Executive Summary

- Whilst some argue thermal coal is only in a cyclical downturn, IEEFA is of the view that thermal coal has entered structural decline. Global demand will peak by 2016, coinciding with a peak in China’s domestic thermal coal consumption.
- IEEFA argues that the coal industry has dramatically underestimated China’s intent to improve energy security through electricity system diversity, and to drive rapidly towards a lower energy intensity of growth. Premier Li is categorical in saying: “There is no turning back in China’s commitment to a sound ecosystem”.
- When the Premier of China trumpets the 5% annual reduction in energy intensity of demand achieved to June 2014 as a key national achievement, the global implications are clear: China is rapidly moving towards a lower carbon economy.
- Japan delivered a 15% reduction in electricity intensity per unit of real GDP over the three year period post-Fukushima. This should be seen as proof that energy efficiency gains could massively transform global electricity systems over the next two decades.
- Renewable energy installs totaled 116GW in 2012 and 120GW in 2013. IEEFA forecasts another 1,000GW of new renewable energy capacity will be commissioned by 2020. This is 20% more than forecast by the IEA in their New Policies Scenario.
- IEEFA forecasts that thermal coal demand globally will peak during the 2013-2020 period around 5,700Mtpa (excluding lignite). Demand will plateau over the following decade. Beyond 2030, we forecast global thermal coal demand to decline at an increasing rate thereafter.
- Given seaborne coal imports are usually the marginal source of supply, a downturn in global demand is likely to hit the seaborne market hardest. IEEFA forecasts seaborne thermal coal demand will average 850Mtpa over 2013-2035, down 15% from current peak levels.

Acknowledgements

The authors would like to acknowledge the editing and content from Bob Burton, Geoff Evison, Tom Sanzillo, Tristan Knowles and Lauri Myllyvirta. This document was prepared by IEEFA for ETA-CTI.
## Contents

1. Introduction 3
2. Projections of future coal demand 6
   1. Where IEEFA differs from the IEA New Policies Scenario 22
3. Country analysis for thermal coal 27
   1. IEEFA Global thermal coal demand overview 30
   2. China 32
   3. United States 43
   4. India 52
   5. South Africa 63
   6. Japan 68
   7. Korea 76
   8. Germany 79
   9. UK 85
   10. France 90
   11. Indonesia 94
   12. Australia 98
   13. Brazil 103

### Appendices

A. Air pollution and coal combustion
B. Water use in coal burning
C. The US EPA’s Clean Energy Plan
D. Tax Imposts on Coal Use
1. Introduction – a global ‘Energiewende’ is pending

“The challenge now faced by the whole world is far more urgent and important. But it can be solved by the same methodical, determined process. The world has no choice.”

Rio Tinto’s Energy CEO, Harry Kenyon-Slaney, Sept’2014

There is an increasing debate about whether global thermal coal is in a deep cyclical downturn or structural decline. The 80-90% share price collapse of almost every coal company globally over the last four years gives a clear guide of how the global equity market views the situation. IEEFA argues that thermal coal has entered structural decline. Global thermal coal demand will peak by 2016, coinciding with a peak in China’s domestic thermal coal consumption.

IEEFA forecasts global thermal coal demand over 2013-2020 will be flat at best, and decline 0.1% annually over 2020-2035. This masks the magnitude of the transformation that is rapidly emerging. With the IEA New Policies Scenario forecasting global electricity demand to increase 1.8% pa over the next two decades, IEEFA forecasts that the entire 50% expansion in global electricity demand by 2035 will be met by non-coal fuel sources.

There is also an inbuilt lag in that once built, a coal-fired power station will serve out most of its effective life due to the largely sunk capital cost of construction. As is happening across Europe and America over this decade, the decline in thermal coal demand globally beyond 2030 will accelerate as inefficient plants built over the last two decades are increasingly decommissioned. With many Indian coal-fired power plants having a useful life as short as 25 years, this underscores IEEFA’s forecast that thermal coal decline will accelerate to -0.4% pa over 2035-2050.

As Rio Tinto’s Energy CEO Harry Kenyon-Slaney said, the magnitude of the climate change crisis is reaching an imperative nations can’t ignore. And like the race to the moon, technology innovation provides the solution. China certainly is driving this transformation far faster than anyone realises. Germany realised the critical importance a decade ago, and its Energiewende is both the blueprint for the world and has driven the cost of implementation down dramatically for everyone else. A Sputnik moment will drive innovation and technology, then economies of scale and financial capital will collectively solve this global imperative.

Key drivers

- **Energy Security**: A key motivator of countries’ energy policy, particularly when most major economies are critically dependent on fossil fuel imports. IEEFA views the strategy of energy sector initiatives to diversify fuel supply towards domestic renewable capacity (on and offshore wind, distributed and utility scale solar, hydro) as playing a key role to improving energy security in Japan, China, India and Germany.

- **Energy Efficiency**: Japan achieved a reduction in total electricity demand of 12% from 2010-2013 despite 1% pa real GDP growth – a reduction of electricity demand per unit of real GDP of 5% pa.
This sets the benchmark of how rapidly change can be achieved with proactive policy. We forecast energy efficiency will play a significantly larger role in curtailing demand going forward.

- The IEA’s Sept’2014 paper “Capturing the Multiple Benefits of Energy Efficiency” is a useful guide.³ UK energy security envoy Rear Admiral Neil Morisetti puts it like this: "Recent events in Ukraine and the Middle East have served to highlight the vulnerability of our energy supplies and the political straitjacket that results from our over-dependence on fossil fuel imports from these volatile regions. The quickest and most effective form of energy security is to use less."⁴

- We note that the UK has reduced electricity intensity of GDP by 2.1% pa over 2005-2013, illustrating sustained reductions are readily achievable. The EU is likely to target a 30% energy efficiency target by 2030, further driving technology uptake and innovation.

- The IEA’s Sept’2013 paper “South East Asia Energy Outlook” shows energy efficiency as the hidden opportunity to meet the rapid acceleration in demand for electricity across Asia, trebling to 1.9% pa over 2013-2035 from the 0.6% pa from 1990-2011. Technology and smart grids will play an increasingly critical role in leapfrogging the emerging market electricity development.

- **Renewable Energy**: IEEFA forecasts a continued acceleration in the deployment of renewable energy. With 116 gigawatts (GW) of solar, wind and hydro-electricity capacity installed in 2012, rising to 120GW in 2013, this follows a CAGR of 10% since 2007. We expect this to continue, such that 1,000GW of additional renewable capacity will be installed globally by 2020.

- Onshore wind has been the main renewable capacity deployed over 2008-2013, running at 37GW pa. Global hydro capacity has been growing at 28GW pa. We forecast deployment rates will accelerate towards 130-150GW pa by 2020, led by 50-70GW pa of solar going forward.

- IEEFA’s forecast for the addition of 1,000GW of new renewable capacity by 2020 is 20% higher than the IEA’s forecast under the New Policies Scenario. However, we note the IEA has consistently underestimated the economies of scale and technology improvements in renewables over the last decade, and continues to do so in our view. The IEA has therefore again underestimated the rate of expansion in this energy market transition over the next decade.

- Whilst the offshore wind market has suffered significant issues in moving towards commercial deployment at scale over 2010-2020, we forecast a near halving of costs per kWh post 2020 this will emerge as another key renewable energy segment of scale. Adding system diversity, offshore wind also offers utilisation rates double that of solar and onshore wind.

- The fossil fuel industry has long argued that grid stability and the need for baseload electricity will prove to be irresolvable obstacles to the continued expansion of renewable energy. IEEFA entirely disagrees with this excuse. Germany reaching 30.8% renewable energy in the first half of 2014, the South Australian market reaching 38% in Aug’2014, and more than 90% of the Brazilian economy being electrified by renewables for the last decade are just three examples illustrating the a smart grid of the future will be increasingly flexible. The increasing ability of electricity storage and Demand Response Management (DRM) to match variable electricity demand and variable supply will reduce the need for expensive reserve capacity. Baseload as an excuse will go the way of thermal coal and the dinosaurs.

- An underappreciated aspect of renewables is the deflationary impact on wholesale electricity prices. It is noteworthy that European wholesale electricity prices are at a decade low, and the decline has accelerated as the share of renewables has expanded. Energy markets have been inflationary for a century. Renewables are like the internet – transformational and deflationary.
Demand Study – A Country by Country Analysis

The electricity sector varies dramatically by country. In Section 3 we examine 12 of the largest electricity markets globally to illustrate country specific drivers of demand and supply, and differing regulatory and resource impacts. To highlight a few:

- Some countries like the US, Indonesia, South Africa and China have huge thermal coal reserves.
- The shale gas explosion is revolutionising the American electricity supply and lowering the cost and emissions of electricity, with profound economic and energy security implications.
- However, most of the largest economies globally import gas (via pipelines or liquid natural gas (LNG)), making this an increasingly expensive if slightly cleaner fuel source.
- Four of the largest electricity markets – Japan, Korea, Taiwan and the UK, import almost all their fossil fuel electricity needs. Energy efficiency becomes key to reducing demand to limit imports.
- The European Union (EU) is increasingly utilising a pan-EU electricity grid, with imports and exports providing valuable balance and flexibility to the system. By contrast, Korea, Japan and Taiwan’s electricity and gas grids are 100% isolated, heightening energy security issues.
- The Fukushima disaster has had profound implications for nuclear power’s social acceptability in Japan, Korea, Germany and France – four of the 10 largest electricity markets globally.
- Fukushima had another profound impication. Severe adversity has driven energy efficiency innovation that has cut Japan’s electricity intensity 15% in just three years. This illustrates what can be done and the speed of the transition. Energy efficiency will progressively be adopted globally to curtail electricity system growth more than is currently anticipated.
- South Africa is the 16th largest electricity market globally, but surprisingly is the 4th largest thermal coal user. The new focus on renewable energy by Eskom is globally important.
- We include France and Brazil as two of the ten largest electricity sectors that both have almost no exposure to coal fired power generation. France is 75% nuclear, and now rapidly adding on and offshore wind and solar, plus boosting energy efficiency. Brazil is 80% hydro and now rapidly adding very cost competitive onshore wind and solar. No talk of boosting coal in either country.
- China and India have underpinned more than 90% of the growth in global thermal coal demand over 2000-2013. A systematic shift in China away from coal is underway, India is likely to follow.

Conclusion

IEEFA forecasts that thermal coal demand globally will peak over the 2013-2020 period around 5,700 million tonnes per annum (Mtpa) (excluding lignite). Demand will plateau over the following decade as key markets like China, America, Japan and the EU continue to decline, but this being offset by still strong growth in coal from India, Korea, Taiwan and South East Asia. Beyond 2030, we forecast global thermal coal demand to experience an increasing rate of decline thereafter.

A second key implication of this study is the consequences for seaborne traded thermal coal. As the flexible but most costly source of incremental supply, a stalling then downturn in demand for coal will first and foremost affect higher cost export coal mines and the associated rail and port infrastructure. Mine mouth coal-fired power plants will be the least affected, given they have the lowest transportation cost (which represent 50-80% of the delivered cost of much of the seaborne thermal coal supply sector when shipping costs of US$5-15/t are included). We see global seaborne coal demand declining 15% to average 850Mtpa over 2013-2035 relative to the 2013 peak.

22 September 2014
2. Projections of future coal demand

This study focuses initially on the long-term coal thermal demand forecasts of the International Energy Agency (IEA), the world’s most referenced energy projections. Comparisons are then made from this basis to fossil fuel industry and broker forecasts to understand where widespread agreement and disagreement exists.

The IEA’s principal document, the World Energy Outlook (WEO), examines the energy trends to 2035 under three different scenarios:

- **Current Policies Scenario**: A scenario that takes into account “only those policies and measures affecting energy markets that were formally enacted as of mid-2013.” The purpose of this scenario is to illustrate both the consequences of inaction and makes it possible to evaluate the potential implications of additional policy measures.

- **New Policies Scenario**: The central scenario of the 2013 World Energy Outlook. In addition to assuming the incorporation of government policies and measures adopted as of mid-2013, the New Policies Scenario also takes into account “other relevant commitments that have been announced, even when the precise implementation measures have yet to be fully defined.” This scenario takes a “cautious view as to the extent to which these commitments will be implemented.”

- **450 Scenario**: This scenario shows a global energy sector on a trajectory with a “near 50% chance of limiting the long-term increase in the average global temperature to two degrees Celsius (2°C).” Up to 2020, the 450 scenario assumes the full implementation - more vigorous policy action than the New Policies Scenario therefore - of commitments under the Cancun Agreements made in 2010. After 2020, OECD countries and other major economies are assumed to set “economy-wide emissions targets for 2035 and beyond to collectively ensure an emissions trajectory consistent with stabilisation of the greenhouse-gas (GHG) concentration at 450 parts per million.”

In light of our focus on the potential impacts of a global energy transition on coal production, this study focuses on the New Policies Scenario and to a lesser degree the 450 Scenario that integrate assumptions of such a change occurring. When referenced, the Current Policies Scenario is principally utilised as a baseline rather than a forecast per se, representing the highly unlikely eventuality that no further energy transition-related policies will be implemented to 2035.

Furthermore, demand forecast analyses in this study have been split into two periods, from 2012 up to 2020 and from 2020-2035 to be consistent with the IEA’s approach and the significance they attribute to climate and environment-related government policies around these timescales.

---

1 A full explanation of the assumptions made for each region in each scenario can be found in the IEA WEO, pages 646-655.
IEA thermal coal demand trends

The figure below reflects the IEA’s WEO thermal coal demand forecasts under these three scenarios in million tonnes of coal equivalent (Mtce) and plots the IEEFA model forecast as a reference point.

**Figure 1: Thermal coal demand diverges dramatically between the New Policies and 450 Scenarios**

- **Starkly different pathways exist**: From 2013 onwards, the New Policies and 450 Scenarios take on very different trajectories. The former reflects an absolute growth in demand of 1012Mtce (24% of 2013 level) to 2035, while demand peaks immediately in the 450 Scenario and falls by 1,428Mtce (35%) by 2035. For thermal coal demand to shift from the New Policies Scenario to the 450 Scenario requires a 2.9% reduction in a compound annual growth rate (CAGR) from 2013-2035, which represents a 2,440Mtce (49%) reduction in thermal coal demand by 2035.

- **Particularly after 2020, the pronounced divergence emerges**: Post-2020 the 450 Scenario reflects strong policy measures being implemented to keep long-term GHG-induced temperature change to 2°C, whereas the New Policies Scenario assumes a less stringent policy effort to “foster renewables, penalise CO2 emissions and address other environmental issues.” This results in the difference between the two scenarios’ CAGRs widening from 1.9% to 2.8%.

---

2 To ensure consistency and readability of the graph, demand data from 2000-2013 is from the IEEFA model.
• **Growth continues in the New Policies Scenario, but slows markedly:** Thermal coal demand does not peak in the New Policies Scenario with a compound annual growth rate of 1.0% to 2035. However, as the IEA notes, this is a significant slowdown on previous years. Furthermore, approximately one half of this growth in the New Policies Scenario occurs before 2020, after which the CAGR slows to 0.6%.

**Total coal demand projections by type**

Coal is typically split into three classifications that reflect the varying composition and energy content of assets. This in turn determines its end use.

*Steam/thermal coal:* Accounts for 71% of global coal demand in 2013 in terms of millions of tonnes. Approximately 70% of global thermal coal is consumed for power generation, 15% in industry and the remainder consumed by residential, commercial and public services, forestry and fishing sectors.

*Lignite coal:* Approximately 16% of global coal demand used almost solely for power generation. While lignite is widely considered to be low quality, most lignite is used at ‘mine-mouth’, and the power stations are configured to utilise this type of low-energy coal. As such, lignite avoids the massive rail/port/shipping transportation and infrastructure costs almost entirely and as such can be extremely cost effective (with the right pollution control technologies in place).[^lignite]

*Coking/metallurgical coal:* Makes up 13% of total global coal demand. Over 85% of coking coal is used for steel making where it produces coke to support a blast furnace charge. Small portions are used in power generation and in industry.

Figure 2 illustrates demand for thermal, coking and lignite coal in the IEA’s New Policies Scenario.

**Figure 2: IEA New Policies Scenario by coal type to 2035 (Mt)**[^graph]

[^graph]: Figures have been adjusted to classify Chinese lignite coal as lignite rather than thermal coal.
• **Thermal coal grows its share of total coal demand:** The combination of: i) falling lignite demand as low quality coal gets pushed from the market; ii) falling coking coal demand as the steel and industry sectors improve their energy efficiency (see point three below); and iii) growing thermal coal demand mean thermal coal’s share of total coal demand grows, but slower than in the past.

• **Thermal coal demand growth halves post-2020:** Slowing thermal coal growth post-2020 is evident, principally as a result of air pollution, climate and other environment-related policies to which the power generation sector is most exposed. Total OECD demand falls in this period, but is more than offset by non-OECD growth. Towards the end of the forecasting period, however, non-OECD growth begins to mirror the path of OECD demand before it. We note this is a continuation of the well established deceleration in growth estimated for the 2012-2020 period of only 1.1% CAGR, a third of the 3.0% CAGR in thermal coal volumes over 1990-2012.

• **Coking coal demand begins to fall:** Over the forecast period, coking coal demand remains more stable than thermal coal because it is less easily substituted in its applications and less influenced by government environmental policies. Total demand grows to 2020 in spite of falling OECD demand due to increased use of pulverised coal injection (PCI). Post-2020, other technologies such as electric arc furnaces are more widespread, efficiency improvements take hold and global crude steel output flattens around 2030. In fact, steel output in China – responsible for over 70% of global coking coal growth over the forecast period- begins to decline.

**Looking to 2050**

Carbon Tracker’s previous research and this report’s accompanying paper consider the impacts of carbon constraints through to 2035. This exceeds the projections of the scenarios in the IEA’s World Energy Outlook publication. However, in the Energy Technology Perspectives 2014 document the IEA presents their 2DS, 4DS and 6DS Scenarios that extend to 2050. These scenarios closely parallel the 450, New Policies and Current Policies Scenarios (through 2035) referred to thus far. The IEA describes the 2DS Scenario as reflecting “a concerted effort to drastically reduce current dependency on fossil fuels, primarily through energy efficiency, renewables and nuclear energy.”

Figure 3 shows the differences between coal sector demand across the three scenarios and contextualises this with demand projections for other energy sectors. It is noteworthy that the figure illustrates cumulative demand over the period 2011-2050.
Figure 3: Total cumulative fossil fuel demand in trillion tonnes of coal equivalent (Ttce) 2011-2050 in IEA Scenarios

- **Lower coal demand is central to achieving 2DS rather than 4DS:** Over the period of 2011-2050, cumulative coal demand in a 4DS Scenario is 30% higher than in a 2DS Scenario – the difference between 4DS and 6DS Scenarios is lower at 17%, illustrating that coal demand is disproportionately significant to achieving the 2DS Scenario. To achieve the 2DS Scenario to 2050, the IEA predict emissions (GtCO$_2$) from power generation will need to reduce by 41% - this would serve to suppress coal demand significantly.

- **Lower primary energy demand growth constrains coal:** By 2050, the 6DS Scenario shows approximately 70% growth in primary energy demand compared to 2011 levels - the 2DS Scenario assumes policy actions that constrain energy demand to 25% over 2011 levels, limiting the growth prospects for coal demand in this scenario.

- **Fossil fuel demand remains significant in 2DS:** Figure 3 reflects that by 2050 fossil fuels make up 70% of energy demand in the 4DS Scenario, which falls to just over 40% in the 2DS. This remains a significant share of energy demand in 2050 of which coal comprises approximately 33% in the 2DS. This is because carbon capture and storage (CCS) is assumed to play a substantial role in supporting coal demand in this period.

Source: IEA, ETA analysis 2014
Figure 4 illustrates the CCS emissions mitigation assumptions of the three scenarios broken down by sector.

**Figure 4: Cumulative MtCO$_2$ captured by CCS by sector 2011-2050**

This graph demonstrates the scale with which CCS is assumed to increase its emissions mitigation contribution in the 2DS compared to the 4DS and 6DS – approximately half of the captured CO$_2$ is assumed to come from the power sector, currently dominated by coal. In the 2DS, CCS is assumed to contribute one-sixth of the total CO$_2$ emissions reductions required to 2050.

The achievability of such contributions seems debatable, however, in light of the lack of current CCS capacity and slow pace with which additional capacity is being installed. According to the IEA, a cumulative 50MtCO$_2$ have been captured globally to date – Figure 4 illustrates this total needs to be over 46,500MtCO$_2$ by 2050 to achieve the 2DS pathway. Consequently, coal demand projected in the 2DS Scenario, which has been demonstrated to be 30% lower compared to 4DS, could be on the optimistic side if CCS does not scale-up sufficiently.

---

4 Note that the ‘Power’ sector includes both coal-fired and gas-fired with the IEA unable to split this total by fuel type. This is because, for instance, coal and gas may both be used in a blast furnace equipped with CCS. Due to the more CO2 intense nature of coal-burning over gas consumption, it can be assumed coal consumptions comprises the majority of power sector captured emissions.
Total coal demand by region: OECD vs non-OECD dynamics

The figure below illustrates the split in total coal demand between OECD nations and non-OECD in the IEA’s three World Energy Outlook Scenarios.

Figure 5: Total coal demand by region, 1990-2035 (Mtce)

Figure 5 shows a general consensus exists across the IEA’s Scenarios that in the OECD, coal demand will slow if not decline in the immediate future. A far greater range of outcomes exists across the scenarios for non-OECD nations.

Consequently, the fate of future global coal demand will, in large part, be determined by i) the scale of economic growth and hence coal demand growth in the more unpredictable and volatile non-OECD markets; ii) the extent to which non-OECD nations closely mirror the OECD’s trajectory of substituting coal consumption with low carbon alternatives; iii. the accelerated uptake of energy and grid efficiency initiatives; and, crucially iv) the rate at which the transition between these two pathways occurs.

Source: IEA, ETA analysis 2014
Industry and broker projections

The forecasts of industry associations and brokers can be key influencers on expectations of future demand trends. Figures 6 compares total coal demand forecasts from the EIA and the oil & gas majors with the IEA New Policies Scenario.

**Figure 6: Shell, ExxonMobil, BP and EIA total coal demand forecasts compared to the IEA New Policies Scenario**

![Graph showing total coal demand forecasts](image)

**Table 1: Projected total coal demand change under different scenarios**

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Short-term 2012-2020</th>
<th>Long-term CAGR</th>
<th>Absolute change from 2012 (Mtce)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEA New Policies</td>
<td>1.1%</td>
<td>2020-2035: 0.4%</td>
<td>814</td>
</tr>
<tr>
<td>ExxonMobil</td>
<td>0.5%</td>
<td>2020-2040: -0.9%</td>
<td>-711</td>
</tr>
<tr>
<td>BP</td>
<td>1.6%</td>
<td>2020-2035: 0.6%</td>
<td>1294</td>
</tr>
<tr>
<td>Shell - Mountains</td>
<td>1.7%</td>
<td>2020-2040: 0.2%</td>
<td>996</td>
</tr>
<tr>
<td>Shell – Oceans Scenario</td>
<td>2.8%</td>
<td>2020-2040: -0.0%</td>
<td>1346</td>
</tr>
<tr>
<td>EIA</td>
<td>2.0%</td>
<td>2020-2035: 1.2%</td>
<td>2289</td>
</tr>
</tbody>
</table>

5 For BP we used the World Coal Association’s conversion factor to Mtce: 1mtoe = 1.435mtce
• **All forecasts, with the exception of ExxonMobil’s, are more bullish on demand growth than the IEA Scenario:** The scenarios of Shell, BP and the EIA all foresee higher growth in coal demand than the IEA New Policies Scenario. The EIA Scenario, the most bullish of those featured, forecasts global coal demand will be 1475Mtce higher by 2035 than estimated in the IEA New Policies Scenario, equivalent to 185% of the 2035 IEA total. This forecast is based on the assumption of strong non-OECD growth to 2035 – the EIA scenario is consistent with the general consensus that OECD growth will decline marginally. We note the EIA is exceptionally detailed but very US centric in its analysis.

• **The IEA’s New Policies seems aggressive even against Shell’s ‘firm and far-reaching’ policies scenario:** Relative to Shell’s ‘Mountains’ Scenario that models a case where ‘stability is the highest prize’ and where those unlocking fossil fuel resources do so ‘cautiously, not solely dedicated by immediate market forces’, the IEA New Policies Scenario is more aggressive by forecasting coal demand approximately 425Mtce lower in 2035. We attribute this to the IEA’s detailed and ongoing analysis into the capital cost trends in non-fossil fuel technologies. With each year, the IEA has consistently increased its rate of technology learnings in renewable energy and decreased capital costs as economies of scale have surpassed all historical expectations. The IEA is therefore more current in its estimates of the huge scope for low carbon solutions to take share from coal in particular.

• **The rate of coal demand growth slows post-2020 in all scenarios:** While the majority of forecasts are bullish on future coal demand growth, all scenarios covered in Figure 7 display significantly lower CAGRs post-2020 than before this date. This could represent agreement that coal demand growth in non-OECD nations will temper and mirror OECD demand trajectories before 2035. In other words, there is agreement the global energy transition will speed up post-2020.

• **In fact, post-2020 three fifths of scenarios have slower growth rates than the IEA New Policies Scenario:** While the forecasts of Shell and ExxonMobil consider absolute coal demand to be higher by 2035 than the IEA’s New Policies Scenario, both also foresee post-2020 coal demand to slow more rapidly than the IEA New Policies Scenario, particularly post-2030. This reflects the inevitability of governments collectively or individually being held to account for carbon emissions pollution. China’s accelerated and comprehensive policy response to air pollution since 2013 shows that tipping points are reached, and then change can be dramatic and rapid. India is rapidly approaching a similar point. Greater demand peaks and troughs, as illustrated in these scenarios in Figure 6, could reflect the effects of more reactionary and aggressive environmental policy actions, potentially in response to increasingly severe climate change.
Citi and IEEFA see a convergence towards zero coal demand growth

In addition to these industry forecasts, brokers have published various perspectives on future coal demand. As illustrated in the figure below, Citi and IEEFA’s forecast for total coal is largely consistent with the IEA’s New Policies scenario – OECD growth declines at a consistent rate from now, while non-OECD demand growth slows to mirror this pathway in the medium-term. Citi has closely examined the deflationary and parasitic nature of renewable energy, energy storage and energy efficiency technologies, and hence the risks to incumbent fossil fuel generators as real retail electricity prices decline going forward.

Figure 7: Incremental coal demand by region, 2010-2030 (Mt)

Figure 7 reflects Citi’s forecast of relatively rapid convergence towards zero growth, without achieving it, by 2030, as OECD coal demand reductions are to increasingly smaller degrees exceeded by non-OECD demand growth. This sees non-OECD increases in coal demand fall from being over 33 times larger than OECD declines in coal demand to under double the size by 2030. Current data suggests that Citi’s forecast of a convergence may be overly conservative with OECD coal consumption declining in 2011 by 29.6Mtce and by 56.2Mtce in 2012 – far exceeding the projections for 2010-2015 made above.

6 The data used in this figure are approximate readings from graphs presented in Citi’s Energy Darwinism: The evolution of the energy industry, 2013. Converted to Mt from Mtoe using IEA WEO figures to estimate a global-level conversion factor which was applied to all data.
This is one reason ETA/IEEFA’s forecast is more bullish on the extent of this convergence by 2030. This sees non-OECD coal demand growth to be lower and OECD declines larger than in the Citi forecast between 2010 and 2015. Over each of the following 5 year intervals, the level non-OECD demand growth exceeds OECD declines is smaller than Citi’s most aggressive prediction, as illustrated by the ratios in Figure 7.

**Wood Mackenzie foresee strong demand growth: An outlier?**

Wood Mackenzie foresee a coal demand curve completely contrasting that of Citi. Whereas Citi believe global coal demand will converge towards zero growth, Wood Mackenzie see very strong growth in demand to 2035. Figure 8 graphs Wood Mackenzie’s forecast for thermal coal (which accounts for 76% of total coal demand today) against the IEA’s New Policies Scenario.

**Figure 8: Wood Mackenzie forecasts for thermal coal, 2013-2035**

![Graph showing Wood Mackenzie and IEA forecasts for thermal coal demand, 2010-2035.](image)

Wood Mackenzie forecast a 3% CAGR to 2020, but in contrast to other broker and industry forecasts is the persistence of this growth through to 2035. While Wood Mackenzie believe the CAGR for thermal coal will slow post-2020, the rate of growth still far exceeds that of the IEA New Policies Scenario, the general consensus amongst forecasters included in this analysis and even that of the EIA who represent the next most bullish coal demand scenario over this period.

The Wood Mackenzie forecast is so bullish about the prospects of future coal demand that they foresee global thermal coal demand to be approximately 11,850Mt in 2035 – this is equivalent to 138% of total global coal demand for all types under the IEA New Policies Scenario and even exceeds total global coal demand for all types under the IEA Current Policies Scenario.
The outlook for coking coal is equally strong, according to Wood Mackenzie. Figure 8 displays their forecasts for coking coal imports to 2035\(^7\). While traded coal accounts for 35% of total coking coal demand, a number of factors underpin the dynamics of traded coal that prevent import data from being able to conclusively reveal absolute coking coal demand globally. Tentatively, however, Figure 8 shows Wood Mackenzie are again more bullish than the IEA New Policies Scenario predicting coking coal imports to grow at a 4.8% CAGR to 2020 and 0.6% afterwards, compared to 1.3% and -0.4% of the IEA.

Overall, this means Wood Mackenzie’s thermal coal demand forecast appears to be an outlier. In light of the upside potential we see for renewable energy, energy storage and energy efficiency technologies and accelerating policy measures transitioning China and India’s coal consumption, we foresee a very different forward demand curve for coal.

**Broker forecasts of seaborne thermal coal demand to 2020**

The IEA predict traded coking coal to 2020 will be largely consistent across their three scenarios in the World Energy Outlook. The outlook for traded thermal coal is far less agreed.

Current levels indicate approximately 15% of all thermal coal is traded, of which over 90% is seaborne.\(^{xvii}\) Figure 9 shows forecasts of seaborne thermal coal imports up to 2020 from a number of brokers – due to the lack of consistency in the level of imports in the start year across the brokers, the year on year percentage change is used to allow comparability.

**Figure 9: Comparing broker forecasts of seaborne thermal coal demand with the IEA New Policies Scenario**\(^{xviii}\)

---

\(^7\) Best available data.
Figure 9 demonstrates a consensus that seaborne demand for thermal coal will grow to 2020. Only three of the four brokers foresee import demand to grow as rapidly as the rate predicted by the IEA’s New Policies Scenario.

Within these trends, two schools of thought seem to exist among the major commodity forecasters. The first, consisting of Wood Mackenzie and Deutsche Bank, sees a trend of increasing rates of growth in thermal coal imports. This is consistent with Wood Mackenzie’s forecasts of strong growth across the global coal sector generally. Deutsche Bank, however, display a growth trend that oscillates around zero growth due to ‘new demand preferences in the largest consuming nations… result[ing] in much lower demand growth going forward’ - that is until 2020 where import demand jumps, relative to previous years, that somewhat distorts the trend over the forecast period.

The second grouping of brokers consists of Citi, Bernstein and Goldman Sachs who both foresee seaborne import demand of thermal coal to increase at a much slower rate than previously to the end of the forecast period in 2018. Goldman Sachs attribute this trend to ‘structural headwinds from regulation, energy efficiency and changes in the energy mix’ due to heightened competition from gas and renewable energy. Citi cite many of the same drivers. Bernstein sees China moving from the world’s largest importer of thermal coal in 2013 to a position post 2015 where China will protect its domestic industry as a priority and hence move to being an occasional, opportunistic exporter. This school of thought is consistent with our outlook of the structural nature of the drivers that will serve to suppress the long-term growth of coal demand.

**In focus: Key coal demand regions**

This summary of coal demand forecasts highlights that the understanding of the regional variations in forward demand is integral to understanding the dynamics of global coal demand. The present nature of the global coal sector is such that just a handful of countries within these regions will fundamentally determine future coal demand.

**China**

Bernstein Research calculate that global total coal demand excluding China from 2007-2012 has declined by 1.2%**x** - China’s significance on shaping past and future form of the global coal sector can not be understated.

There is simultaneously agreement and uncertainty between brokers in their forecasts of China’s future coal demand. Agreement lies in the fact that China is taking steps to slow the growth of its coal consumption – an era that Citi brands an ‘anything but coal’ energy strategy - through a portfolio of approaches including carbon intensity, energy intensity and coal consumption targets, emissions trading schemes, carbon taxes and low-carbon energy incentives, all driven on the large part by its worsening air pollution crisis.

What appears uncertain across opinion is when these drivers will combine with each other and those drivers supporting further coal demand to peak China’s coal demand and begin its plateau. For example, credit ratings agency Standard & Poor’s predict peak demand will occur by 2020**, Deutsche Bank put this date at 2016** while Bernstein Research forecast the peak to arise in 2015.
and Morningstar forecasts a peak in China coal in 2014.\textsuperscript{xii} The IEA summarise the underlying drivers creating such uncertainty when predicting China’s thermal coal demand in Figure 10.

**Figure 10: Uncertainties within the China’s short-term thermal coal demand**\textsuperscript{xxiii}

Beyond 2018, the IEA’s New Policies Scenario foresees steady coal demand growth in China to 2020, after which demand only rises a further 69Mtce (2% of 2011 level) to a plateau between 2025 and 2030. The CAGR between 2020 and 2035 is a meagre 0.05%. Inherently, therefore, coking and thermal coal demand do not grow strongly in this scenario.

Citi’s research is largely consistent with the IEA outlook. Thermal coal for power generation is by far the largest single coal consuming sector in China, accounting for approximately 50% of the total. The figure below demonstrates Citi’s forecast for coal’s share of power generation to steadily decline to 62% by 2020.

**Figure 11: Citi forecast declining coal share of power generation**\textsuperscript{xxiv}
The IEA New Policies Scenario continues along this trajectory anticipating coal to supply 55% of power generated in 2035. Wood Mackenzie are more bearish seeing coal make up 51% of total power generation by 2030.\textsuperscript{xxv} This future would significantly reduce China’s thermal coal demand, having knock-on effects for the global coal sector.

With regards to coking coal, the picture is similarly bearish with the IEA forecasting in their New Policies Scenario that Chinese production of steel and cement, the major consumer of coking coal, peaks before 2020 and declines thereafter resulting in a CAGR of -0.9% between 2020 and 2035.

India

Since 1965, global total coal demand has essentially been flat, apart from China and India which have represented over 100% of the world’s demand growth. With many agreeing that China’s coal demand could lower in the medium-term, Indian demand becomes increasingly integral to the fate of the global coal sector.

Since 2000, India’s coal use has more than doubled to 485Mtce in 2012 and forecasts generally indicate this strong upward trend will continue. Two-thirds of coal demand in India stems from the power sector, where two-thirds of electricity is from coal-fired power plants. Coal burning for power generation sees a CAGR of 3.1% between 2011 and 2035 - more than doubling to 452Mtce – in the IEA’s New Policies Scenario. Citi concur, but foresee much of this growth occurring in the very short-term, with CAGR at 9% from 2013-2017.

The IEA and Wood Mackenzie are in agreement over industry metallurgical coal demand growth, with the New Policies Scenario predicting a tripling of crude steel production to 2035 that largely correlates with the production curve produced by Wood Mackenzie in the figure below.

\textbf{Figure 12: India steel production 2000-2025}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure12}
\caption{India steel production 2000-2025}
\end{figure}

\textit{Source: Wood Mackenzie 2013}
US

The rapid emergence of gas-fired and wind on the supply side plus energy efficiency on the demand side in the US resulted in thermal coal’s share of electricity generation to drop from 53% in 1990 to 43% in 2011 – the IEA and broker forecasts predict this trend to continue. In the New Policies Scenario power sector coal consumption will drop to under 520Mtce in 2035 from 625Mtce in 2011.

The switch to gas-fired power has already retired 22GW of coal-fired power generation capacity to date. The US House Energy and Commerce Committee’s Subcommittee on Energy and Power in July 2014 called for an independent reliability assessment in light of the U.S. EPA’s projection that nearly 180 GW of generation capacity will retire between 2010 and 2020 because of the Clean Power Plan and other factors, such as the Mercury and Air Toxics Standards, or MATS. While politically motivated, this call is likely to show that electricity system reliability is improved with the increased diversity of supply coupled with better grid interconnectivity across regions.

Environment-related policy implementations are the main driver of this change, in particular i) 2013’s New Source Performance Standard (NSPS) which mandates new power plants not to exceed the new standard of 1,100lb CO₂/MWh; ii) emissions standards set by the National Ambient Air Quality Standards set to tighten from 2015; iii) implementation of the EPA’s Maximum Achievable Control Technology (MACT) standards; and iv) the potential implementation of the proposed Clean Power Plan Rule to regulate existing coal- and gas-fired power plants to achieve a 30% reduction of power sector emissions by 2030.

Europe

The IEA’s New Policies Scenario sees Europe’s thermal coal demand fall steeply from 445Mtce to 253Mtce. This equates to just 11% of power generation in 2035, a 57% fall on the 2011 level. Europe’s transition mirrors that of the US quite closely with increasingly stringent policy regulations retiring coal consumption capacity that is nearing the end of its lifetime.

Indicatively, Wood Mackenzie and Citi research expect 55GW of coal-fired capacity to be retired by 2024 in Europe’s major economies (Figure 13) as plants close as a result of the Large Combustion Plan Directive initially, followed by those who opt out and close due to regulations outlined in the Industrial Emissions Directive. Overall, this results in coal’s share of power generation to fall by 42% over this time period in their scenario (Figure 14).

**Figure 13: Cumulative power generation in major European economies**

![Cumulative power generation in major European economies](image)

**Figure 14: Coal-fired capacity closures in major European economies**

![Coal-fired capacity closures in major European economies](image)
2.1 Where IEEFA differs from the IEA New Policies Scenario

The New Policies Scenario is the IEA’s central scenario as set in third quarter 2013. The thermal coal forecasts presented by IEEFA incorporate a number of new developments over 2014 we expect are yet to be incorporated into the IEA’s annually revised forecasts. IEEFA expects material changes to the assumptions underpinning the IEA’s central premise when the 2014 edition is published next month, many of which reduce electricity and/or coal consumption expectations.

IEEFA’s global thermal coal demand forecast of 5,510Mtpa by 2035 is 1,103Mt or 16.7% below the IEA New Policies Scenario estimate for 6,614Mtpa by 2035. Relative to 2013 coal demand, this presents a very different trajectory. Where the IEA New Policies estimate assumes 18% growth over the next 22 years, IEEFA forecasts an absolute decline of 2% or 80Mtpa from 2013 levels.

Key points of difference to the IEA reflect IEEFA’s assumption of:

1. Lower forecasts for real GDP growth in China and India;
2. A longer assumed useful life for renewable generation capacity;
3. Greater technology advances driving higher capacity utilisation rates for wind and solar;
4. Greater capital cost reductions for onshore wind and solar energy driving greater installations;
5. Taxes at coal’s point of use have seen a material step up in 2014;
6. A faster removal of fossil fuel subsidies; and
7. IEEFA’s projections assume the US Clean Energy Plan is enacted largely as proposed.

Reduced GDP Growth in China and India

The IEA World Energy Investment Outlook 2014 details that the IEA / IMF has materially downgraded their medium term real GDP growth forecasts for the world’s two largest coal consuming nations, China and India. For China, the IEA in March 2014 confirmed it will incorporate China’s real GDP at 7.0% pa through to 2020, downgraded from 8.1% pa. For India, GDP growth through to 2020 has been downgraded from 6.5% to 6.1% pa. IEEFA forecasts real GDP growth averaging 6.5% pa for China and 5.5% pa for India for 2013-2020, both marginally lower than the likely new rates incorporated by the IEA. This reflects our confidence that both countries will need to continue to push for more sustainable growth over the long term, lowering the near term to deliver better balance. Both countries financial systems reflect massive imbalances of excessive near term growth and will constrain the ability of each country to fund unsustainable grow near term.

Reducing China’s GDP growth for 2014-2020 by 1.1% pa equates to 7% cumulative – which could reduce the IEA’s projected coal demand from China of 3,026Mtce by 200Mtce pa, everything else being equal.

Reducing India’s GDP growth for 2014-2020 by 0.4% equates to 3% cumulative – which could reduce the IEA’s projected coal demand from India of 605Mtce by 20Mtce pa, everything else being equal.

Stronger Performance of Renewables – Useful Life

The IEA assumes wind and solar power have a life of 20 years. The useful life used by the equity markets is generally 25 years (see Iberdrola 2013). Repowering (replacing small, old wind turbines with new, larger, taller turbines to triple the electricity output) has been a feature of the wind...
market prior to end of useful life for many EU windfarms, but this actually arises because the site has excellent wind resources and sees the installation of new wind turbines that are 2-5 times more powerful, meaning this upgrade is commercially valuable. The IEA could be underestimating wind output by 10-20% pa by outer years to 2035, and overestimating winds levelised cost of energy.

**Stronger Performance of Renewables – Technology**

The IEA assumes that rooftop solar capacity factors will improve by 1% in aggregate over the 2012-2020, and a further 1% over 2020-2035 globally on average.\(^{xxix}\) For the US, this takes rooftop solar up 100basis points (bps (each is 0.01%)) to 17% and Europe up 100bps to 13% by 2020. For utility scale, the gain is 150bps over 2012-2020, and then 100bps over 2020-2035. China and India are assumed to both reach 18% and the US 19% by 2020.

By contrast, First Solar Inc. in 2014 set out its five year solar roadmap that includes a 100bps annual improvement in the capacity factor through to 2018, targeting 20%. The technology rate of learning in solar continues to exceed all expectations and First Solar is ahead of plan for its 500bps improvement by 2018.

The first audit of India’s average utility scale solar projects of 2012-13 delivered an average utilisation rate of 19%, already ahead of the 18% IEA target for 2020.

**Stronger Performance of Renewables – Lower Capital Costs**

The IEA assumes that utility solar see economies of scale improve by 4% pa real over the 2012-2020, and a further 2% pa real over the 2020-2035 period.\(^{xxx}\) For the US, this takes utility solar down to US$2,230/kW by 2020.

By contrast, First Solar Inc. forecasts in its 2014 five year solar roadmap a 10% pa reduction in the total installed cost of solar, with a 2018 target of US$990/kW.

The IEA assumes the real capital costs for onshore wind decline by a marginal 0.3-0.7% pa over 2012-2020, despite massive technology improvements that have seen the average size of an onshore turbine double to over 2.0MW over the last five years alone. The cumulative installed onshore wind base globally should double in this period to approach 700GW by 2020.

The IEA has made key assumptions on the capital costs of power projects, using 2012 real prices. For renewables this cost estimate is generally being revised down over time as the massive deflationary effect of the two factors above combine – technology and economies of scale. The starting point of the 2012 capital cost of renewables is too high, implying a higher levelised cost of capital and hence a lower take-up rate.

To illustrate, for 2012 the IEA uses a capital cost for large scale hydro in India at US$1.9m/MW rising to US$2.0m/MW in real terms by 2020, yet a review of 5 recent major hydro projects with a combined capacity of 4.5GW currently under construction have an average capital cost of US$1.1m/MW, 40% below the IEA estimate.\(^{xxxi}\)

For large scale solar, for 2012 the IEA uses a capital cost in India at US$2.1m/MW, falling to US$1.5m by 2020. Yet in 2013 the World Bank estimates the average capital cost for Indian utility solar projects tendered at US$1.2-1.3m/MW, again 40% below the IEA.\(^{xxxii}\)
The economies of scale and rate of technology improvement in solar continues to exceed all expectations, be it from the IEA, the EIA, the NREL or the solar companies themselves. The IEA has a history of underestimating the magnitude of change with respect to renewable energy, resulting in an underestimation of installation rates. Figure 15 provides an illustration of the growth in cumulative solar and wind installations globally over the decade to 2010, and contrasts that to the IEA forecasts made at the start of the decade. The IEA underestimated renewable installs by a factor of 500%. Given the rapid advances being reported through 2014, IEEFA is of the view that this ‘conservatism’ results in an underestimate of renewables and hence a significant overestimation of thermal coal demand.

**Figure 15: The IEA has materially, consistently underestimated Renewables**

![Graph showing cumulative solar and wind installations globally over the decade to 2010, and contrasts that to the IEA forecasts made at the start of the decade.](image)

Figure 16 provides a forecast of relative cost competitiveness of each main type of electricity source, as estimated by Siemens, assuming deployment in the UK by 2025. Siemens employs an all-in cost of electricity. This starts with the levelised cost of energy (LOCE) and adds transmission and variability costs to derive a system cost. To the system cost Siemens adds social impact, employment effects and geopolitical effects to determine a social cost of electricity. IEEFA has applied a similar if less complicated logic – renewable costs keep coming down, and fossil fuel-power plant costs are appreciating. Renewables increase energy security and boost local employment. The relative merits mean an increasing rate of deployment of renewables over an ever wider geographic sphere.
Figure 16: The Levelised Cost of Energy, plus system and social costs – the UK by 2025

![Levelised Cost of Energy Chart]

Source: Global Wind Energy Council April’2014

Figure 17 details renewable energy installs globally over 2001-2013. This illustrates the 10% CAGR over this period. IEEFA forecasts 1,000GW of renewables will be installed over 2014-2020.

Figure 17: Annual Renewable Capacity Added by Technology (2001-2013)

![Annual Renewable Capacity Chart]

Source: IRENA Sept’2014
The US Clean Energy Plan

Under President Obama’s direction, the EPA in June 2014 proposed a raft of measures to achieve a combined 30% reduction in carbon emissions across America by 2030 from 2005 levels. This targets 5-10% larger cuts to coal-fired power generation by 2030 that the IEA’s New Policies Scenario builds in. This could reduce the US’s coal demand by 2030 by an additional 50-100Mtpa. Refer Appendix C for more detail.

Coal Taxes at Coal Point of Use

IEA assumes excise and tax rates on fuels remain unchanged. This assumption is likely to be challenged when the IEA releases its 2014 estimates in light of the number of coal taxes introduced or existing coal taxes doubled in 2014 alone (Mexico, Chile, Korea, India and China – refer Appendix D). Increasing fuel taxes at the point of consumption is a policy initiative to encourage the use of lower carbon emission technologies. Korea’s $16-18/t coal tax could reduce Korea’s coal demand by 5-10% pa, or 5-10Mtce pa.

A faster removal of subsidies

The IEA assumes that energy-related consumption subsidies are removed over time. The biggest subsidy for electricity consumption is in India where the distribution utilities, who are mostly state owned entities, lose US$10bn pa and are subsidised another $5bn pa. As this $15bn pa consumption subsidy is removed via increased prices, consumption will fall, everything else being equal. Given this would see retail electricity rates rise on average 20% pa as a result, electricity demand would fall 10-20%, assuming a price elasticity of demand of 0.5-1.0x. This could reduce India’s coal demand by 2025 by 75-100Mtpa.
3. Country Analysis for Thermal Coal

Energy Demand Trends – Top Global Electricity Markets

Our global thermal coal demand analysis reviews the growth trends of the 20 largest countries in terms of population, GDP, coal consumption and / or electricity demand to 2020 in detail, with a extrapolation of our top-down analysis through to 2035. We present a summary of twelve of the largest electricity systems in the world, providing a comparison of the electricity intensity, real GDP growth and electricity growth since 2000 to give a base historic growth rate. To this we provide an evaluation of energy intensity and economic transition, plus evaluate the current and likely renewable energy, gas, nuclear and hydro electricity generation plans. The impact of key regulations and the increased impact of taxes and emissions trading schemes (ETSs) on coal-fired power generation are also taken into consideration. Examining the compound impact of these drivers, ultimately, determines the change in coal demand forecasted for that country.

Figure 18 details the world’s top 20 Electricity markets and highlights the oversized importance of the top two – China and the US.

**Figure 18: World's Largest Electricity Markets (2013, TWh)**

<table>
<thead>
<tr>
<th>Country</th>
<th>2013</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>5,362</td>
<td>1</td>
</tr>
<tr>
<td>US</td>
<td>4,260</td>
<td>2</td>
</tr>
<tr>
<td>India</td>
<td>1,103</td>
<td>3</td>
</tr>
<tr>
<td>Japan</td>
<td>1,088</td>
<td>4</td>
</tr>
<tr>
<td>Russian Federation</td>
<td>1,061</td>
<td>5</td>
</tr>
<tr>
<td>Germany</td>
<td>634</td>
<td>6</td>
</tr>
<tr>
<td>Canada</td>
<td>627</td>
<td>7</td>
</tr>
<tr>
<td>France</td>
<td>568</td>
<td>8</td>
</tr>
<tr>
<td>Brazil</td>
<td>557</td>
<td>9</td>
</tr>
<tr>
<td>South Korea</td>
<td>535</td>
<td>10</td>
</tr>
<tr>
<td>Mexico</td>
<td>294</td>
<td>11</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>292</td>
<td>12</td>
</tr>
<tr>
<td>Italy</td>
<td>288</td>
<td>13</td>
</tr>
<tr>
<td>Spain</td>
<td>285</td>
<td>14</td>
</tr>
<tr>
<td>Iran</td>
<td>263</td>
<td>15</td>
</tr>
<tr>
<td>South Africa</td>
<td>256</td>
<td>16</td>
</tr>
<tr>
<td>Taiwan</td>
<td>252</td>
<td>17</td>
</tr>
<tr>
<td>Australia</td>
<td>245</td>
<td>18</td>
</tr>
<tr>
<td>Turkey</td>
<td>239</td>
<td>19</td>
</tr>
<tr>
<td>Indonesia</td>
<td>216</td>
<td>20</td>
</tr>
</tbody>
</table>

*Source: BP Statistical Year Book 2014*

Figure 19 details several key statistics for 2013 for each of the countries reviewed in detail. The US is still the largest economy in terms of GDP, and also has the highest per person electricity consumption (as measured in terawatt hours per person).

Since 2011 China has had the largest electricity system globally, with total consumption of 5,362TWh in 2013. Not only the world’s largest electricity market, China also has a very heavy dependence on coal-fired power generation, such that China consumed 50% of the world’s thermal coal production.
in 2013. IEEFA forecasts China’s coal consumption will peak by 2016, and decline thereafter as the country installs more of every non-coal source of electricity to diversify their grid.

**Figure 19: Adjusted Real GDP, Populations and Electricity Consumption**

<table>
<thead>
<tr>
<th>2013 Country Name</th>
<th>Population</th>
<th>Electricity System TWh</th>
<th>GDP PPP</th>
<th>TWh / GDP</th>
<th>TWh / Person</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>23.5</td>
<td>245</td>
<td>1,000</td>
<td>24.5%</td>
<td>10.4</td>
</tr>
<tr>
<td>Brazil</td>
<td>203.0</td>
<td>557</td>
<td>2,423</td>
<td>23.0%</td>
<td>2.7</td>
</tr>
<tr>
<td>China</td>
<td>1,366.0</td>
<td>5,362</td>
<td>13,395</td>
<td>40.0%</td>
<td>3.9</td>
</tr>
<tr>
<td>France</td>
<td>65.8</td>
<td>568</td>
<td>2,278</td>
<td>24.9%</td>
<td>8.6</td>
</tr>
<tr>
<td>Germany</td>
<td>80.6</td>
<td>634</td>
<td>3,233</td>
<td>19.6%</td>
<td>7.9</td>
</tr>
<tr>
<td>India</td>
<td>1,270.0</td>
<td>1,103</td>
<td>1,293</td>
<td>85.3%</td>
<td>0.9</td>
</tr>
<tr>
<td>Japan</td>
<td>127.3</td>
<td>1,088</td>
<td>4,699</td>
<td>23.2%</td>
<td>8.5</td>
</tr>
<tr>
<td>Russia</td>
<td>142.9</td>
<td>1,061</td>
<td>2,556</td>
<td>41.5%</td>
<td>7.4</td>
</tr>
<tr>
<td>South Africa</td>
<td>53.0</td>
<td>256</td>
<td>597</td>
<td>42.9%</td>
<td>4.8</td>
</tr>
<tr>
<td>South Korea</td>
<td>50.2</td>
<td>535</td>
<td>1,667</td>
<td>32.1%</td>
<td>10.7</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>63.2</td>
<td>357</td>
<td>2,391</td>
<td>14.9%</td>
<td>5.6</td>
</tr>
<tr>
<td>United States</td>
<td>319.5</td>
<td>4,260</td>
<td>16,800</td>
<td>25.4%</td>
<td>13.3</td>
</tr>
</tbody>
</table>

*Source: World Bank, BP Statistical Review 2014*

The US electricity and thermal coal consumption is second largest globally. However, US thermal coal consumption is down 12% in 2013 relative to 2000. A steep decline in US coal demand is forecast for the 2013-2030 period, reflecting the huge impact of the shale gas revolution that is still very specific to the US. President Obama’s Clean Power Plan will accelerate this decline.

India is not only the third largest electricity and thermal coal market globally, but has also been the fastest growing major coal import market. Given the very low electricity consumption per person, the challenges for India are huge. India has to somehow maintain sufficient electricity system growth to support continued GDP growth whilst removing the massive subsidies that put retail electricity prices around the lowest rates in the world. India also has an excessively financially geared power sector, and one of the highest transmission loss rates globally. The problems facing India’s electricity sector are legion, and will take considerable time to overcome. We forecast that India’s coal demand will grow, but that the import coal demand will disappoint the very optimistic views generally held in the financial market.

South Africa is the 16th largest electricity market globally, but surprisingly is the 4th largest thermal coal consuming nation. An abundance and dependence on coal historically could change rapidly with the massive focus on renewable energy by the South African government, Eskom, global renewable energy developers and the major African banks to jointly build electricity system diversity.

Japan is the 4th largest electricity market and the 5th largest thermal coal end market. However, given Japan imports almost 100% of its fossil fuel needs, energy security has taken on an even greater national focus post-Fukushima. As such, IEEFA has a very non-consensus forecast for Japanese coal imports to peak in 2013/14 and decline thereafter based on massive world-leading energy efficiency gains and the accelerated deployment of solar since 2012 (11GW in 2014, second only to China).
Korea is the 6th largest coal consumer globally and like Japan almost entirely dependent on fossil fuel imports (oil, coal, uranium and LNG). Unlike Japan, Korea has four trends working driving up coal demand; 1. economic growth above the OECD average; 2. is heavily skewed to electricity intensive sectors (eg steel, construction, shipbuilding); 3. no material renewable energy installation programs are underway; and 4. energy efficiency has not been effective in curtailing electricity demand growth. We see Korea as one of the few major growth markets for thermal coal.

Europe has led the way with the development of the European Union’s ETS and a number of mutually reinforcing policies like the Large Combustion Plant Directive issued in 2001. The global financial crisis has weakened the absolute focus on reducing the EU’s carbon intensity. Nevertheless, Germany and the UK illustrate the magnitude of the transition achieved to-date, which will increasingly emerge over the 2013-2020 period. This is driven by the sustained focus on energy efficiency (an EU target of 30% by 2030), the pricing into the system of the cost of carbon emissions and the continued build-out of renewables. Germany’s progress has been masked near term by the dramatic reduction in reliance on nuclear post-Fukushima. Over the next decade, the UK will dramatically cut coal consumption under closures driven by the European Union Large Combustion Plant Directive, while Germany will continue to transition away from a collective reliance on nuclear, thermal and lignite fuel sources.

France was included in this analysis to illustrate that a country can successfully remove its reliance on coal without any economic impact. France’s electricity system is 75% reliant on nuclear, and having unsuccessfully tried to diversify into gas-fired generation in recent years, now onshore and offshore wind and solar are increasingly the key to electricity system diversity.

Despite being the largest exporter of thermal coal globally, Indonesia has a relatively small electricity market and hence limited domestic coal demand. However, like much of South East Asia, Indonesia is forecast to sustain strong economic growth and this will continue to drive a rapid electrification of the country. With only a limited national focus on energy efficiency and renewable energy, much of this demand growth will be derived from coal over 2013-2020. The opportunities are significant for system diversification, particularly for wind, geothermal and distributed solar with storage.

Australia is burdened by one of the most expensive electricity grid structures globally, giving rise to very high and rising retail electricity prices. Given excessive investment and a low population density, grid operating costs are 70% of the retail price of electricity. Australia has experienced five years of declining electricity demand, leaving the country with 8GW of surplus generating capacity. With good solar radiation and high retail prices, the increasing penetration of distributed solar (adding distributed solar with storage) will accelerate this decline.

Last but not least, we analyse the Brazilian electricity sector. The 9th largest in the world, Brazil is unique in this selection of leading countries in that coal-fired power generation is almost totally absent from its electricity mix. With no material fossil fuel production (except for deep sea oil), Brazil has an electricity system some 80% reliant on domestic and imported hydro-electricity. With exceptional onshore wind and solar resources, Brazil is rapidly diversifying its electricity grid into these newer areas to improve energy system diversity and hence energy security.

Section 3.1 overleaf presents the high level trends of the IIEFA coal demand model to 2035 before looking at each major economy in more detail.