World Energy Outlook 2012. International Energy Agency (Paris). Paris: IEA (dist. by OECD), Nov 2012, 668p, 150 EUR (PDF E120) from www.iea.org or OECD. (www.worldenergyoutlook.org)

The quantity and quality of energy supply is central to the future. This annual report is, by far, the most extensive and authoritative survey of energy trends, which are projected to 2020 and 2035. Much press attention, at least in the US, has been given to the startling forecast that the US will become the world's largest oil producer by 2020 (see below). But there is much, much more to this important report that deserves attention.

Notably, a central theme of the IEA report involves four scenarios : **Current Policies** (business as usual baseline), **New Policies** (the central scenario, assuming recently-announced commitments cautiously adopted), **450 Scenario** (policies providing a 50% chance of limiting global increase in temperature to 2°C, and CO^2 at 450ppm), and **Efficient World Scenario** (all economically viable energy investments are made, which lowers growing demand for fossil fuel and boosts economic output.)

Many people worldwide applaud the transition to renewable sources of energy. So does the IEA, but, as indicated here, there is still a long way to go before renewables make a major impact. Conversely, many people also believe that we have reached or will soon reach the point of "peak oil," which will accelerate use of renewables. This wishful thinking is nowhere to be found in the hard-nosed IEA report, which views global oil demand rising through 2035, with any shortfalls made up by "unconventional oil" and rapid development of Iraq's extensive oil resources. Not good news for climate change, of course, but these are the sober realities ahead. "Wild cards" may appear (e.g., a US carbon tax, new technologies not on the horizon), but IEA does not consider them.

The quotations below are merely a small sampling of the many significant points that are made in this dense report.

GENERAL FINDINGS

1. US Developments. "*Energy developments in the US are profound*" and their effect will be felt worldwide. "By around 2020, the US is projected to become the largest global oil producer (overtaking Saudi Arabia until the mid-2020s) and starts to see the impact of new fuel-efficiency measures in transport. The result is *a continued fall in US oil imports, to the extent that North America becomes a net oil exporter by 2030."* (p.23) Even a few years ago, output of oil and gas had been widely assumed to be in inevitable decline. "*This energy renaissance has far-reaching consequences for energy markets, trade, and, potentially, even for energy security, geopolitics, and the global economy."* (p.74)

2. Sustainability? "Taking all new developments and policies into account, *the world is still failing to put the global energy system onto a more sustainable path."* (p.23) Even with the New Policies Scenario—our central scenario—"global energy demand grows by more than one-third over the period to 2035." Despite growth in low-carbon sources of energy, "fossil fuels remain dominant in the global energy mix, supported by subsidies that amounted to $523 billion in 2011, up almost 30% on 2010 and six times more than subsidies to renewables." (p.23)

3. Emissions. *"Emissions in the New Policies Scenario correspond to a long-term average global temperature increase of 3.6°C."* (p23)

4. Efficiency. "Energy efficiency is widely recognized as a key option…but current efforts fall well short of tapping its full economic potential." (p.24) Even with New Policies in place, four-fifths of the potential in the buildings sector and more than half in industry still remains untapped.

5. The 2°C Goal. "*The climate goal of limiting warming to 2°C is becoming more difficult and more costly with each year that passes."* (p.25) The 450 Scenario examines actions necessary to achieve this goal, finding that "almost four-fifths of the CO^2 emissions allowable by 2035 are already locked in by existing power plants, factories, buildings, etc."

6. Electricity Access. "Despite progress in the past year, *nearly 1.3 billion people remain without access to electricity and 2.6 billion do not have access to clean cooking facilities."* (p.29) Nearly $1 trillion in investment is needed to achieve universal energy access by 2030, and abandon use of traditional biomass.

7. "Thirstier" Energy. Water is essential for energy production: for power generation, for extraction and processing of oil/gas/coal, for transport, and increasingly for crop irrigation to produce biofuels. "*The projected rise in water consumption of 85% over the period to 2035 reflects a move towards more water-intensive power generation and expanding output of biofuels."* (p.29) In sum, "energy is becoming a thirstier resource," and water is growing as a criterion for assessing the viability of energy projects. The vulnerability of the energy sector to water constraints is widespread, affecting, among others, shale gas development, power generation, and Canadian oil sands.

8. Energy Prices. Price remains an important determinant of energy trends, and "history has shown that *energy prices are notoriously difficult to predict*." (p.38) It is unlikely that the future will follow any of the precise paths in the four IEA scenarios, which simply demonstrate how markets could evolve under certain conditions. (In the New Policies scenario, the average crude oil import price rises to $120/barrel in 2020 and $125/barrel in 2035. Under the Current Policies Scenario, higher prices are needed to balance supply with the faster growth in demand reaching $145/barrel in 2035. In the 450 Scenario, lower oil demand means less need to develop costly oil and a decline to $100/barrel by 2035.

9. Iraqi Oil. "*Iraq makes the largest contributon by far to global oil supply growth."* (p26) Its ambition to expand output after decades of conflict is not limited by the size of its resources or costs of production. Four chapters are devoted to the Iraq outlook for oil and gas (pp.385-498). Oil output is expected to rise from 3 million barrels/day in mid-2012 to 6 mbd in 2020 and 8.3 mbd in 2035 (11 mbd in the high case; 5.3 mbd in the delayed case). Without this supply growth, oil prices would by almost $15/barrel higher by 2035. Iraq stands to gain almost $5 trillion from oil exports through 2035. In 2012, the Iraq Ministry of Oil announced 143 billion barrels of proven reserves, and some 215 billion barrels of undiscovered resources. Exploration is expected to "add substantially to proven reserves over the coming decades." (p.422)

10. CCS Technology. "The pace of development of carbon capture and storage technology remains highly uncertain. It could prove to be critical to the prospects for coal use in many regions." (p.47) In the long term, it is also likely to be critical to prospects for natural gas and energy-intensive industries globally. The technology exists, "but only a handful of commercial-scale CCS projects are currently operating."

THE FOUR SCENARIOS

* **Current Policies Scenario.** The baseline, where government policies enacted or adopted by mid-2012 continue unchanged. Under this scenario, use of coal grows from 2,378 Mtoe in 2000 and 3,474 in 2010, to 4,417 in 2020 and 5,523 in 2035. Oil grows from 3,659 Mtoe in 2000 and 4,113 in 2010, to 4,541 in 2020 and 5,053 in 2035. CO2 emissions rise from 30.2 Gt in 2010 to 44.1 in 2035. [NOTE: Clearly not acceptable.]

* **New Policies Scenario.** Where existing policies are maintained, and recently-announced commitments are plans are implemented in a cautious manner. Under this "central" scenario, use of coal grows from 3,474 Mtoe in 2010 to 4,082 in 2020 and 4,218 in 2035. Oil grows from 4,113 in 2010, to 4,457 in 2020 and 4,656 in 2035. CO2 emissions rise from 30.2 Gt in 2010 to 37.0 in 2035. [NOTE: Still not acceptable.]

* **450 Scenario.** Rather than a projection based on past trends, a plausible energy path is described, consistent with actions having about a 50% chance of meeting the goal of limiting the global increase in average temperature to 2°C, which requires a limit of 450 ppm of carbon-dioxide equivalent in the atmosphere, now at about 390 ppm (some argue—strenuously—that a lower target is necessary; see Bill McKibbon's www.350.org). In the 450 Scenario, coal grows slightly from 3,474 Mtoe in 2010 to 3,569 in 2020, and declines by a third to 2,337 in 2035. Oil also grows slightly from 4,113 in 2010 to 4,282 in 2020, declining to 3,682 in 2035. CO^2 emissions rise slightly from 30.2GT in 2010 to 31.4 in 2020, and then decline to 22.1 in 2035. [NOTE: Far better than above, but still quite likely to be too little, too late, to forestall ruinous climate change.]

* **Efficient World Scenario.** Explores the results of improving energy efficiency in every way that makes economic sense, involving necessary policies to eliminate market barriers. Four chapters are devoted to discussing efficiency (pp267-384). Key steps include strengthening measurement and disclosure of energy efficiency to make gains more visible to consumers, regulations to prevent sale of inefficient technologies, and financing instruments. Realizing this scenario would boost cumulative economic output through 2035 by $18 trillion. A chart on p.299 lists dozens of sub-sectors and technologies where improved efficiency is possible for industry, transport, and buildings. Another chart on p.329 lists key policies by sector (e.g. stringent building codes, retrofits, retirement of inefficient industrial facilities, support for smart grids).

MAJOR SOURCES OF ENERGY

1) Oil. Even in the New Policies scenario, *"growth in oil consumption in emerging economies, particularly for transport in China, India, and the Middle East, more than outweighs reduced demand in the OECD, pushing oil use steadily higher."* (p.26) Oil demand reaches 100 mbd in 2035, up from 87.4 mbd in 2011, and the average price rises to $125/barrel in 2011 dollars by 2035. The transport sector now accounts for more than half of global oil consumption, and this share increases as the number of passenger cars doubles to 1.7 billion and the demand for road freight rises quickly (in part because fuel-economy standards for trucks are much less widespread). "*The net increase in global oil production is driven entirely by unconventional oil"*—light tight oil in the US and oil sands in Canada. (p.26)

2) Natural Gas. Global demand grows in all scenarios, but the outlook varies by regions. Low prices and abundant supply in the US enables gas to overtake oil around 2030 to become the largest fuel in the energy mix. China's consumption will grow rapidly, from 130 billion cubic meters in 2011 to 545 bcm in 2035. Unconventional gas from hydrofracking accounts for nearly half the increase in global production to 2035, but there is uncertainty in many countries about the extent and quality of the resource base, and concerns about environmental impacts.

3) Coal. *"Coal has met nearly half of the rise in global energy demand over the last decade, growing faster even than total renewables."* (p.27) Whether coal demand continues to rise strongly will depend on policies that favor lower-emissions energy sources, deployment of more efficient coal-burning technologies, and—especially in the longer term—CCS technology. Policy decisions carrying the most weight for the global coal balance will be in China and India, which account for almost three-quarters of projected non-OECD coal demand growth, whereas OECD coal use declines.

4) Nuclear. *"The anticipated role of nuclear power has been scaled back"* in the wake of the 2011 Fukushima accident. Japan and France seek to reduce nuclear power, while its competitiveness in the US and Canada is challenged by relatively cheap natural gas. Projections for growth in installed nuclear capacity are lower than in 2011. While nuclear output grows in absolute terms (driven by expanded generation in China, Korea, India, and Russia), "*its share in the global electricity mix falls slightly over time*." (p.28)

5) Renewables. A steady expansion of hydropower and rapid expansion of wind and especially solar results in renewables accounting for almost one-third of total electricity output by 2035. Consumption of biomass and biofuels

grows four-fold. The rapid increase in renewables is underpinned by falling technology costs, rising fossil-fuel prices, carbon pricing, and especially by continued subsidies—from $88 billion globally in 2011 to nearly $240 billion in 2035.

Other chapter topics discuss electricity demand and supply, "emissions lock-in" (in that the average lifetime of energy infrastructure is long), oil production prospects under each scenario, water for energy and regional stress points, and measuring progress toward energy for all.

An Annex provides extensive tables for energy demand in various sectors and for energy sources through 2035 under each of the first three scenarios (for the world, US, OECD, US, Japan, EU, Russia, China, India, Africa, Latin America, and Middle East).

COMMENT

There is much that is worthwhile and important in these 668 pages of extensive IEA analysis, which include numerous charts and tables.

But several complaints should be aired:

* No index is provided to enable quick access to specific topics scattered in the 668 pages.

* The 450 Scenario and the Efficient World Scenario do not appear to be compared, nor is there any mention of how the two might be pursued together.

* Only a single paragraph appears to be devoted to carbon capture and storage technology (CCS) to handle the anticipated increase in carbon emissions, and there is no mention of the role of endangered forests, oceans, and soils as carbon sinks.

* Similarly, only a single paragraph is devoted to global geothermal electricity generation (p.230), expected to increase from 11 GW to 40 GW by 2035, but still a small share of renewables at that time. Testor et al. and Gore (see below) see far more promise.

* At the least, a chapter on the world's major energy companies would be helpful, but this topic seems to be taboo. For starters, see **Private Empire: ExxonMobil and American Power** by journalist Steve Coll (Penguin, May 2012, 685p, $36), on the world's largest energy giant, with operations in some 200 nations and territories.

* The lack of considering potential "game-changing" wild cards (and not-so-wild cards), as regards both technology (e.g., small and widely-distributed nuclear reactors) and legislation (e.g., a carbon tax, especially in the US).

* The 150 EUR price will deter all but the largest organizations from purchase.

ALSO SEE other very different energy overviews:

Global Energy Assessment: Toward a Sustainable Future, by the German Advisory Council on Global Change and the International Institute for Applied Systems Analysis (Cambridge U Press, Oct 2012, 1,882p, L75pb; www.globalenergyassessment.org), a huge analysis involving over 500 researchers, appears to offer even more than the IEA Outlook reviewed here. It emphasizes an integrated energy system strategy and options with multiple benefits, notably energy efficiency (the most cost-effective near-term option), renewables (which could be >90% of

primary energy in some regions by 2050), and co-production (of synthetic transportation fuels, cooking fuels, and electricity with CCS). Similar to the IEA Outlook, the GEA also advocates universal access universal access to electricity and cleaner cooking fuels and stoves by 2030.

Sustainable Energy: Choosing Among Options (Second Edition) by Jefferson Testor and four others (MIT Press, Oct 2012, 1,019p, $90) is a rather technical textbook, with 21 chapters on such topics as technical performance, project economic evaluation, energy systems, geothermal (the global resource base is large and well-distributed, and the technical potential is "vast"), ocean wave and tidal, energy management, synergistic complex systems, and all of the other usual energy sources.

The Quest: Energy, Security, and the Making of the Modern World by Daniel Yergin (Penguin, Sept 2011, 804p; GFB Book of the Month, Nov 2011), an engagingly-written overview that covers much if not all of the IEA topics: the new world of oil, the history of peak oil theory, the "shale gale" of unconventional gas and oil, climate and carbon, the potential for biofuel, and much more. But Yergin sees geothermal as "limited by geology and the availability of the right kind of 'hot rocks' underground." (p.714)

Our Choice: A Plan to Solve the Climate Crisis by former Vice President Al Gore (Rodale, Nov 2009, 416p; GFB Book of the Month, April 2010), reporting on more than 30 "Solutions Summits" of leading experts convened by Gore, on such topics as the climate change threat, the potential of concentrated solar thermal power, biomass, geothermal power (potentially "the largest source of power in the US and world), forests and soils as carbon sinks, depleted soils enhanced by biochar, limits of CCS, energy efficiency improvements, smart grids, and more. This book, which still has much to offer, provides the starkest contrast to the IEA analysis of what is desirable and feasible for addressing energy-related responses to climate change.

To conclude on a hopeful note, a recent article by Elizabeth Kolbert (*The New Yorker,* 10 Dec 2012, pp29-30) reports on growing bi-partisan interest in a US **carbon tax**, which is now even supported by ExxonMobil. She cites Bob Inglis, a former Republican Congressman, who told the Associated Press that "*I think the impossible may be moving to the inevitable without ever passing through the probable.*" If so, as Kolbert notes, "it would have global significance"—surely as great as the recent upheaval in oil and gas supplies. And it would remind us, once again, of the need to be alert to a wide range of possibilities.

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