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Backgrounder

Energy 2030

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Energy 2030: Backgrounder

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ENERGY 2030: DEMAND AND SUPPLY DYNAMICS

KEY INSIGHTS

- **The Role of "Unconventional Sources" of Energy will increase**: According to projections, renewables, hydroelectricity, and nuclear energy will play a more important role in 2030, particularly in the power sector. While the use of renewables will increase by over 430%, nuclear energy and hydroelectricity will expand by 54.5% and 48.5% respectively. Both OECD and non-OECD countries will witness a growth in unconventional energy, but the latter – led by China and India – will see the biggest increases.

- **Fossil Fuels will remain the most important part of the energy bucket:** Despite the growth in the supply of non-fossil energy, fossil fuels will continue to play the predominant role, supplying more than 78% of the total energy. Coal, oil, and natural gas will continue to be the main sources of energy for industry, power, and transportation, only marginally displaced by renewables in the power sector.

- **Technical advances will increase oil and gas supply in the Americas**: North America will witness the greatest growth in both oil and natural gas, owing primarily to the application of a combination of horizontal drilling and hydraulic fracturing, for the production of shale oil and gas. As such, the production of shale will make the U.S. – hitherto the largest oil importer in the world – self-sufficient in oil production. Beyond the Americas, technically recoverable shale reserves have been found in other regions, – particularly China and Russia – but their economic and social recoverability still needs to be assessed.

- **Energy consumption in the Asia-Pacific Region will expand, while production will fail to keep up:** The Asia-Pacific region – primarily due to the growth of India and China – will see a vast increase in energy consumption. While the supply deficits for oil and natural gas will continue to expand, the region will also witness a translation of its surplus of coal into a deficit, becoming a net importer of coal.

Assessing Gaps: A Snapshot of Energy Demand and Supply in 2030[1]

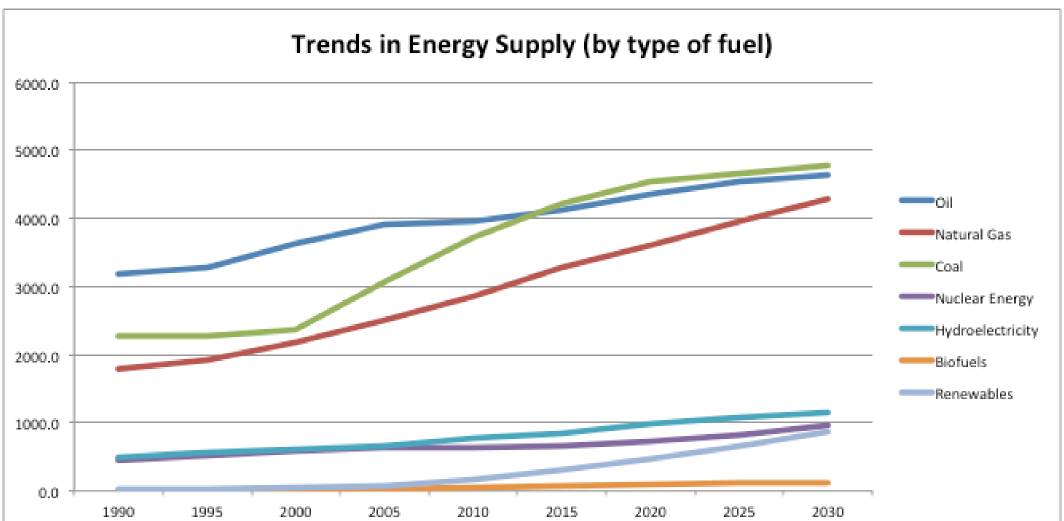
(Million tonnes oil equivalent)	SUPPLY	DEMAND	SURPLUS/DEFICIT
World Total	**16712**	**16716**	**4**
Total Oil Production	4645.5	4760.9	-115.4
North America	943.2	926.5	16.7
S & C America	514.2	395.3	118.9
Europe & Eurasia	811.7	824.2	-12.5
Middle East	1544.9	527.1	1017.8
Africa	507.2	228.4	278.7
Asia Pacific	324.3	1859.3	-1535.0
Total Natural Gas Production	**4280.7**	**4251.6**	29.1
North America	983.3	906.8	76.5
S & C America	232.9	241.7	-8.8
Europe & Eurasia	1110.0	1165.3	-55.3
Middle East	794.1	670.0	124.1
Africa	350.7	167.9	182.7
Asia Pacific	809.8	1099.9	-290.1
Total Coal Production	**4783.1**	**4701.0**	82.1
North America	515.0	447.9	67.1
S & C America	76.2	43.2	33.0
Europe & Eurasia	416.4	402.5	13.9
Middle East	0.6	8.5	-7.9
Africa	192.2	136.2	56.0
Asia Pacific	3582.7	3662.8	-80.1
Total Nuclear Energy	**967.9**	**967.9**	0.0
North America	227.8	227.8	0.0
S & C America	12.1	12.1	0.0
Europe & Eurasia	304.2	304.2	0.0
Middle East	5.2	5.2	0.0
Africa	6.2	6.2	0.0
Asia Pacific	412.3	412.3	0.0

[1] BP 2030 Energy Forecast

Total Hydroelectricity	**1156.5**	**1156.5**	0.0
North America	167.2	167.2	0.0
S & C America	241.9	241.9	0.0
Europe & Eurasia	233.7	233.7	0.0
Middle East	10.6	10.6	0.0
Africa	45.1	45.1	0.0
Asia Pacific	458.0	458.0	0.0
Total Renewables Production	**878.1**	**878.1**	0.0
North America	191.5	191.5	0.0
S & C America	36.5	36.5	0.0
Europe & Eurasia	262.9	262.9	0.0
Middle East	9.5	9.5	0.0
Africa	20.6	20.6	0.0
Asia Pacific	357.1	357.1	0.0

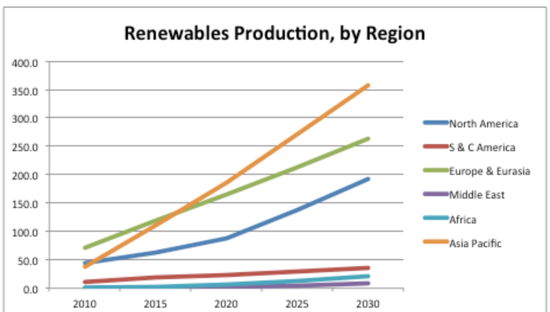
I. The Role of "Unconventional Sources" of Energy will increase…

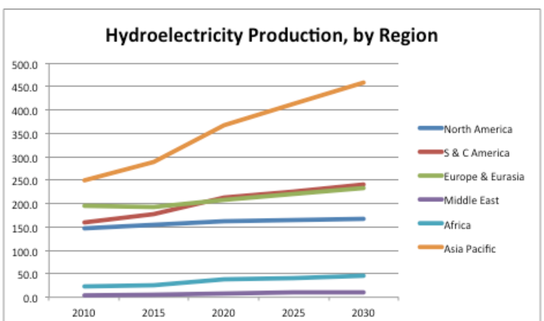
Image 1

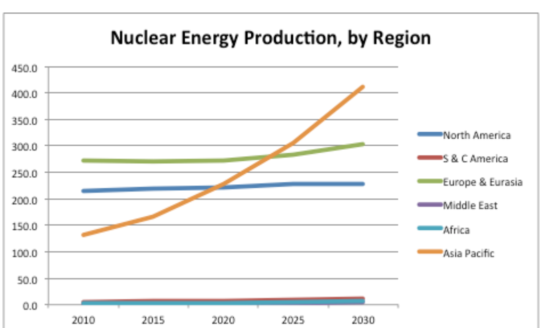


Note: Authors' calculations based on EIA data

In 2030, the total energy supply in the world will be 16841.3 Mtoe, a proportionate increase of 38.4 % from the 2010 supply of 12168.0 Mtoe. While the supply of all fuels is projected to grow during this period, unconventional sources of energy – or non-fossil fuels, including renewables, hydroelectricity, and nuclear – are projected to witness the greatest growth. While the supply of renewables will increase by over 430% to reach 878 Mtoe, nuclear energy and hydroelectricity will expand by 54.5% and 48.5% respectively. The International Energy Outlook Report of the U.S. Energy Information Administration (EIA) attributes this growth of renewable energy to government policies that mainstream the role of renewable energy, stating that "in many parts of the world, concerns about security of energy supplies and the environmental consequences of greenhouse gas emissions have spurred government policies that support a projected increase in renewable energy sources."[2]







Renewables, nuclear, and hydroelectricity will play a significant role in the generation of power, together accounting for about 39% of the total energy consumed by this sector; while hydroelectricity will provide 15% of the energy, nuclear will provide 12.5%, and renewables 11.3%. The EU leads the way, with 26% of power generated from renewables in 2030. The rest of the OECD follows with a lag, and then the non-OECD also starts ramping up the share of renewables in power.

As demonstrated by the charts alongside, the Asia Pacific region is projected to see the greatest expansion, and by 2030, the region will emerge as the biggest supplier of non-fossil energy in the world, supplying 41% of the total renewable energy, 40% of the hydroelectricity, and 43% of the nuclear energy.

[2] http://www.eia.gov/forecasts/ieo/more_highlights.cfm

These forms of energy will grow strongly in both OECD (which will see a growth of 2% per annum) and non-OECD (5.1% per annum) countries. The growth for the former is concentrated in renewable power, while that for the latter will be more evenly split between renewables, nuclear, and hydro. While the EU will lead the world in renewable energy supply, starting 2020, the US and China will emerge as the largest sources of growth. Furthermore, during the 2020-30 period, the non-OECD will add more renewable power than OECD.[3]

Worldwide, hydroelectricity and wind are the two largest contributors to the increase in global renewable electricity generation, with hydropower accounting for 52% of the total increment and wind 28%. The EIA notes that the mix of the two renewable energy sources varies significantly between the OECD and non-OECD regions. In the former, most economically exploitable hydroelectric resources already have been developed, leaving few opportunities to expand large-scale hydroelectric power projects. Subsequently, majority of the renewable energy growth in OECD countries will stem from the growth of nonhydroelectric resources. Per EIA estimates, more then 70% of the projected growth in OECD renewable energy sources is attributed to nonhydroelectric renewables.

China and India are set to see the largest increases in renewable energy generation in the world. India's capacity will double in 2030, compared to its 2010 capacity, while China's is expected to almost triple. China's energy policies have increasingly been supporting renewables, and the country has a goal to generate at least 15% of its total energy output by 2020 using renewable energy, as the government aims to shift to a less-resource intense economy. China has made investments to the tune of $264 million in renewable energy projects in 2011, and per its current Five Year Plan, hopes to spend $473 billion on clean energy investments by 2015. The country has already begun making significant progress - in 2010, China ranked second to the U.S. in wind-powered electricity generation and third globally in offshore wind capacity, but by 2011, it overtook the U.S. in terms of installed wind capacity, although not in wind-powered electricity generation. By 2040, China's projected total generation from wind power plants is expected to be 637 billion

[3]http://www.bp.com/liveassets/bp_internet/china/bpchina_english/STAGING/local_assets/downloads_pdfs/BP_2012_2030_energy_outlook_booklet_en.pdf

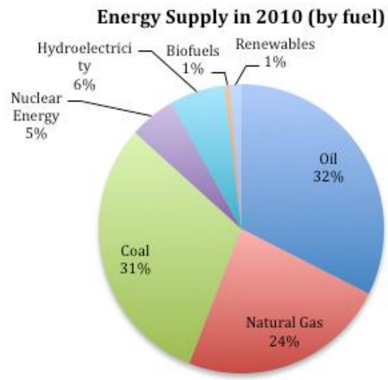
kilowatthours, growing at an average rate of 9.3% per year. Consequently, wind energy will account for 26% of China's total renewable energy generation, compared to just 6% in 2010 (EIA).

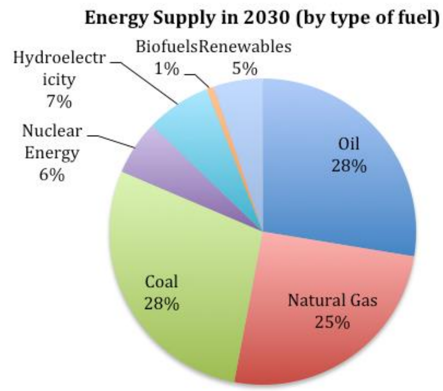
Nuclear output is expected to increase rapidly between 2010 and 2030, averaging 7.8% per annum. BP attributes this to the ambitious nuclear expansion programs in China, India, and Russia. The EIA report echoes this, stating that nuclear capacity will expand by 86% in non-OECD countries, led by China, India, and Russia, which will account for the greatest increment in world net installed nuclear power from 2010 to 2040. The report further states that, China is expected to add 149 gigawatts of nuclear capacity between 2010 and 2040, India 47 gigawatts, and Russia 31 gigawatts. India, with a goal of increasing its nuclear generating capcity to 14.6 gigawatts (EIA) by 2020, hopes to substitute coal-fired generation with nuclear power. India hopes to set into operation seven nuclear reactors by 2016. Apart from these three countries, installed nuclear capacity is also anticipated to increase in other regions, including Turkey, Poland, and France.

While there is general uncertainty surrounding the future of nuclear power, stemming from concerns about plant safety, waste disposal, and the proliferation of nuclear waste materials, in the wake of the Fukushima Daiichi disaster, the EIA appears optimistic that this uncertainty will be offset by the increases in countries like Russia, China, and India.

… But Fossil Fuels will remain the most important part of the energy bucket

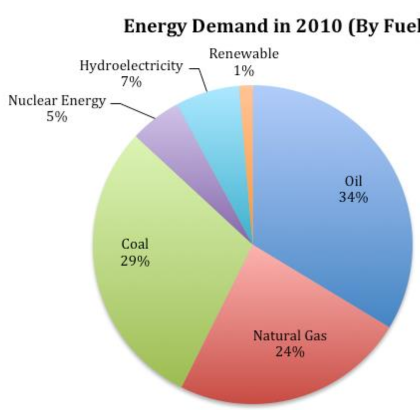
Despite the rapid growth of non-fossil energy sources, the composition of the energy basket will largely remain the same, and fossil fuels – oil, natural gas, and coal – will remain the main suppliers of energy, accounting for over 78% of the energy supply in 2030.

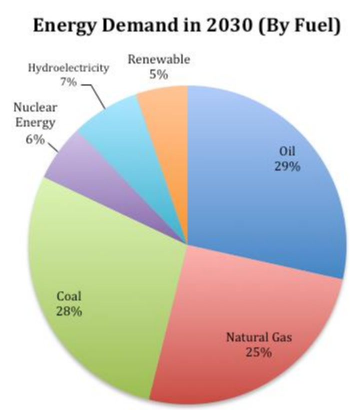




As the charts above demonstrate, the top three fuels produced in 2030 will be Coal (accounting for 28% of the total energy basket), Oil (28%) and Natural Gas (25%). This is similar to the situation in 2010, although, while the share of natural gas remains more or less the same, the share of both oil and coal in the total energy production is projected to decline – the share of oil is expected to decline by 4% between 2010 and 2030, while that of coal is likely to fall by 3%.

These trends are mirrored on the consumption/demand side as well, with oil accounting for 28% of the global energy demand in 2030, natural gas 25% and coal 28%. The demand for oil and coal is primarily driven by the Asia Pacific region, – led by India and China – which is projected to consume 39% of the global oil supply and 78% of the coal. This is discussed in further detail later in this paper.





In terms of their end/sectorial uses, fossil fuels will be comprehensively important. Oil, coal, and natural gas will all play a significant role in the industrial sector, each providing approximately a third of the sector's energy demand, echoing the 2010 trend.

In the power sector, coal and natural gas will be the most sources of energy. While natural gas continues to provide the same share – 21% – of the sector's total energy demand as it did in 2010, the share of coal declines by 6%, owing primarily to an increase in the share of renewable energy. Regardless though, coal continues to be the most important source of energy for this sector, still accounting for 38% of its total needs.

In the transport sector, oil continues to be the main source of energy, accounting for almost 90% of the sector's total energy consumption. However, the share of both natural gas and renewables increases, albeit marginally.

II. Technical advances will increase oil and gas supply in the Americas…

The total production of oil in 2030 is projected to be **4645.5** Mtoe, representing a proportionate increase of 17.7% from the 2010 production. The Middle East will continue to be the largest producer of oil, accounting for a third of the total production; 20% will be produced in America, 18% in Europe and Eurasia, 11% in South and Central America, 11% in Africa, and 7% in Asia Pacific. North America will witness the greatest increase in oil production (45%), followed by South and Central America (37%). Oil production in the Middle East is expected to rise by 29.7%, and in Africa by 6%. Both Europe and Eurasia, and Asia Pacific will see a decline in oil production. For the former, oil production is expected to decline by 4.5% between 2010 and 2015, and then remain almost constant until 2030, leading to a net decrease of about 5%. For the Asia Pacific region on the other hand, oil production is expected to remain constant until 2020, and then decline by 15.4% between 2020 and 2030.

Apart from oil production, North America will also see a significant growth in the production of natural gas, which, according to EIA projections, will grow in the OECD Americas by 56% between 2010 and 2040. The United States will account of three-quarters of this growth, with an increase from 21.2 trillion cubic feet in 2010 to 33.1 trillion cubic feet in 2040.

The EIA attributes the strong prospects of growth in oil and gas supply in the Americas to contributions from deepwater pre-salt resources in Brazil, bitumen in Canada, and tight oil in the United States, and technological advances.
In Brazil's case, production growth is based on the successful development of its offshore pre-salt resources, made available by relatively high oil prices and technological improvements in extraction techniques for very deep water. These large deepwater pre-salt resources are estimated to include as much as 28 billion barrels oil equivalent. The Sapinhoa oil field began producing oil from pre-salt deposits in early 2013, and in mid-November, Petrobras announced the production of crude oil at the Papa Terra field.

One of the most prominent examples of technological advances being applied to the production of crude oil is seen in the rapid growth of U.S shale/tight[4] oil and gas in recent years. According to Canada's National Energy Board, tight oil resources are made available when the combination of horizontal drilling and multi-stage hydraulic fracturing is applied to very low permeability shale, sandstone, and carbonate geologic formations, making oil production possible from many previously uneconomic or inaccessible reservoirs. Such oil development began with the Bakken play in the Williston Basin area of North Dakota and Montana in the U.S. By the end of 2012, the production in North Dakota increased sevenfold from its 2005 levels.

Because they have proven to be quickly producible in large volumes at a relatively low cost, shale/tight oil and shale gas resources have revolutionized U.S. oil and natural gas production. Tight oil production in the US has witnessed a growth from an average of 0.2 million barrels per day in 2000 to an average of 1.9 million barrels per day in 2012, for 10

[4] Although the terms shale oil and tight oil are often used interchangeably in public discourse, shale formations are only a subset of all low permeability tight formations, which include sandstones and carbonates, as well as shales, as sources of tight oil production. Within the United States, the oil and natural gas industry typically refers to tight oil production rather than shale oil production, because it is a more encompassing and accurate term with respect to the geologic formations producing oil at any particular well. EIA has adopted this convention, and develops estimates of tight oil production and resources in the United States that include, but are not limited to, production from shale formations. (Source: EIA)

select formations. In 2012, shale provided 29% of the U.S.'s total crude oil production, and 40% of its total natural gas production. The EIA estimates that U.S. shale gas production will grow from 4.9 trillion cubic feet in 2010 to 16.7 trillion cubic feet in 2040. According to BP projections, "Shale gas and coal bed methane (CBM) will account for 63% of North American production by 2030, and the sustained growth of shale gas raises the prospect of LNG exports from North America by 2030."

Global Shale Reserves:

Even beyond North America, shale oil and gas deposits exist in sedimentary basins throughout the world, and the assessment of these resources has begun to gain momentum. A 2013 EIA-commissioned assessment of shale oil resources in 41 countries estimated 345 billion barrels of technically recoverable shale oil resources and 7,299 trillion cubic feet of technically recoverable natural gas.

Table 1. Technically recoverable shale oil and shale gas resources in the context of total world resources

	Crude oil (billion barrels)	Wet natural gas (trillion cubic feet)
Outside the United States		
Shale oil and shale gas[1]	287	6,634
Non-shale[2]	2,847	13,817
Total	**3,134**	**20,451**
Increase in total resources due to inclusion of shale oil and shale gas	**10%**	**48%**
Shale as a percent of total	**9%**	**32%**
United States[3]		
Shale / tight oil and shale gas	58	665
Non-shale	164	1,766
Total	**223**	**2,431**
Increase in total resources due to inclusion of shale oil and shale gas	**35%**	**38%**
Shale as a percent of total	**26%**	**27%**
Total World		
Shale / tight oil and shale gas	345	7,299
Non-shale	3,012	15,583
Total	**3,357**	**22,882**
Increase in total resources due to inclusion of shale oil and shale gas	**11%**	**47%**
Shale as a percent of total	**10%**	**32%**

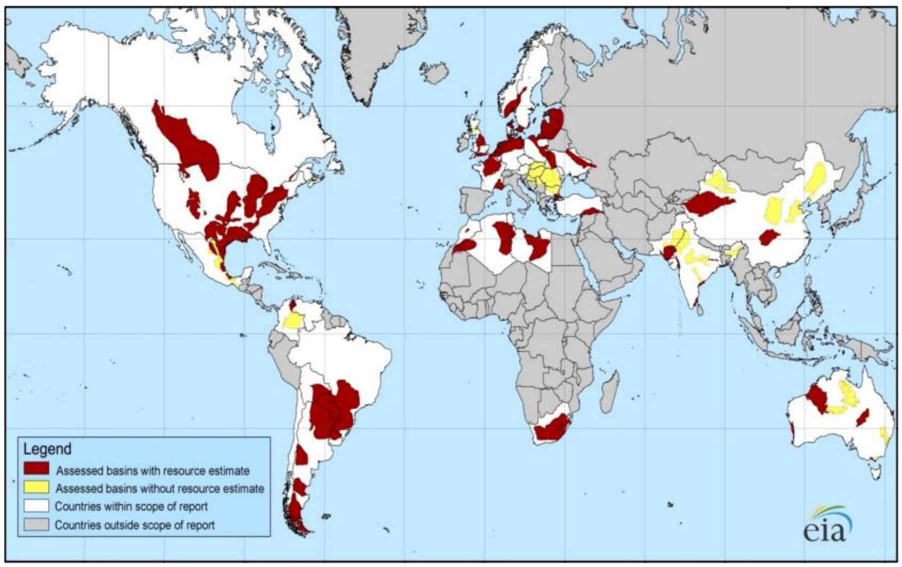
[1] Advanced Resources International, Inc. (ARI) 2013.

[2] *Oil & Gas Journal*, Worldwide Report, December 3, 2012; U.S. Geological Survey, An Estimate of Undiscovered Conventional Oil and Gas Resources of the World, 2012, Fact Sheet 2012-3028, March 2012; U.S. Geological Survey, Assessment of Potential Additions to Conventional Oil and Gas Resources of the World (Outside the United States) from Reserve Growth, 2012, Fact Sheet 2012-3052, April 2012.

[3] U.S. Energy Information Administration, various reports.

Of these 345 billion barrels of technically recoverable shale oil resources, the U.S. holds about 17%, while Russia holds about 22%. In addition to the U.S. and Russia, China, Argentina, and Libya hold significant shale oil resources, together accounting for about 25% of the world total.

As regards the technically recoverable shale gas resources, the U.S., – which holds about 9% of the world total – is ranked fourth, after China (15.3%), Argentina (11%), and Algeria (9.8%).

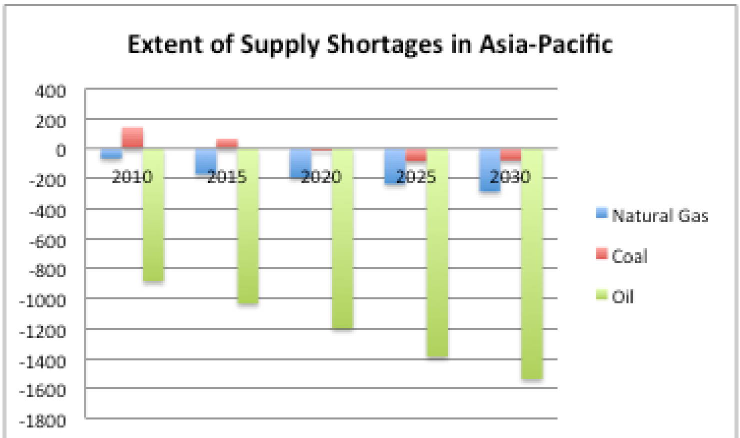


Source: U.S. Energy Information Administration

But moving forward, it is important to note that while these deposits – particularly those in China and Russia – hold significant potential, in terms of their *technological recoverability*, their *economic and social recoverability* still needs to be assessed. On the other hand, producers in Canada and the U.S. benefit from the oil and gas industry infrastructure that has already been established. Consequently, the EIA report notes that the pace of shale energy development in other parts of the world is likely to be slower, as the required infrastructure could take many years to be set in action. But should these challenges be ameliorated, shale deposits could provide enough additional supply to affect oil prices.

…But energy consumption in the Asia-Pacific Region will expand, while production will fail to keep up

By 2030, the Asia-Pacific region's demand of all fossil fuels will increase, and indeed, drive global consumption – while its consumption of oils will increase by 45%, that of natural gas will increase by 119%, and coal by 56%.



With fossil fuel supplies, however, failing to keep up with this increased consumption, the Asia-Pacific region will face severe shortfalls in its fossil fuel supply. Until 2010, the region had surplus supply of coal, to the tune of 138.3 Mtoe; by 2030 however, this surplus will translate into a deficit of 80.1 Mtoe. It's shortfalls of both natural gas and oil will continue to rise, and by 2030, it will face a shortfall of 1535 Mtoe in oil and that of 290.1 Mtoe in natural gas.

Most of this increase in energy consumption is attributed to the rise of China and India. The Asia-Pacific region accounts for almost 79% of the increase in global liquids consumption, rising from 1281.7 Mtoe in 2010 to 1859.3 Mtoe in 2030. The EIA echoes this, and further notes that, "demand growth in China and India surpasses the combined liquids demand growth of the rest of the world." In China, the demand for all fossil fuels will expand in the 2010-30 period, led by gas, which will increase by 283%, oil by 73%, and coal by 34% (BP). In India's case too, the demand for all fossil fuels will increase – oil by 108%, gas by 101%, and goal by 97%.

The EIA also attributes this increased oil demand in China to its transition from a manufacturing to a service-oriented economy. Such a transition will make the transportation sector more important, and will cause the energy demand in transport to rise by 118% (BP). Oil provides 90% of the energy required by this sector (BP), causing China's consumption of oil to increase considerably. By 2035, China will more than double its liquids consumption compared with the 2010 level (EIA), and thus, overtake the United States as the world's largest consumer of liquid fuels.

Apart from the vast increase in oil-demand, another striking feature of the demand-supply dynamics in the Asia-Pacific region is the translation of a surplus in coal production in 2010, to a deficit by 2030. This is a noteworthy trend because China and India are the world's largest and third largest producers of coal in the world respectively, and the production of coal in both countries is expected to rise by 1.6% per annum (EIA).

While China has typically been a net exporter of coal, it became a net importer starting 2009. By 2011, the total imports of coal rose to 240 million short tons (EIA). This may be attributed to the large increase in coal consumption – between 2000 and 2010 for instance, the average increase in coal consumption was 200 million tonnes per year (EIA). But between 2010 and 2040, the annual growth in coal consumption is expected to reduce to 90 million per year (EIA), and while coal remains the leading fuel in Chinese energy demand, its share falls from 71% today to 55% in 2030 (BP). This slower growth, coupled with China's major infrastructure projects and policy initiatives – including an expansion of the country's mine capacity in the northern and western provinces, as well as the emphasis on building up industrial zones closer to coal producing areas – will allow it to increase its domestic coal production and make coal transportation more efficient.

On the other hand, India's consumption of coal will increase by 97% between 2010 and 2030, as the energy consumed by the power sector rises by 104%. While India's consumption of coal has been very modest compared to China's, India's challenge lies on the supply side, causing it to increase its coal-imports to the tune of 160 million tonnes between 2010 and 2040. The EIA lists some of the bottlenecks coal production faces in

India – from delays in regulatory approvals, to opposition based on environmental concerns, land acquisition issues, forest clearing, resettlement and rehabilitation, all challenges that take considerable time and effort to resolve. Additionally, inefficient utilization of rail capacity also affects about one-half of the coal transported within India, but getting approvals to expand rail transportation is a difficult and cumbersome process. As a consequence of such bureaucratic and regulatory hurdles, India's coal imports are projected to increase from 140 million tonnes in 2011 to more than 300 million tonnes in 2040. Majority of these imports are steam coal for electricity generation, and coking coal for the industrial sector.

2

Implications of Geopolitical Stress on Energy Trade

Key Insights

- New discoveries of energy reserves combined with new technologies to extract energy more efficiently will lead to a dramatic shift in existing dependency on energy-dominant countries and regions (such as Russia and the Middle East).
- Lower carbon-emission prospects of natural gas have begun to appeal to a larger number of countries, leading to a geographical shift of focus on energy resources and changing demand-supply dynamics.
- There will be less reliance on OPEC, yet the Middle East will remain lowest cost producers as they move into developing their natural gas resources.
- Developments will determine whether currently energy-dominant countries will maintain their positions of power, or whether new discoveries and shifting demand-supply dynamics will lead to a shift in political order.

Over the next decade, the international energy market is likely to see a large shift in both supply and demand for a number of reasons. Much of the growth in energy consumption occurs in countries outside the Organization for Economic Cooperation and Development (OECD), known as non-OECD, where demand is driven by strong, long-term economic growth. From 2010 to 2040, energy use in non-OECD countries increases by 90 percent; in OECD countries, the increase is 17 percent.[5]

In this context, geopolitical trends have a significant impact on energy production, prices and trade. Indeed, higher energy prices resulted in a resurgence of resource nationalism and the tendency to exert greater state control over indigenous resources. They have also, in some cases, allowed producers to use energy resource leverage to further foreign policy and political agendas. Although sovereign nations have always exerted control over indigenous resources, the revision of legal and regulatory structures has created an atmosphere of

[5] International Energy Outlook, US Energy Information Administration, July 2013.

investment uncertainty and reduced access for non-state players. [6] Taking these developments into account, one must consider whether currently energy-resource-dominant countries will maintain their positions of power or whether new discoveries of 'unconventional' and conventional resources will lead to a shift in political order.

First, the shale gas revolution in the US will most likely reduce its exposure to international energy markets as it turns the world's largest consumer of gas into an exporter. Shale oil will also emerge as a route to self-sufficiency for the US, as the shale oil revolution taking place in the United States could result in the tripling of shale oil output to five million barrels a day by 2017, likely making the U.S. the top oil producer in the world in just a few years.[7]

Second, new and growing gas consumers in South and East Asia and the Middle East will continue to emerge, interacting with large oil-exporters and oil prices in a dramatic way. The increased availability of unconventional natural gas is putting pressure on longstanding contractual arrangements that underpin the oil-linked gas-pricing paradigm.[8]

Third, new discoveries of gas in Australia and East Africa will most likely add to the global supply of liquefied natural gas (LNG). Growing energy consumers such as China and India will face increased global competition from former LNG exporters Indonesia and Malaysia, now preparing to import LNG to meet domestic demand.[9]

Fourth, as the Arab Spring raised oil prices and concerns about energy security around the world, the Middle East is likely to be at the center of the shift in global energy markets as it negotiates with dramatic political change.

In 2011, the International Energy Agency (IEA) suggested that the world was entering a 'golden age of gas'. Even before the widespread use of new technologies such as hydraulic

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[6] Verrastro, F. 2010. The Geopolitics of Energy. Centre for Strategic and International Studies: Colombia.
[7] Maugeri, L. 2013. The US Shale Oil Boom. Belfer Center for Science and International Affairs, Harvard Kennedy School.
[8] Ibid.
[9] Brookings Doha Energy Forum 2013 Policy Paper. A Brookings Doha Center – Energy Security Initiative Report.

fracturing and horizontal drilling and the discovery of new quantities of shale gas, the global energy sector anticipated a rise in the proportion of natural gas. In 2005, the IEA had forecasted that "gas will overtake coal by 2020 as the world's second-largest primary energy source"[10] with demand growth led by emerging Asian economies. Now, with the so-called 'unconventional' gas revolution in the US, the potential for wider diffusion of new production techniques, and the role of gas in putting the global economy on a lower-carbon development pathway, prospects for fuel look to be more optimistic than anticipated.

The US shale gas revolution and the global gas market

Perhaps the most dramatic change in the global gas landscape is the transformation of the US natural gas sector. While the US was expected to be a primary importer of LNG throughout the 2000s to meet growing demand, it is now facing the very real prospect of being an LNG exporter. The shale gas 'revolution' has seen the US increase natural gas production by approximately 20% between 2008 and 2012. Indeed, the advent of hydraulic fracturing, or "fracking," has led US oil production to rise by 30%, and gas production by 25% in just five years. Shale gas contributed almost nothing to US natural-gas supplies at the start of the century whereas by last year, its share had soared to 34%, with the US Energy Information Administration predicting a further rise to one-half by 2040. As a result of this bonanza, US domestic energy prices have plummeted.

These changes in supply have also been important for European and Asian gas importers who are looking to benefit from this greater supply– many of which had already planned on increasing the share of natural gas in domestic energy mixes.

Newfound reserves of gas

The US shale gas revolution, however, is only estimated to account for ten percent of global reserves that could total to as much as 6,622 trillion cubic feet. According to gas-sector analysts, the greatest potential lies in shale reserves in other parts of the world – predominantly China (which is estimated to have over 1200 tcf of technically recoverable shale gas resources, the largest global reserves), Argentina (774 tcf), Mexico (681 tcf) and South Africa (485 tcf). Smaller reserves in a number of European countries such as Poland

[10] "World Energy Outlook: 2005," International Energy Agency, 83.

(187 tcf) and Ukraine (42 tcf[11]) have also received attention for their geopolitical implications, as they have traditionally been dependent on Russia for supplies of natural gas. Successful development of domestic shale reserves could reduce the continent's gas-driven economic and political dependency on Russia and Russia's energy dominance in the region.

The shale gas revolution is not only limited to the US. Australia is rapidly pursuing development of its coal-bed methane CBM resources, with China, India and Indonesia close behind. A number of other countries spread across Asia, East Africa, Europe and South America are also optimistic about prospects for their own shale gas reserves. The development of methane hydrates in Japan coupled with large reserves of conventional sources in East Africa will widen dispersion of gas resources. According to the forecasted growth in natural gas trade by the discovery of these resources, the IEA projects that between 2010 and 2035, international natural gas trade will grow by nearly 80%. [12]

Territorial, economic and political concerns

Territorial disputes over other sources of energy have also contributed to geopolitical stress. Increased competition for untapped oil and gas fields is likely to add to the intensity of disputes over contested offshore territories with promising hydrocarbon deposits. This is a major factor in the dispute between China and Japan over a disputed patch of the East China Sea which is believed to sit atop a large natural gas field. A similar dispute has arisen in the South China Sea, with undersea oil and gas reserves again a source of friction and conflict. [13] China claims large swaths of the eastern South China Sea, overlapping with claims from Malaysia, Brunei, Vietnam, and the Philippines. Vietnam has offered India seven oil blocks, including three on an exclusive basis, and joint prospecting in some Central Asian countries. Chinese objections have included demarches, pressure on companies not to sell equipment

[11] Energy Information Administration, US Department of Energy. 2011. World Shale Gas Resources: An Initial Assessment of 14 Regions outside the US.
[12] "World Energy Outlook: 2012," International Energy Agency, 146.
[13] Klare, M. 2012. The Geopolitics of Oil: Old and New. World Security Studies Hampshire College, Association for the Study of Peak Oil.

to India and the alleged buzzing of an Indian warship that had transited through the disputed portion of South China Sea.[14]

The Iran-Pakistan-India pipeline too is rife with geopolitical obstacles. While the Iranian section of the pipeline (over 900 km) is almost complete, no work has happened on the 780-km segment of Pakistan's soil. Pakistan's fundamental problem is financing the project, yet there are other factors are in play. For example, Saudi Arabia is seemingly uncomfortable with Pakistan-Iran links while Riyadh has already expressed displeasure over the West's nuclear deal with Iran. While Pakistan has assured that the project will not be abandoned, further developments will decide the fate of the IPI, particularly as the pipeline passes through the troubled province of Baluchistan.[15]

Despite the onslaught of shale gas reserves and new conventional resource discoveries in locations like the Eastern Mediterranean and East Africa, coal-bed methane (CBM) in Australia or gas reserves in the Arctic, there are several concerns and uncertainties regarding the scale of new resources and how fast they can be developed. In particular, the economics of deep-water projects, the sustainability of the US shale production, the environmental repercussions of fracking, and the replicability of the shale revolution elsewhere are all open to question. A range of policy decisions from regulations on hydraulic fracturing in the US to decisions on the future of civil nuclear power in Japan to negotiations on climate change measures could have a significant impact. Concerns have also been raised regarding the timing of development of East African gas, with anxiety about policy and infrastructure constraints delaying production and eventual exports. Indeed, the policy framework deciding oil and gas development in Mozambique in still nascent while in Tanzania it is still under development. However, domestic political pressure to extract rent from foreign firms looking to export is bound to increase as does interest in both countries' reserves. Clear regulatory and fiscal frameworks are necessary to work towards an effort to ease the physical infrastructure to produce, process and export the gas.[16]

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[14] The Hindu, Vietnam offers India seven oil blocks in South China Sea, November 2013.
[15] The Hindu Business Line, Nov 29, 2013. The Iran-Pakistan-India gas pipe-dream.
[16] Banks, J. 2013. Could East African Gas Impact U.S. Liquified Natural Gas Exports?. Brookings Up Front blog.

The shale gas revolution in the US also faces uncertainties regarding concerns over the sustainability of production. Shale wells have very steep production decline curves, suggesting that a massive amount of wells will need to be drilled to maintain and increase production. In addition, if the gap between natural gas prices and oil prices remain wide, rigs will continue to decline: the number of natural-gas-producing rigs in the US is at its lowest level in more than a decade.[17] However, new markets will develop for gas if the gap between gas and diesel remains wide as increased demand in transportation, railroad locomotives and marine transportation will spur more drilling. Replicability of the shale revolution is also a big concern – the diversity of geologic formations and the difficulty of obtaining geological data, limited water availability, resistance to resource development in densely populated areas and local regulatory frameworks may stand in the way of domestic production.

Policy considerations in certain countries also stand in the way of energy supply and demand outlook. Environmental policy in the US is still in flux and may prevent America from emerging as a lead gas exporter, uniform standards for the fracking process may add to wellhead costs, reducing an economic incentive to export LNG. All these uncertainties may slow the rapid growth in demand for natural gas – particularly LNG. Internationally, the outlook for nuclear power and its impact on gas demand is also unclear as, particularly in Japan, the government is still considering the reintroduction of its nuclear power plants.

The impact of regional political economy on energy resources

The shale revolution may lead countries that are heavily dependent on oil markets to see turmoil. In an open letter to the Saudi oil minister earlier this year, billionaire investor Prince Alwaleed warned that the country should begin examining how to further diversity its economy should American and Asian shale production start eating into Saudi market share[18]. As a result of these concerns, the country has since announced that it will begin accelerating its natural gas production.[19] As renewable energy continues to be developed, natural gas is the most practical alternative for power generation. As long as countries in the region were

[17] U.S. Energy Information Administration. 2013. Crude oil and natural gas drilling activity.
[18] Business Insider, July 29, 2013. Prince Alwaleed: Fracking Is Bad News For Saudi Arabia.
[19] Reuters, Oct 13, 2013. Saudi Aramco says ready to use unconventional gas for power plant.

able to meet their economic demands through rents from crude oil exports, natural gas remained an accessory to oil production. However, with rapidly growing populations and the need to diversify their economies away from raw material exports, the region's countries are now realizing the value of natural gas. According to IEA projections, natural gas demand in the Middle East is projected to increase by more than 70% between 2010 and 2035.[20] While production is also projected to grow by the same proportion, around one third of that growth is expected to be from Qatar which will export the vast majority of it as LNG to customers outside the region. As the Middle East and countries of the Gulf experience rapid demographic and industrial change, the provision for affordable and reliable sources of energy will be increasingly important in ensuring political stability and economic and environmental sustainability.

However, many of the countries in the region (including Kuwait, UAE and Saudi Arabia) are facing an acute shortage of gas. Despite the Gulf's intrinsic endowment of natural gas, the distribution of those resources is uneven as regional politics pose an obstacle to efficient allocation. While the region's largest reserves are held by Iran, its relationship with the Gulf is fraught and countries in the region are being forced to burn crude oil to meet demands (both an environmental and economically costly practice). Indeed, as Iran has been thus far unable to develop its energy resources because of strict international sanctions and Qatar has remained content with current levels of gas production for profitable export of LNG, additional production of the region's largest resource is unlikely in the near-to-medium term. While other neighboring countries – the UAE (215 tcf) and Saudi Arabia (288 tcf) – have sizable resources, they face economic, political and technical obstacles to production. Furthermore, the traditional scheme of subsidized domestic energy prices in the Gulf region will become unsustainable, are it is likely to crowd out investment and job opportunities in other sectors.[21]

Natural gas use is likely to play a large role in economic and political sustainability in the region. However, for it to do so, there needs to be reform in gas pricing in the region so as

[20] "World Energy Outlook: 2012," IEA, 134.
[21] Brookings Doha Energy Forum 2013 Policy Paper. A Brookings Doha Center – Energy Security Initiative Report.

to attract the investment necessary for increased production. In the Middle East, political instability deters investments that would help the region build natural gas infrastructure and remain competitive in the changing global market. [22]

China and India: Growing energy consumption needs

In 2011, India was the fourth largest energy consumer in the world after the United States, China, and Russia. India's economy grew at an annual rate of approximately 7 percent since 2000 and proved relatively resilient to the 2008 global financial crisis. In the International Energy Outlook 2011, EIA projects India and China to account for the biggest share of Asian energy demand growth through 2035. India's energy policy above all focuses on securing energy sources to meet the needs of its growing economy: primary energy consumption has more than doubled between 1990 and 2011. At the same time, India's per capita energy consumption remains lower than that of developed countries, according to the International Energy Agency (IEA). Given that the service industry accounts for more than half of India's output, further economic growth could remain relatively non-energy intense. [23] India's largest energy source is coal, followed by petroleum and traditional biomass (e.g., burning firewood and waste). The government may not be able to deliver secure supplies to meet demand because of fuel subsidies, increasing import dependency, and inconsistent energy sector reform. Despite having large coal reserves and a healthy growth in natural gas production over the past two decades, India remains very dependent on imported crude oil. In early 2013, India's petroleum minister V. Moily announced that the ministry would work on an action plan to make India energy independent by 2030 through increased hydrocarbon production, unconventional resources such as coal-bed methane and shale, foreign acquisitions by domestic Indian companies, and reduced subsidies on motor fuels. These actions either increase India's energy supply or lower demand.[24]

China is the world's most populous country and has a rapidly growing economy, which has driven the country's high overall energy demand and the quest for securing energy resources. It is the world's second largest oil consumer behind the United States and the largest global

[22] Ibid.
[23] US Energy Information Administration. Country Data: India.
[24] Ibid.

energy consumer, according to the International Energy Agency (IEA). The country was a net oil exporter until the early 1990s and became the world's second largest net importer of oil in 2009. China's oil consumption growth accounted for half of the world's oil consumption growth in 2011. Natural gas usage in China has also increased rapidly in recent years, and China has looked to raise natural gas imports via pipeline and liquefied natural gas (LNG). China is also the world's largest top coal producer and consumer and accounted for about half of the global coal consumption, an important factor in world energy-related CO2 emissions.[25]

While China has made an effort to diversify its energy supplies, hydroelectric sources (6 percent), natural gas (4 percent), nuclear power (1 percent), and other renewables (0.3 percent) account for relatively small shares of China's energy consumption mix. The Chinese government set a target to raise non-fossil fuel energy consumption to 11.4 percent of the energy mix by 2015 as part of its new 12th Five Year Plan. EIA projects coal's share of the total energy mix to fall to 59 percent by 2035 due to anticipated higher energy efficiencies and China's goal to reduce its carbon intensity (carbon emissions per unit of GDP). However, absolute coal consumption is expected to double over this period, reflecting the large growth in total energy consumption. China is also increasing its reliance on African oil. Like the United States, China seeks to bolster its ties with African oil producers by developing close ties with African leaders and by supplying arms and military aid to friendly African states. In an effort to diversify its sources of oil and natural gas and increase its reliance on internal supply lines, China is expanding its energy ties with Central Asia and the Caspian Sea region.[26]

[25] US Energy Information Administration. Country Data: China.
[26] Klare, M. 2012. The Geopolitics of Oil: Old and New. World Security Studies Hampshire College, Association for the Study of Peak Oil.

3

Global Energy Architecture at 2030: The P5 agenda

Planning, Politics, Policy, Production and Pollution

"The most dire judgment of the [IPCC] report is that, no matter what is done from now on, the cumulative impact of previous emissions will be the predominant driver of the late 21st century outcomes. In other words, there is nothing we can do to stop the burn; at best, we can keep it on simmer. Everything now seems to rest on adaptation and mitigation."[27]

KEY INSIGHTS

- There is an 'aspirational gap' between resource supply and demand from developing countries driven by more energy-intensive modes of living and production.
- Industrialized countries bore historical responsibility for environmental problems such as climate change. However, it is the aspirants of the developing world that will bear the greatest burden of their own soaring energy consumption and economic growth.
- It is imperative to adapt our energy mix to reduce carbon emissions, invest in environment-friendly sources, while simultaneously reducing the energy-intensity of our modes of production and living through efficient technology and substitution.

At the 8th Asia Gas Partnership Summit this month, India's Prime Minister Manmohan Singh noted that "With oil and gas constituting around 41 per cent of India's primary energy consumption, India is expected to be the 3rd largest energy consumer by 2020," To bridge the gap between supply and demand, the government is encouraging domestic and global companies to explore onshore and offshore regions. India, which imports about 80 per cent of its oil needs and more than half of its natural gas requirement, has market based pricing

[27] Subir Gokarn: Slow Burn. Business Standard, October 6th, 2013.

for crude but sub-market rates for gas. A new pricing regime is envisaged from April 1, 2014, which will nearly double rates to $8.2-8.4 per million British thermal unit in an effort to meet vast needs.[28]

Industrialized countries have, thus far, borne historical responsibility for environmental problems such as climate change. However, the last few decades have seen a geographical shift in who pollutes and suffers most from intensive energy use. Ultimately, it is the aspirants of the developing world that will bear the greatest burden of their own soaring energy consumption and economic growth. It is imperative, then, to adapt our energy mix to reduce carbon emissions, invest in environment-friendly sources, while simultaneously reducing the energy-intensity of our modes of production through technology and substitution. According to the International Energy Agency, improved energy efficiency in buildings, industrial processes and transportation could reduce the world's energy needs in 2050 by one third, and help control global emissions of greenhouse gases. Energy efficiency and renewable energy are considered to be the twin pillars of sustainable energy policy and are high priorities in sustainable energy.

The Aspiration Gap

According to the BP energy consumption projections for 2030, between 2010 and 2030, the total energy consumption in North America and Europe and Eurasia will increase by only 3.75% and 8.65% respectively, but by over 72% in the Asia Pacific region, 71.8% in the Middle East, and 56.8% and 58.2% in South and Central America, and Africa, respectively.

This increase in the total energy consumption in these regions also translates to an increase in their energy consumption per capita. As the table below demonstrates, currently, in countries such as India, China, and Brazil, the per capita energy consumption is 19.58 million Btu, 77.86 Btu, and 67.88 Btu respectively, compared to 314.54 million Btu in the United States, 418.96 million Btu in Canada, and 162.92 million Btu in Japan. Per the projected

[28] India needs market-based energy pricing to meet vast needs. The Hindu, December 3rd, 2013.

consumption for 2030, China, India, and Brazil, all attempt to bridge this gap, with their per capita energy consumptions increasing, although the gaps with other countries will continue to exist.

Country	**Per Capita Energy Consumption in 2010 (in million Btu)**	**Per Capita Energy Consumption in 2030 (in million Btu)**
China	77.86	122.62
India	19.58	29.84
Japan	162.92	199.15
USA	314.54	296.80
Brazil	67.88	106.72
Russia	213.36	261.51
Canada	418.96	422.48
Australia/NZ	268.67	278.91

Table 1: Per Capital Energy Consumption in 2010 and 2030[29]

Carbon Taxes

The case for carbon taxes rests on economic principle of Pigovian taxes, or the internalization of externalities. As such, a carbon tax creates incentives to reduce greenhouse gas emissions. "Done well, it would gradually shift consumer demand, production methods, new investment, and technology development towards less emissions-intensive goods and services without unduly burdening poor households."[30] In addition to shifting demand, it also raises greater revenue, which may be allocated towards the development of energy alternatives. Economists – across the spectrum – consider carbon pricing to be an effective tool to reduce greenhouse gas emissions in a cost-effective manner. In 2011, Chicago Booth's Initiative on Global Markets surveyed 41 prominent economists about the statement: "A tax on the carbon content of fuels would be a less expensive way to reduce

[29] Calculations based on total energy consumption and population projections by EIA
[30] Adele Morris, Warwick McKibbin, Peter Wilcoxen. *China's Carbon Tax Proposal Highlights the Need for a New Track of Climate Talks*. Brookings Institution, March 15, 2013. Accessed: December 2, 2013.

carbon-dioxide emissions than would a collection of policies such as 'corporate average fuel economy' requirements for automobiles." 90% of the respondents agreed, while only 2% disagreed with the statement.[31] An OECD-led study of climate change policies in fifteen countries similarly finds that, "carbon taxes and emission trading systems are the most cost-effective means of reducing CO_2 emissions, and should be at the centre of government efforts to tackle climate change."[32]

In terms of their environmental benefits, a number of studies have demonstrated the effectiveness of carbon taxes in reducing emissions. A paper by Warwick McKibbin, et al, estimates the benefits that a simple excise tax of $15 per metric tonne of CO2, rising at 4% per year on account of inflation, could generate. They find that such a policy would result in emissions reductions to the tune of 2.5 billion metric tonnes, or 34% by 2050, and cumulative emissions fall by 40 BMT through 2050. Additionally, the carbon tax will raise $80 billion at the start, rising to $170 billion in 2030, and $310 billion by 2050.[33]

Significantly, carbon taxes are also considered to be more efficient than subsidies that seek to promote the use of alternative fuels. An OECD study demonstrates that taxes and trading systems are preferred to policies such as feed-in tariffs, subsidies, and other regulatory instruments. According to the report, the average cost of reducing a tonne of carbon emissions in the road transport sector can be up to eight times higher when instruments other than fuel taxes are used.[34] Similarly, Adele Morris concludes that, "no subsidy policy is a substitute for a price on carbon." In validating her argument, she cites a recent modeling study comparing clean energy subsidies with carbon taxes. The study estimates that a carbon tax would lead to emissions reductions of 20 times more than that produced by similar-sized tax credits for energy efficient household capital.[35] While some subsidies like the production tax credit in the United States, have been helpful in increasing research, and the development and use of alternate technologies, Economist Laura D'Andrea Tyson writes that "such

[31] IGM Forum, Chicago Booth.
[32] OECD. http://www.oecd.org/newsroom/carbon-taxes-and-emissions-trading-are-cheapest-ways-of-reducing-co2.htm
[33] Warwick McKibbin, et al. *The Potential Role of Carbon Tax in U.S. Fiscal Reform.* The Climate and Energy Economics Project, Brookings Institution.
[34] OECD
[35] Adele C. Morris. Clean Energy 2011. Brookings Institution

subsidies would be even more effective in combination with a carbon tax that would make fossil fuels less price-competitive and would stimulate research on renewable and energy-saving technologies."[36]

Currently, carbon taxes have been introduced in some form or the other in a variety of countries. According to a study by the National Renewable Energy Laboratory, "carbon taxes are most commonly placed on gasoline, coal, and natural gas." The report also finds that there are large differences among the tax rates across various countries – from Sweden's $105 per metric tonne of CO2 to California's $0.045 per metric tonne of CO2). Tax rates are determined based on the objectives of the policy – while higher rates induce behavioral changes, lower rates are directed at generating funds for carbon mitigation programs.

A 2013-World Bank report finds that countries that have either implemented or scheduled carbon-pricing policies account for 21% of global greenhouse emissions. Furthermore, if China and Brazil, and other countries that are actively considering carbon taxes, the share goes up to more than 50 percent.[37] The report further finds that majority of the taxes are in Europe, with some additional examples in Australia, Japan, and South Africa. Australia's carbon pricing system came into effect in 2012, and imposes a tax of US$24 per tonne of CO2, to increase annually at 2.5%.[38] Finland, which was the first country to introduce carbon taxes, imposes a tax of $30/metric tonne of CO2, which have generated annual revenues of $750 million. In 2000, the Finnish government determined that as a consequence of this carbon tax, emissions had reduced by roughly 4 million metric tonnes of CO2 between 1990 and 1998.[39]

Incentivizing Renewables

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[36] Laura D'Andrea Tyson. *The Myriad Benefits of a Carbon Tax*. New York Times, June 28, 2013. Accessed December 2, 2013.
[37] Laura D'Andrea Tyson
[38] Alexandre Kossoy, et al. *Mapping Carbon Pricing Initiatives*. Carbon Finance at the World Bank. May 2013.
[39] Jenny Sumner, et al. *Carbon Taxes: A Review of Experience and Policy Design Considerations*. National Renewable Energy Laboratory.

As a local solution to global problems, renewable energy can allow specific actors new forms of power by enhancing energy security through energy independence and diversification, or as a means to a new international dynamic.[40] There is a consistent message across the Asia Pacific region when it comes to future energy pathways: governments are more willing to offer significant incentives for the private sector to meet often ambitious renewable energy targets. Generally, fossil-fuel generated electricity dominates production capacities as they account for approximately 75% of electricity production in India and approximately 90% in Indonesia, Thailand and Japan. Countries with relatively higher renewable sourced-energy have achieved this through hydropower investment. For example, the Philippines, China and Vietnam have acquired significant capacity for hydropower yet still continue to use coal and/or gas as primary sources for electricity. Indeed, while a focus on developing renewables is driven by realities of harsh climate change impact as well as growing air and water pollution, it also stems from the desire to ensure long-term energy security and reduce reliance on imports.

Renewable energy offers powerhouses like China and India the opportunities to stake new claims in energy markets and foster home-grown green industries. Increased domestic targets and outbound investment backed by the state-run China Development Bank are helping to drive the country's clean energy sector as Chinese companies pursue opportunities for finance and equipment packages for projects in Latin America, MENA and Australia. However, investment in infrastructure remains an obstacle, with many countries (China, India, Germany and Denmark, for example) now battling with capacity-constrained grids as well as balancing issues from increasing intermittency as more renewables are deployed.[41] It is therefore anticipated that capacity markets, such as those proposed under the UK's new Energy Bill, and cross-border interconnections, such as the North Sea "super-grid," will become increasingly important as a means of creating security of supply. The other potential obstacle is the newly discovered supplies of natural gas. Cheap gas in the US has led to debates on the cost-effectiveness of renewables and many in the sector fear that a "dash for gas" in pursuit of lower capital costs could divert attention away from greener energy solutions. [42]

[40] Singapore International Energy Week, 2013. Impact of renewable energy on geopolitical complexities.
[41] Ernst and Young, 2013. Renewable energy country attractiveness indices: February 2013.
[42] Ibid.

Initiatives in developing alternatives

Tax concessions, feed-in tariffs and importation concessions for renewable energy-related items are a few of the common measures to encourage private sector investment. Several countries have introduced some form of renewable energy legislation and also pushed for energy efficiency laws or incorporated energy policies into development strategies. Jurisdictional issues and varying barriers in foreign investment across provincial and national governments also play a part in some countries where, in practice, laws may not be as welcoming to extra-state players. [43] Government incentives and targets for renewable energy production are of different scale and capacity. For example, Malaysia aims to have 17% of its energy demand met from renewable sources by 2030, the Philippines aimed to increase the capacity of renewable sources by 100% of 2002 levels by 2013, while Thailand aims to have 25% of electricity generates from renewable sources by 2021. East Timor is seeking a 50% shift of energy production from renewable energy in 8 years as they regard renewable energy a more effective tool for development than traditional sources of power. India plans to double its renewable energy capacity to 55,000 MW by 2017 as part of efforts to increase efficiency of its energy use, including non-conventional energy sources such as wind, solar, and energy from biomass.[44]

Mongolia, for example, has constructed its first large-scale renewable project - a large wind farm to help the country achieve its target of 25% renewables by 2020. China, a global powerhouse of renewable technology, strives to make progress in the sector as its capacity for renewable energy is increasing faster than its coal capacity. China has been leaving the drive into solar photovoltaics manufacturing, which has been bringing prices down while also introducing pilot carbon trading platforms. Since the 2011 Fukishima disaster, Japan has approved a number of renewable energy projects.[45] Earlier in the year, the Indian government inaugurated solar power plants commissioned under Phase-I of Jawaharlal Nehru National Solar Mission and unveiled the foundation stone of Phase-1B of the Jaipur

[43] DLA Piper, 2012. Renewable energy in the Asia Pacific: A Legal Overview.
[44] India to double renewable energy capacity by 2017: Manmohan Singh. Press Release, April 2013.
[45] Ibid.

Metro in Rajasthan, noting that both projects will constructively contribute and support economic growth and progress by being environmentally friendly in the long-term. [46]

Rank[1]		Country	All renewables	Wind index	Onshore wind	Offshore wind	Solar index	Solar PV	Solar CSP	Biomass/ other	Geo-thermal	Infra-structure[2]
1	(1)	China	70.1	76	78	69	65	67	47	59	50	73
2	(2)	Germany	65.6	68	65	80	61	70	0	68	58	72
3	(3)	US[3]	64.9	63	65	56	70	69	73	61	67	58
4	(4)	India	61.8	61	66	39	65	67	52	59	43	60
5	(5)	France	57.3	59	60	56	55	59	30	58	35	59
6	(6)	UK	54.7	62	59	78	42	48	0	57	35	64

Renewable Energy Attractiveness Index

For most countries in the region, government-owned bodies have had a monopoly in the generation, transmission, and/or distribution of electricity. While some countries such as Japan have privately-owned regional monopolies, there is a distinct lack of competition across the energy sector. This presents a sizable challenge to the movement of foreign capital needed to boost development of the renewable sector. China and India have appeared in the 'Renewable Energy Country Attractiveness Indices'[47] (shown above), which scored out of 100, are calculated on the basis of renewable infrastructure and technology factors and offer an insight into considering an attractive renewable energy market for investment.

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[46] Renewable energy 'good solution' to urbanization, says Dr. Manmohan Singh. ANI, September 2013.
[47] Ernst and Young, 2013. Renewable energy country attractiveness indices: February 2013.