal for the global projects, but the surplus capital generated in the local economies from these new power engine countries should find its way to the new investment opportunities in coal projects.

Fact four: ease of conversion from fuel to energy

When energy needs for nations and economies are planned, a number of factors need to be considered:

- Availability of the fuel source and its abundance.
- Its efficiency in its usage.
- Its cost and competitiveness, both present and future.
- The security and guarantees for present and future supplies.
- The environmental and social risks and its safe usage throughout the lifecycle of energy conversion process.

As there are a number of fuel options available for energy generation from various sources, they all have their unique advantages and disadvantages when it comes to decision making for the preferred option (Figure 3).

Can the trend for coal be reversed?

It appears that coal is becoming a lonely force in the fight to survive in the old, established economies. However, this struggle is expected to last a little longer than anyone anticipated due to the hard facts, such as growing world population, energy needs of newly developed countries, availability of the energy sources and fundamentally the fuel economics.

Although the old economies are becoming increasingly wary of coal-related projects and resisting investing in them, it is expected that this trend will take some time to catch up with the newly developed economies such as BRICS, MINT and the Next Eleven.

For example, C. Agaton investigated the options of coal, renewable and nuclear energy in investment decisions for the Philippines by using a 'real option approach' to analyse whether investment decisions will be in favour using coal for electricity generation or shift to alternative energy sources.[2] Agaton's investigation concluded that timing is essential when considering investment decisions and, despite the risk of having a nuclear accident, investment in nuclear energy seemed to be attractive in the Philippines. He further commented that with long-term reliability, nuclear energy may only serve as a transition technology from coal to renewable as concerns of the public about safety issues, proliferation of nuclear material, long-term nuclear waste disposal and the risks of using nuclear energy needs to be considered first.

It is interesting to note that the energy sources mentioned in Figure 3 have a number of pros and cons associated with them and there is no single magical answer for the question of energy demands in the short-term.

Item	Coal	Gas	Oil	Solar	Water - Rivers	Water - Tidal	Wind	Geothermal	Biomass	Nuclear (Uranium)
Technology	Mature	Mature	Mature	Relatively new	Mature	Relatively new	Mature	Mature	Mature	Mature
Technical Challenges	Low	Low	Low	Low	Low	Low to medium	Low	Low to medium	Low	Low
Flexibility in sustainable energy provision	High	High	High	High	High	Medium	Low to medium	Low to medium	Medium to high	High
Availability	In abundance	In abundance	Finite, very valuable	Free	Water dependant	Free	Free	Free	Abundant (waste material)	Abundant but can be limited in supply due to market conditions
Reliability for quick energy provision	Yes	Yes	Yes	Yes/No	Yes	Intermittent and unpredictable;	Yes/No	Medium to high	Low to medium	High
Fuel Cost	Very competitive	Competitive but depending on the market	Competitive but depending on the market	Free	Free	Free	Free	Free	Low	Competitive
Installation cost	Medium	Medium	Medium	High + re-arrangement of network distribution infrastructure	High	Medium to high	Medium to high	Medium to high	Low	Low
Production Cost	Very competitive	Very competitive	Competitive	Very low	Low	Low	Low	Low	Low	Low
Storage/distribution cost	Low	Low	Low	High	Low	Low	Low to medium	Medium to high	Low	Low
Technical Investigation for investment	Relatively short	Medium to short	Medium to long	Short	Medium to short	Medium to short	Medium to short	Medium to short	Short	Very long and complex
Health & Safety Risks	Low	Storage risks, fracking concerns for shale gas	Storage risks	Very low	Low	Low	Low to medium	Low	Low	Low
Other positives	Options to produce liquids from coal	Quick solution for short term requirements	Quick solution for short term requirements	No greenhouse gas emissions	Clean source (non-pollutant); Contribution into the development of the local communities, farming, tourism, recreation etc., eco-system,	Higher efficiency; no greenhouse gas emissions	No green gas emissions	Higher efficiency; no greenhouse gas emissions; small land foot print for installation	Certain degree of flexibility (generation of CH_4, biodiesel and other forms of biofuels) in relation to a sustainable energy provision;	Long term stability in energy provision
Emissions in power generation	CO_2, NOx, Sox, particles	CO_2, (but less in quantity) + some contaminants hence its cleaning	CO_2	None with the exception of initial solar panel manufacturing	None	None	None	None	Carbon Neutral	None
Visual Impact	Medium impact from surface mines	Low	Low	Low to medium	Low	High	High	Low	Low	Low
Other concerns	Acid mine drainage	Political and security risks in its provision by pipelines through the energy corridors; Fracking concerns for shale gas	Pollution concerns on its transportation, storage and usage;	Space dependant hence requirement for large areas, inefficiency rates, sunlight dependant, conventional energy source to be in stand-by mode	Likely environmental damage/change in eco-system; conflicts due to water scarcity between the neighbouring countries; possible local draughts; risk of flood in downstream locations; siltation in river channels/dam reservoir and change in local hydrological/ hydrogeological regime;	Limitations in close to the land; Environmental concerns on the local fauna and flora; Limitation in useful period (tide dependent on certain times); Disruptions to maritime traffic;	High levels of noise pollution; Threats on the surrounding natural habitats;	Some localised environmental issues; concerns on the localised earthquakes or ground instability; induced change in hydrogeological regime;	Some pollutants after burning; de-forestation; it can be in-efficient and expensive	Large infrastructure; a very stable geological location for the plant; high risk and consequences sector, concern on the waste product hence long term storage options in advance; potential security target for terrorists and other criminals; still a finite resource;

Figure 3. Advantages and disadvantages of various energy sources.

However, a clear conclusion can be deduced that renewable energy sources and nuclear energy will be the inevitable choice in the long-term if the scale of economics and safety concerns are addressed permanently. Until then, thermal coal will still be regarded as a viable option in the list of choices available to the new economies in the coming decades by providing a crucial response to an integrated energy solution (Figures 4, 5 and 6).

Moreover, any practical and economic solution to greenhouse gas emissions in this transition period in the form of greenhouse gas capture, storage and conversion, particularly in the form of CO_2 sequestration, will be able to prolong the existence of coal in the future further.

In addition, coal still has a crucial role in other relevant industries, particularly in cement manufacturing as it is used as an energy source in cement production due to large amounts of energy requirements. It takes about 200 kg of coal to produce 1 t of cement and approximately 300 - 400 kg of cement is needed to produce 1 m^3 of concrete. According to the article 'Coal for cement: Present and future trends' by Saunders & Edwards, 4.18 billion t of cement were produced globally in 2016, and China's cement production alone reached 2.4 billion t. The total cement production is extrapolated to reach 5.7 billion t by 2050. By-products from coal combustion, such as fly ash, also play an important role in the manufacture of cement and in the construction industry generally.

However, the same environmental concerns that are observed in the old economies will also increasingly be the fundamental force when it comes to investment decision in the new economies.

In addition, the decision-makers will be picky when it comes to investment decisions, as the new economies will also be the new battle ground for the advocates of non-fossil fuel usage.

For this reason, if the owners of coal projects want to entice the investment capital for power generation, the projects should be attractive enough for the investors not only financially, but also technically and environmentally.[3] Therefore, the following points need to be considered from the beginning by the project owners:

- A good competent technical team with international experience needs to be in place to run the projects.
- A thorough geological and mining investigation is essential to establish the quantities of coal available for power plant operations.
- A thorough investigation on coal quality characteristics including the trace elements from coal deposit to power plant is necessary to determine the coal performance in boilers and emissions from the power plant.
- Selection of the appropriate technology for power generation based on the coal quality characteristics.
- Appropriate measures to mitigate the NOx, SOx and CO_2 emission by using efficient and cost-effective clean coal technology methodologies.
- The amount of waste (ash, gypsum etc.) generated from the power plant and appropriate measures on its handling need to be considered from the beginning.
- Appropriate environmental and social impact assessment on coal and power plant operations need to be undertaken and the measures to mitigate the impacts are essential to implement.

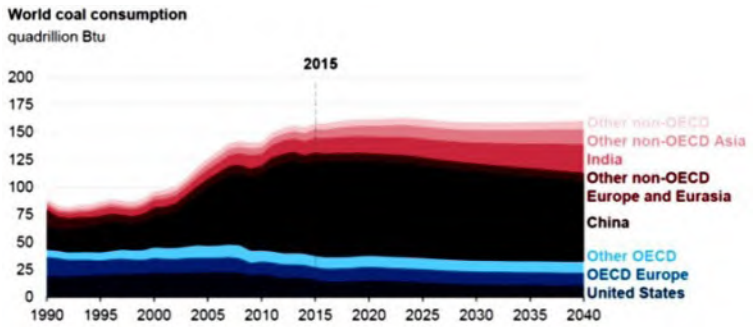

Figure 4. Coal use projection in the coming decades. Source: Energy Outlook 2017 by US Energy Information Administrative.

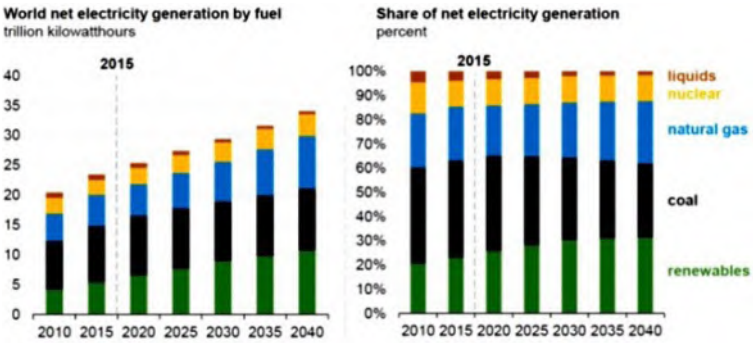

Figure 5. Energy sources in power generation in the coming decades. Source: Energy Outlook 2017 by US Energy Information Administrative.

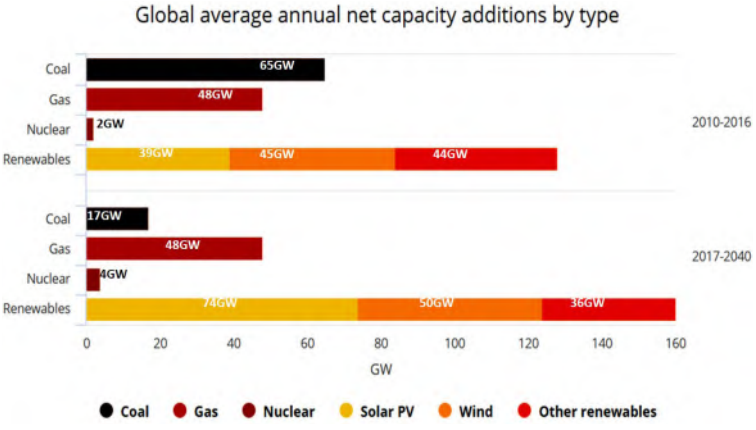

Figure 6. Comparison of energy sources prior to 2017 and after 2017. Source: IEA, 2017.

- Securing a social license to operate both the coal mine and the power plant is essential to run the operations in a conflict-free environment.
- Any consideration for CO_2 sequestration options will be an additional positive point in final investment decision.

Conclusion

Investing in any thermal coal project to generate energy is becoming an increasing risk for investors in the western spheres due to concerns about coal being associated with greenhouse gas emissions and, consequently, global warming.

However, the current and projected trends in world population, economic growth and energy needs dictate that thermal coal will be staying on the scene for the foreseeable future, at least, for newly developed economies, namely the group of countries in BRICS, MINT and the Next Eleven. It appears that these countries will be the centre of economic development globally and shape up the energy demands in the coming years.

It can also be concluded that renewable energy sources and nuclear energy will be the inevitable choice in the long-term if the scale of economics and safety concerns are addressed permanently. Until then, in this transitional period, thermal coal will still be regarded as a viable option in the list of energy sources available in the new economies in the coming decades by providing crucial response to an integrated energy solution.

However, environmental concerns will still dictate the rules of the game. Therefore, it is essential to prepare coal projects in a meticulous way so that the decision-makers behind investments can be fully satisfied with the pros and cons of the project and make an informed choice accordingly. Therefore, technical consultants such as DMT will still be busy in assisting the project owners, investors and other stakeholders in the coming years. WC

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