

Energy, Transport and the Environment: Providing Energy Security

Iain C. Conn

Abstract Growing global demand for energy as well as recent geopolitical and technical concerns and issues have served to move energy security up the policy agenda. At the same time the challenge of stabilising greenhouse gas emissions at “safe” levels remains a clear scientific imperative. It is time to stop ‘polishing the 2050 diamond’ and to take practical steps today towards a lower carbon, secure energy future. Moving to action is more important than ever. We must now take the practical steps available to us that can begin to make a material impact on meeting both climate and energy concerns affordably. Pathways for both transport and power are available to us today that can radically reduce emissions without threatening energy security and at a reasonable cost to consumers. The geopolitical relationships necessary to accelerate progress must also be leveraged to accelerate alignment and convergence towards a coherent set of global energy relationships and markets which enable economic progress and stability.

1 Introduction

Energy is at the heart of economic development and indispensable to our way of life. We need energy to be secure but we also need it to be affordable. Increasingly we also need lower-carbon energy as part of a sustainable lower-carbon economy. The balancing of these objectives in a robust policy framework is a truly demanding task and one of the main challenges facing us all in the twenty-first century.

I. C. Conn (✉)

BP p.l.c., 1 St. James’s Square, London, SW1Y 4PD, UK

e-mail: connic@bp.com

Equally we cannot afford to be so taken up with the long-term challenge—what might be described as ‘polishing the 2050 diamond’ in the endless search for future perfection—that we fail to move into action. There are practical steps open to us now that can deliver material progress towards a secure and lower-carbon economy. We should not hesitate to get started on this long-term journey.

The framing of future energy policy would be a difficult enough task without allowing for the unexpected but recent events have been a reminder that the unexpected should always be factored into our thinking. Tragedies such as those in March 2011 in Japan can overtake industries and companies as well as countries. Fukushima could well change the immediate outlook for the nuclear industry, just as the Gulf of Mexico accident in 2010 asked fundamental questions of the oil industry about safeguards in deepwater drilling.

Any serious review of energy policy consequently needs to begin with an ‘eyes wide open’ look at the realities of global energy. This is what BP has tried to do in its Energy Outlook to 2030 [1] publication. This essay starts with a look at this analysis before reviewing some of the practical steps open to policy-makers and then looking at the international alignment that will be needed to deliver the desired outcomes. There are many policy choices to be made and they can have far-reaching consequences. It is hoped that this paper can provide some useful signposts for this task.

2 Energy Outlook 2030

BP’s best judgement of the likely path of global energy markets to 2030 takes into account anticipated policy, technological and economic changes [1]. It is in many ways a ‘reality check’, a best view of the future energy world weighed on a balance of probabilities; it’s not a ‘business as usual’ extrapolation (Fig. 1).

It recognises that global energy demand is fundamentally driven by population and GDP growth. By 2030, global population is projected to rise by around 20% but global income is projected to double. Energy consumption is likely to continue to grow as a result. This upward pressure will be mitigated to some degree by increased efficiency, which will be reflected through a reduction in energy intensity or the energy needed to produce one unit of GDP (Fig. 2).

Three key points emerge from this analysis. First is the projection of a 39% absolute increase in global energy consumption between now and 2030—a huge figure, but much lower than the expected doubling or more of global GDP.

Second is the changing balance of the energy world. In 2010 the total energy consumptions of the non-OECD and OECD were similar. However, by 2030 it is expected that the non-OECD will grow by a further 68% but OECD consumption will remain nearly static. This rebalancing has significant implications for the geopolitics of global energy and this is discussed in more detail later in this paper.

The third key point is on global energy mix. Energy evolution has never been quick, due to the scale of the “installed base” and the pace of technology.

Global Energy Consumption and Energy Mix

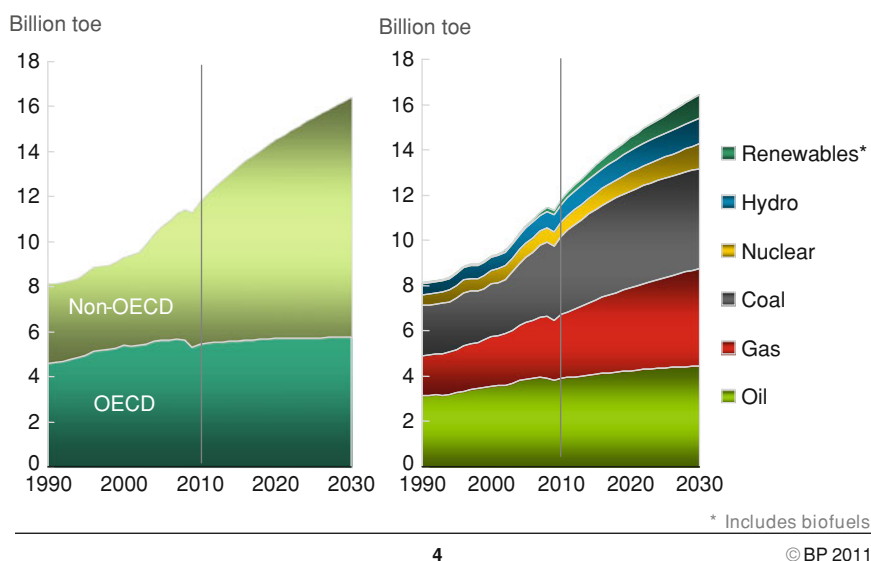


Fig. 1 Shows expected global energy consumption and energy mix from 1990 through to 2030. (Published with kind permission of © BP 2011. All Rights Reserved.)

However, over time important shifts in the global energy balance are clearly evident. Although oil use continues to grow gradually in absolute terms, the share accounted for by oil as a proportion of total world primary energy is declining steadily, while coal is maintaining its market share and growing significantly in absolute terms. However, by far the fastest growing source of energy to 2030 will be renewables. These include biofuels, produced and traded as a global commodity, which by 2030 could meet about 9% of transport fuel demand. Equally, despite these impressive growth rates, non-hydro renewables including biofuels will still account for only some 6% of global primary energy by 2030. Hydro and nuclear are projected to account for another 7% each of global primary energy over this period (Fig. 3).

The balance of the remaining 80% will be split almost equally among oil, coal and natural gas. Of these, natural gas will increasingly be the fuel of choice for power generation. It is a plentiful resource, flexible and economic and burns with half the CO₂ emissions of coal and half the capital cost per unit of generating capacity. It is also ideal for matching with intermittent renewable supplies. As a

Energy Intensity of Development

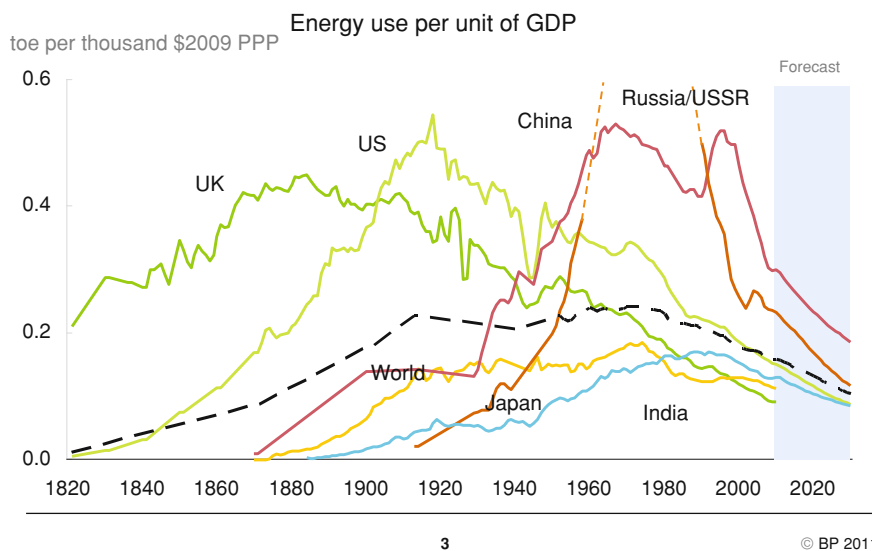


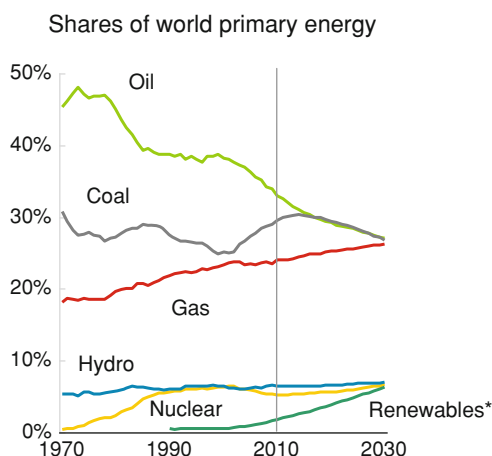
Fig. 2 Is compiled from recorded national economic data. The *left hand* vertical axis shows tons of oil equivalent per unit of GDP and the horizontal axis runs from 1820 to the present day. The series of curves shows the development of energy intensity for a range of countries over this period. The analysis shows that energy intensity peaks in all economies at the high point of heavy industrial development. Thereafter there is a general convergence towards a consistent and much lower intensity of energy use (Published with kind permission of BP 2011. All Rights Reserved.)

result, natural gas is expected to be the ‘big winner’ among the hydrocarbon fuels, gaining market share from both coal and oil.

Under much more aggressive climate policies, it is still unlikely that the world will get near to the Intergovernmental Panel on Climate Change (IPPC) Fourth Assessment Report’s Working Group III stabilisation target of 450 parts per million of atmospheric CO₂eq. required to keep temperature increases within reach of 2°C. Ultimate stabilisation levels will not be known until well into the next century. However, the choices made in the next 20 years, particularly in power generation, will set the likely long-term path (Fig. 4).

This is a sobering reflection but the purpose here is not to step back from the challenge but to caution a sense of realism into the energy policy debate. It can be asserted that the promotion of renewables will create employment and substitute for oil and gas imports. However, the world will still be hugely dependent on fossil fuels in 2030 and there will be economic and competitive consequences for countries adopting this approach if the remainder of the world is using a more cost-competitive and carbon-intensive energy mix.

Global Energy Mix



* Includes biofuels

5

© BP 2011

Fig. 3 Shows the same data as the previous analysis but with fuel mix plotted as a percentage of total world primary energy. The category of renewables includes biofuels but excludes the small-scale dispersed use of biomass, particularly for heating and cooking, in parts of the world. (Published with kind permission of © BP 2011. All Rights Reserved.)

3 Practical Steps Forward

The challenge is significant but equally there are policy choices open in technology, energy mix, carbon pricing and effective markets that can help to meet the triple objectives of energy security, competitiveness and climate change.

Of the areas of potential public policy action that are open to legislators, four can be seen as relatively easier to achieve: encouraging competition; energy efficiency programmes; promoting energy research and development; and, education and communication. Others are much harder: developing long-term and economy-wide price signals for CO₂; the implementation of transitional incentives to speed up the deployment of near-commercial technologies which need a helping-hand down their cost curves; targeted regulatory action; and, international tax and trade mechanisms. Most governments find, in reality, that even that the 'easier' policy areas present significant challenges.

The first, and best, practical step to take—good for security, good for affordability, good for availability and good for lowering CO₂ emissions—is to increase

Global CO₂ Emissions

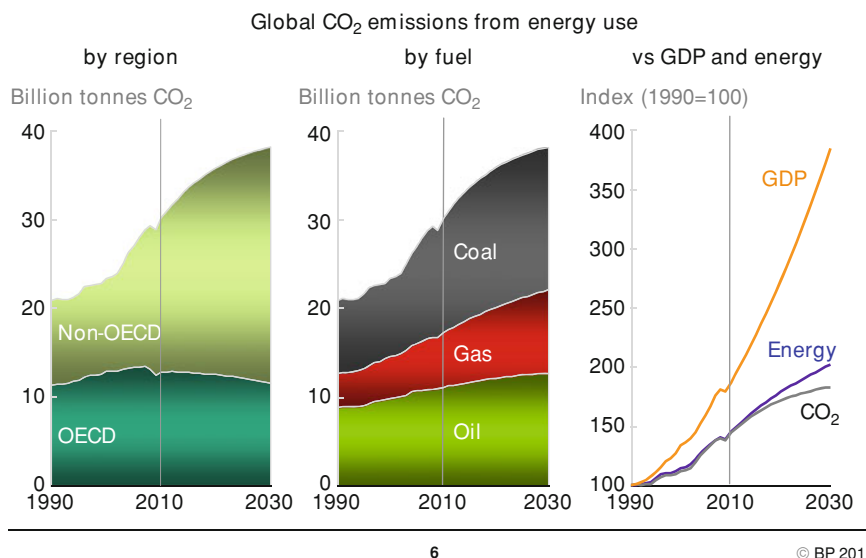


Fig. 4 Shows the projected trend of global emissions in line with these projections of energy mix. Even with reducing energy intensity and tightening national, regional and international climate change policies, global CO₂ emissions are forecast to rise by 27% by 2030. (Published with kind permission of © BP 2011. All Rights Reserved.)

the efficiency of energy use. Transport accounts for around 23% [2] of global CO₂ emissions and remains a fast growing sector. By far the most cost effective way to more efficient transport, without fundamentally changing patterns of consumption or existing infrastructure, is greater efficiency of existing internal combustion engines. Combining greater efficiency with progressive hybridisation and the correct biofuels can significantly reduce emissions from transport.

The blue line in Fig. 5 shows declining CO₂ per km driven, versus the additional purchase cost of vehicles with new technology, relative to conventional gasoline cars today. The key is to distinguish between near-term and longer-term options. In the longer-term—beyond 2030—battery electric vehicles and maybe even hydrogen fuel cells are likely to play a more material part in vehicle transport. It will be more rational to do this once the grid has been more fully decarbonised in order to deliver the full CO₂ reduction potential. Electricity storage technology also needs to evolve for the performance and cost of batteries to be competitive. Even just on environmental grounds, the current average emissions performance for battery electric vehicles in Europe remains above that which can be achieved with hybrids. Electric vehicles will have their time, but not just yet.

Biofuels are compatible with liquid fuelled vehicle efficiency improvements and can further reduce CO₂ emissions...

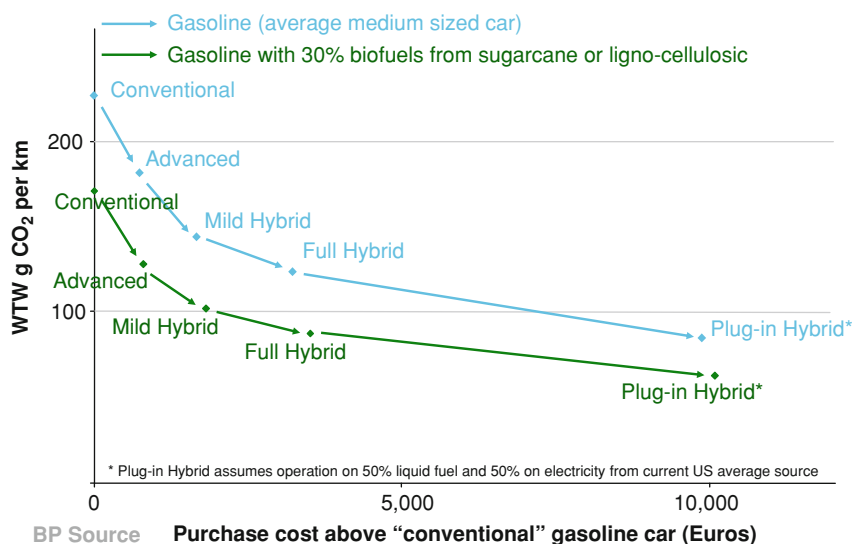


Fig. 5 Declining CO₂ per km driven, versus the additional purchase cost of vehicles with new technology, relative to conventional gasoline cars today (*blue*) and the additional benefit that can be gained from the use of sustainable biofuels (*green*) (Published with kind permission of © BP 2011. All Rights Reserved.)

In the shorter term, at least up to 2030, by far the most effective pathway to lower-carbon transport is to make existing vehicle engines more efficient. There are major gains to be obtained from advanced gasoline engine technology in particular. Combined with step-by-step hybridisation, we can see the potential for nearly halving CO₂ emissions per km at a much lower cost than for a battery electric vehicle.

The green line in Fig. 5 shows the additional benefit that can be gained from the use of sustainable biofuels.

When such a vehicle pathway is combined with the use of sustainable biofuels it becomes even more effective in reducing CO₂ from transport and can reduce emissions by about as much as electric vehicles run off a gas-powered grid—but at a fraction of the cost. For this reason, several companies are already investing heavily in the global supply of sustainable and CO₂-efficient sugarcane and ligno-cellulosic-based gasoline components. The biofuels also usefully add to the diversity of supply of future liquid transportation fuels.

A key point is that these technologies are either already available or experiencing valuable breakthroughs and build on existing deep industrial strengths and capabilities. We can be confident that such an approach can deliver progressive, achievable and material efficiency gains and CO₂ reductions in the transport

sector. The pathway for transport is clear and can be pursued today, making a material impact using the existing energy infrastructure—a point not to be overlooked given the costs associated with a switch towards an electrified road transport system.

The other key use of energy is for electrical power generation, accounting for around 40% [3] of global CO₂ emissions. Economic growth in the developing economies will demand huge global additions of electrical power capacity by 2030. The types of capacity installed are likely to impact energy security and CO₂ emissions to 2050 and beyond. If we make the wrong decisions now, we are locked into the consequences for a long time to come. For power generation by far the most productive pathway is composed, once more, of energy efficiency plus greater use of natural gas in combined cycle gas turbine plant, growth in nuclear and ultimately renewables.

Some of the reasons why gas is an attractive and practical policy choice have already been mentioned. It is a plentiful resource, flexible and economic and burns with half the CO₂ emissions of coal, and half the capital cost per unit of generating capacity. In addition, the flexibility of gas fired plant can be very effective in complementing the natural intermittency of wind and solar power operations. On this basis, natural gas should be seen both as a preferred transition fuel to a lower-carbon economy and as a fundamentally advantaged energy supply option in its own right. The surprising and regrettable thing is that, instead of incentivising gas in power for these reasons, policymakers risk squeezing gas out—by promoting expensive, risky and relatively inefficient zero-carbon technologies that are not yet ready for deployment on a very large scale, and themselves risk being superseded by more advanced technologies fairly soon. Zero-carbon power technologies are evolving fast and, like electric vehicles, the time will come for them to be deployed at scale. In the meantime, natural gas can deliver low-carbon and security benefits for power generation on a large scale at low cost now, just as efficiency plus biofuels can deliver the same for transport. This is perhaps the most obvious area where governments need to ‘stop polishing the 2050 diamond’ and move ahead with these practical pathways as soon as possible.

One final but important point is on the physical availability of natural gas. Recent appraisals of global unconventional gas reserves [1], based on the huge expansion in the production of shale gas, tight gas and coal bed methane in the US, could add as much as 30 years of supply to proven global gas reserves. The transformation of the North American gas market has had the knock-on effect of depressed gas prices: US gas prices are now chasing parity with coal rather than fuel oil. This is leading to the displacement of coal in US power generation on price. Plentiful domestic gas supply has also freed up cargoes of liquefied natural gas (LNG), which had originally been targeted for the US market, to be attracted by prices offered in other regions. In Europe, this has already caused pressure on traditional oil-indexed contract prices as unprecedented amounts of cheaper spot LNG became available from 2009 and into early 2011. LNG that can be diverted from North America is now offering the possibility to Japan of alleviating power shortages thereby resulting from the devastating earthquake of 11 March 2011.

This increased availability of gas supply from diverse sources today, together with the anticipation of additional indigenous supplies of unconventional gas tomorrow, has very substantially reduced concerns over gas security of supply.

So, having looked at the practical steps which can be taken now, the focus in the rest of this paper is on three key external relationships and how they will shape the energy future in which the important energy choices have to be taken.

4 Europe and Russia

These policy choices are rightly a central preoccupation in European energy policy thinking. However, given the approach set out in the first part of this essay, it can be argued that the basic objectives and direction of travel are well understood and the main questions are around implementation and competitive impact. It can consequently be argued that the really big choices for Europe are not so much about internal energy policy as external energy relationships. If Europe does not get these external choices right, policy implementation will become disconnected from the global picture with damaging implications for both economic competitiveness and energy security.

Europe is a significant global energy power but other countries and regions have an increasing interest, and say, in energy too. Furthermore these interests are changing in quite fundamental ways. In 2010 China became the largest global energy consumer, accounting for around 20% of global energy consumption. India and Indonesia are following and Brazil is emerging as both a major producer and consumer. All of these shifts are real and substantive and cannot be wished away.

Geography and history ensure that Europe and Russia are bound together in the same political and economic space. A theoretical question can be asked about the need for a Europe/Russia relationship. In reality it is evident that there is no choice—Europe and Russia are obliged to live and work together and the only real choices are about how well or otherwise to go about this task.

This is true right across the energy sector. An extraordinary network of natural gas pipelines joins the Eurasian continent from the depths of Siberia to the core European energy markets. The pattern for oil pipelines is basically similar. Russia accounts for over 30% of European oil supplies and around 23% of natural gas [4]. In total, Russia supplies about one quarter of European energy requirements, without counting supplies from other countries which also transit via Russia. The infrastructure that makes this possible should be seen not as a liability but a valuable asset. It joins producers and customers and allows both to find competitive advantage in a global market.

Importantly for Europe, this infrastructure also provides a competitive basis for energy to continue to flow west, even as demand continues to grow in the east. The supply lines have also proved to be reliable and Russia kept energy supplies flowing to Europe throughout the course of the Cold War. Of course, this infrastructure is not and cannot be exclusive in terms of access into the EU market.

European Gas Supply Diversity

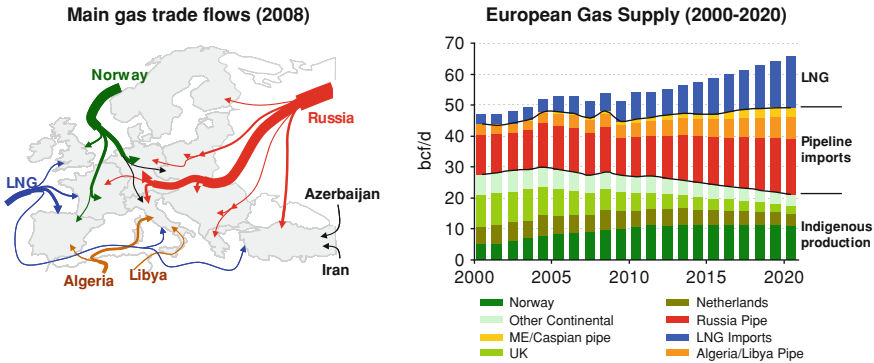


Fig. 6 Gives a view of the diversity of natural gas options open to Europe through to 2020 and beyond. To this can be added the potential for unconventional gas within Europe's own boundaries. There are many choices but a stable and mutually beneficial relationship with Russia will also strengthen the security of supplies from the Caspian, Central Asia and the Middle East. Unless Europe becomes self-sufficient in gas from unconventional sources such as shale gas, Russia will in all circumstances remain an indispensable partner in Europe's energy mix (Published with kind permission of BP 2011. All Rights Reserved.)

Europe will also inevitably encourage other gas infrastructure systems, such as the Southern Corridor, North Africa pipelines and LNG re-gasification to find their place in the market, while also making it easier for gas to cross internal member state borders in case of gas shortages in any part of the EU (Fig. 6).

So Europe and Russia have everything to gain from working together and much to lose from standing apart. Gains include energy security, co-investment opportunities, key sources of economic competitiveness and stability on a long border in an increasingly uncertain world.

5 China

Over the last 10 years, Chinese GDP has almost tripled and energy consumption has more than doubled. According to the IEA [5], this growth has made China the leading global emitter of energy-related CO₂ and the Chinese leadership

recognises that this energy intensive pattern of growth is not sustainable into the longer-term, not least given China's concern for energy security given its growing import dependency for fossil fuels. In the last Five Year Plan ending 2010, China set a target to reduce energy intensity of GDP by 20% and official statements [6] show an achieved outcome of 19.1%. China also has one of the world's largest programmes to develop non-fossil fuels, with the intention that non-fossil fuels should account for 15% of total energy consumption by 2020 [7].

The next Five Year Plan up to 2015 focuses on the issues of energy mix and sustainability and sets out an intention to:

- increase the share of non-fossil fuels in total primary energy consumption from 8.3 to 11.4%
- increase the share of natural gas in the total energy mix from 4 to 8%
- reduce energy GDP intensity by 16%
- reduce CO₂ GDP intensity by 17%.

However, despite all these efforts, it needs to be recognised that China is still a developing country, with GDP per capita on a Purchasing Power Parity basis of around \$6,000 per annum, compared to \$30,000 for the EU27 and \$45,000 for the US. As this gap closes, Chinese growth will continue to drive global energy demand. It is expected that Chinese total energy demand will increase by 80% over the next 20 years, accounting for over 40% of the global energy demand increase in this period [1] (Fig. 7).

However, there is no need to see Chinese energy consumption as a cause for global alarm, nor a threat to good energy policy. The reality is that China's success is increasingly at the heart of a prosperous globalised world. The global financial system has been largely stabilised by Chinese finance. Chinese imports underpin world export demand, while Chinese exports satisfy global consumer needs and support international competitiveness. This is also the case in the energy sector. China's success in energy diversification, energy efficiency and adoption of lower-carbon technology, is presenting major economic opportunities as well as being critical for global energy policy success. Indeed, China's ability to deal effectively with its environmental challenges will largely determine the global environmental outcome.

So in reality there is little choice—in terms of self-interest—except to engage with China at every stage of its journey. China's success is and will be shared by the rest of the world. For business there are worries—not without reason—about security of intellectual property and access to investment opportunity. The appropriate means must of course be found to protect these and other interests. Equally, other governments need to be clear that non-engagement is no choice at all, although the manner of engagement is a critical choice. The issue is whether countries and regions can make the crucial step to align around common interests, or will these be lost in the traditional but ultimately futile search for narrow commercial or national advantage.

On this basis there is a strong argument that engagement with China should stand at the very front of the foreign policy agenda, providing coherence on every aspect of analysis, assessment, representation and strategy. China is not only

China Energy Consumption and Imports

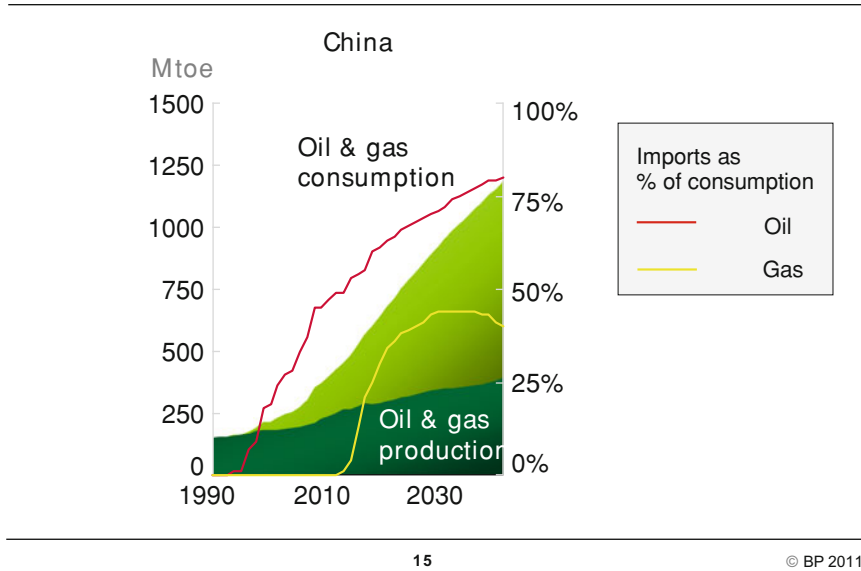


Fig. 7 Shows the impact of this growth on Chinese oil and natural gas consumption and imports. The darker green shows combined domestic oil and natural gas production. The lighter green shows total oil and gas consumption and illustrates the import ‘gap’. It can be seen that Chinese oil demand is expected to more than double by 2030, accounting for 65% of global oil demand growth from today. By 2030, oil import dependency is projected to be at levels similar to Europe. However, gas import dependency may slow after 2020, as a result of the development of indigenous unconventional gas. (Published with kind permission of © BP 2011. All Rights Reserved.)

changing within its borders, it is also changing the world. This change will be an important consideration for future energy policy and governments need to understand and make sure they are part of this change. Working together, it should be possible to reach alignment on a coherent approach to energy policy, encourage partnership between energy companies and co-develop and deploy key research and technologies.

6 The United States

Finally it is important to turn to the United States, where the same challenges in energy policy need to be addressed at a time of economic recovery.

There are differences of course. The US will remain a major importer of oil but, in contrast to Europe and China, will also continue to be a significant oil producer. The

US will, in addition, be a major producer of natural gas, where unconventional sources give it a good chance of complete supply independence for the next 100 years or more. Given this reality, it might incidentally be thought a surprise that the coal industry can lobby so successfully in resisting the promotion of natural gas.

However, the differences in energy balance should not obscure shared wider interests. In a multi-polar world, there is a common interest in aligning the key global relationships for the future—whether with Europe, China or the other major emerging economies. The intention should be to address these relationships as friends as well as competitors.

In energy policy there is much to gain from an aligned approach—whether on energy markets, financial regulation, carbon pricing, new energy technologies or key international relationships. It makes no sense at all to divide international markets by ill-matched policy and regulation, still less by fragmented international action. The US and EU economies could be viewed as a single energy market in the context of intense global competition and this points to the importance of aligned energy policy. This does not necessarily mean a treaty but it does require broad alignment on the pace and intensity of policy interventions, in order to avoid unintended and damaging dislocations on both sides.

A good example is tariff policy on biofuels. If both sides of the Atlantic are not aligned, this will create an unintended arbitrage resulting in biofuels flowing preferentially to either the US or Europe. This dislocation could also prevent the evolution of the Atlantic basin fuel pool as a commoditized source of cheap bio-components. However, perhaps the biggest issue and opportunity is in CO₂ pricing. Europe is pursuing cap and trade for CO₂. The US is still debating its own policy approach. In the end which mechanism is used is not important. What matters will be the timing and intensity of the application of such policy measures. If these are not coherent, then such policy interventions will result in dislocations in the markets between different regions. If coherent, policy interventions can crystallise alignment on global CO₂ pricing and accelerate the global process. No third country or region could afford to ignore an aligned EU and US in carbon markets and pricing.

Therefore, the most important reason for alignment is that it would result in more rapid international climate action and provide a critical accelerant to the necessary but slow UNFCCC process. It would probably also encourage alignment with China. If it were possible to achieve this coherence of the major trading blocs, the world would find that it had successfully laid the foundation for global energy policy in the twenty-first century.

7 Conclusions

This essay has looked at some of the challenges and choices facing the world of energy looking to 2030 and beyond.

The provision of energy security today is more complex than before, particularly if you embrace the challenges of the shifting mix of energy demand growth

and that of climate change. For many decades, the solution to energy security has largely been one of secure supplies, largely of fossil fuels, combined with a drive for limited diversification. Energy demand continues to increase, and we will still be dependent on fossil fuels for decades to come. However today, “more energy” and “alternative energies” will not solve the equation on their own. We must add the hugely important ingredients of “less energy” (i.e., energy efficiency), “energy research and development”, and, if we are to get anywhere quickly, more proactive “foreign energy policy” along key axes. These of course must be bound up in sound energy policy within each major jurisdiction to ensure that competitiveness and economic growth are also maintained. This is a complex equation.

There is no one answer for energy security and different countries and blocs will take different pathways. The growth in global energy demand is such that all energy sources and technologies will be required. However, there are today practical pathways which make a material difference in transport and power and these should be pursued with urgency as a matter of pragmatic imperative. Both start with energy efficiency using today’s technologies, and natural gas, biofuels, and indeed nuclear power can all play major roles in moving economies materially in the right direction while we also research and innovate around longer-term technologies and options. The important thing is to stop only “polishing the 2050 diamond” and start to make practical and material steps today through implementation of the right policies.

Finally, it is also clear that the very necessary UNFCCC process could see some welcome acceleration if key economic blocs could strive towards energy policy alignment and coherence. This can be achieved without being bound up in a formal agreement or treaty. The US and Europe face very similar challenges, with industries in a similar stage of development. Transatlantic alignment on the intensity of policy changes could make a material contribution. Engagement and alignment around areas of mutual benefit with a number of key economic blocs such as Russia and China will also accelerate progress.

Today there are some really big choices which have to be made if we are to achieve progress while also delivering the provision of greater energy security. Although progress is slow, we have come a long way in the last 15 years, and there are some very pragmatic options available, both within our economies and between them, which provide more than a glimmer of hope.

References

1. BP p.l.c. (2011) BP energy outlook 2030. BP p.l.c., London, based on data from the International Energy Agency, The U.S. Energy Information Administration, the United Nations Statistics Division, The World Bank et alia
2. King DA, Inderwildi OR (eds) (2010) The future of mobility roadmap, 2nd edn. Oxford University, Oxford
3. International Energy Agency (2010) World energy outlook. International Energy Agency, Paris. ISBN: 978-92-64-08624-1

4. BP p.l.c. (2011) BP Statistical review of world energy. BP p.l.c., London
5. International Energy Agency (2010) CO₂ emissions from fuel combustion. International Energy Agency, Paris. ISBN: 978-92-64-08027-8
6. U.S.-China Economic and Security Review Commission (2011) 12th five-year plan (2011–2015). http://www.uscc.gov/researchpapers/2011/12th-FiveYearPlan_062811.pdf
7. National Development & Reform Commission (NDRC) (2007) Medium and long-term development plan for renewable energy in China. National Development & Reform Commission (NDRC), Beijing. <http://en.ndrc.gov.cn/>

Energy, Transport, & the Environment

Addressing the Sustainable Mobility Paradigm

Inderwildi, O.; King, S.D. (Eds.)

2012, VIII, 713 p. 195 illus., 36 illus. in color., Hardcover

ISBN: 978-1-4471-2716-1