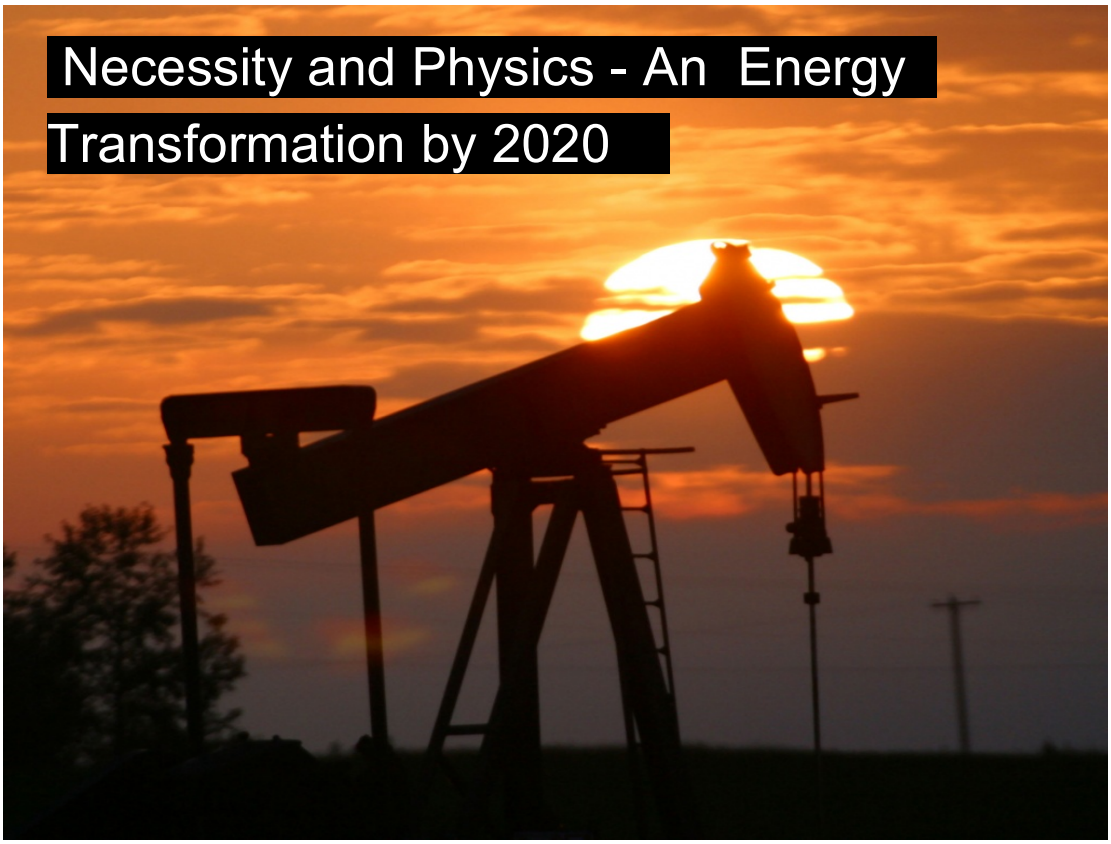
Necessity and Physics - An Energy Transformation by 2020



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Necessity and Physics - An Energy Transformation by 2020

SUMMARY: Renewables will likely dominate energy growth by 2020, led by China's strategic energy requirements, relegating fossil fuels to a residual supply source: oil companies need to develop contingency plans now

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"For the first time, renewables accounted for more than half of net annual additions to power capacity, and overtook coal in terms of cumulative installed capacity in the world"

So begins the latest report on from The International Energy Agency (IEA) updating their view of renewable energy growth.

Its headline is a key landmark and important enough, but the report also points at three other fast-emerging trends, with even wider implications for the energy world.

- **A strong mix of policies support renewable growth -** A powerful linkage of health, security and climate policies is accelerating the use of renewables in key markets, especially the fast-growth ones - PV Solar and Wind
- **The transition will be rapid** - Renewables are a fundamentally different type of energy - a technology rather than extractive fuel - so the transition underway will be far quicker than previous ones. They are already dominating incremental growth, transforming fossil fuels into "residual" forms of energy.
- **China will take on leadership** - China will lead the world in renewables manufacture and deployment, having reached a limit to its dependence on fossil fuels, and having already developed significant technological expertise

The Impact

A tipping point by 2020 – External analyst views based on IEA data suggest that by 2020 we will reach a tipping point when all the growth in world energy demand is satisfied by renewables – forcing the long-term decline in the use of fossil fuels. This tipping point may have been reached already in the OECD and China.

Early market reaction - As financial markets begin to anticipate these changes, they will react rapidly putting further pressure on oil and gas business models.

Large international oil firms are especially vulnerable – Major oil and gas firms need to develop contingency business plans, and rely less on consensus industry forecasts which are underestimating the pace of transition. They are high-cost producers in an intensifying contest for declining market share.

OVERVIEW

The energy transition from hydrocarbons to alternative forms such as solar and wind is only disputed in one dimension: time. Fossil fuels are finite, alternative sources of energy for future generations are required.

Recent analysis by the IEA, and financial analysts suggest that this transition is already mature, and the pace is accelerating far quicker than consensus oil and gas industry analysts predict.

Their thesis is based on three elements: Policy, Technology and China.

If correct, this rapid shift will soon have major implications for incumbent energy companies and future energy economics.

POLICY

IEA's New Faith in the Rise of Renewables

The IEA Medium Term Market Report on Renewable Energy has just been published, and has increased its estimate of the pace of growth of renewables.

Indeed, its likely that their latest analysis could still undershoot actual outcomes as noted here.

The rise of renewable energy: low-growth (hydro and nuclear) plus fast-growth (PV Solar and Wind) has been treated cautiously by both the IEA and oil industry analysts.

The skepticism is due in part to headwinds from public attitudes, inconsistent political support, and often polarized arguments around the real impact of climate change, which is often viewed as its main driver. The technologies of wind and solar themselves have often been dismissed as ever-nascent, with fundamental flaws due to intermittency and land access.

However, the IEA's tone in this report seems to have changed, and moved toward optimism: *"For the first time, renewables accounted for more than half of net annual additions to power capacity, and overtook coal in terms of cumulative installed capacity in the world"*

In addition to highlighting the milestone the IEA cite three key drivers driving a wider and faster change than previously predicted: Local Air Pollution (especially in China and India), National Energy Security (China a key example), and International Climate Agreements such as Paris COP21 providing "momentum".

This a powerful combination of concerns. The first two are immediate and tangible, rather than long-term, and impact individual countries and their populations directly. The latter provides a global context and support base for a wide range of initiatives and investments.

Powerful Policy Vectors

Local Health: The IEA has noted recently that air quality issues have accounted for over 6 million global premature deaths annually, predominantly in urban centres, with 25% occurring in China and India. Between them, these two countries have almost 50 of the world's top 100 most-

polluted cities, with India hosting all of the top five.

Reduced oil and gas infrastructure via accelerated solar and wind substitution, along with energy efficiency, are key opportunities to curb this air quality issue.

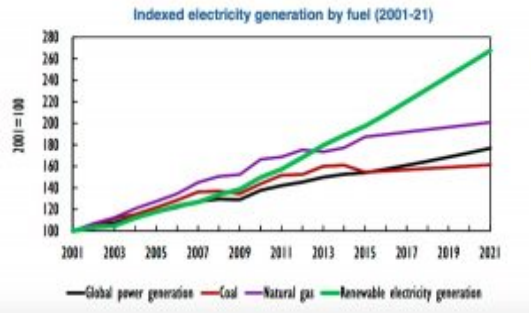
National Security: Concerns over energy security have also caused a switch in priorities: fossil fuel prices have lowered recently, but remain volatile with supply concentrated in just a couple of global sources. For both China and India with large developing populations, and limited indigenous resource, this model of energy access is unsustainable. IEA's own figures predict that China and India will need to import 90% and 80% respectively of their oil demand by 2040. It is unlikely either country will continue with this structure, opting for alternative energy options as quickly as feasible.

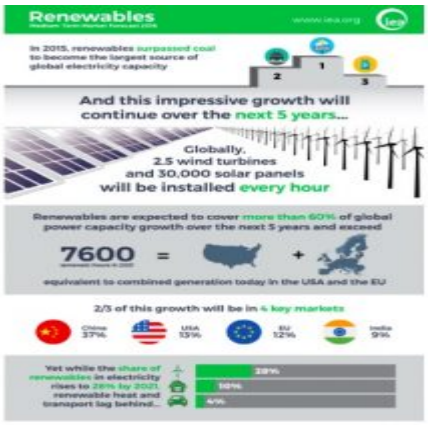
International Climate and CO2: The climate policies via Intended Nationally Determined Contributions (INDCs) from the 2015 Paris summit provides international support to renewable investments and initiatives – catalyzing the efforts driven by health and security. The IEA report indicates, however, that even this falls well short of the 2degC commitment – by their estimate an accelerated case of a further 30% increase in renewable capacity growth is required to properly tackle climate targets over the next 5 years.

When health and security are used in conjunction with international climate efforts, the forces behind renewable investment and adoption become more solid and immediate – and more relevant to a voting public. This is reinforced when renewable energy offers increased options for home-based employment in its manufacture and deployment.

Given this policy-based acceleration, the IEA has raised its projections for renewable deployment globally, as shown below indexed to 2001. Whilst coal and gas essentially remain flat, renewable growth, before any accelerated case, is due to increase by 50% from 2015. And this is not just a feature of a low base to begin with.

An IEA info-graphic also indicates the pace and depth of change: 2.5 wind turbines and 30,000 solar panels installed per hour for the next 5 years, creating an annual capacity of over 7,600 TWh, or enough to power the US and EU completely.





Even these projections may remain on the low side. This is because the IEA tend to equate

estimated future capital expenditures as a proxy for growth rates. However, as the unit costs of solar and wind continue to decline even if capex is flat or slightly down, overall energy growth continues - same spend, more capacity.

This is the opposite of oil and gas capex, where large increases have resulted in the same or lower supply output.

It also highlights why this transformation will be different from any previous changes to the energy mix.

TECHNOLOGY

A new type of Transition: Renewables are a Technology, not a Commodity

Renewables are a technology - this point cannot be stressed enough as a differentiator from past transitions, and is detailed comprehensively is a series of papers by analyst Kingsmill Bond of the research firm Trusted Sources (TS) - the series of papers in this link provide a comprehensive and fresh analysis of the energy transition from a pragmatic external viewpoint.

In every major energy switch of the last two centuries, one finite carbon-based fuel was gradually, with much laborious, large-scale effort, extracted to replace the previous form: solid coal was substituted by liquid oil and then both by natural gas. As each form is fungible with the other they can also co-exist for extended periods.

This time, however, a technology is the method of replacement.
As a technology, renewables can be developed globally, and can "piggy-back" on existing infrastructure (roads, grids, roof-tops and so on). They do not need natural endowments of fossil resources, and they can benefit from global manufacturing scale and positive learning curves.

So, in sharp contrast to previous transitions, when an energy technology is widely deployed, its costs reduce – following classic manufacturing and engineering experience curves of typically 20% cost reduction for every doubling of capacity. It is labeled Swanson's Law in the renewables industry, but it is just a specific expression of a general manufacturing principle.

Transitions involving commodity extractions follow the opposite curve. Costs tend to increase with time, as the easiest resources, large and needing simple technology, are exploited first, with smaller reservoirs, requiring more complex technology, developed later. Oil follows this arc, with the added complication that the cheapest resources are held in geopolitically fragile areas.

(Note – shale oil is a commodity outlier - it exhibits many manufacturing characteristics, hence its recent emergence as a major world energy source. But it's likely to be a US-only phenomenon at this scale, and it suffers from the wider limitations of hydrocarbons: CO2-emitting, finite, restricted by geology.)

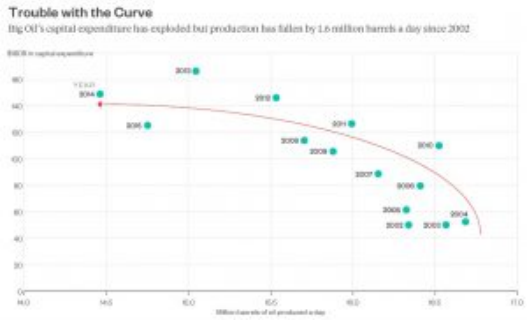
Regarding renewable cost development, current solar PV costs of as low as $60-100/MWh make them competitive with traditional fuels, even with subsidies and intermittency factored in (the Levelized Cost of Electricity, LCOE, basis). More interesting than that is the trend in pricing, as shown in the IEA report, and this report by IRE NA, the International Renewable Energy Agency, and the way in which prices are being discovered.

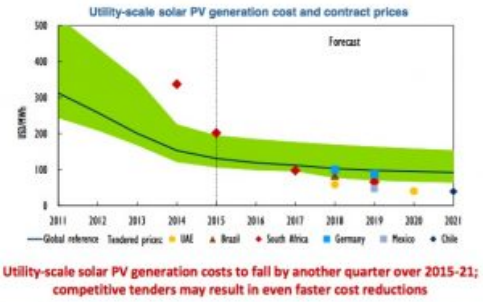
Renewable price discovery is not via marginal costs as in hydrocarbon extraction, but by auctions

for renewable deployment across the globe in a variety of countries. This accelerates price deflation. As the technology spreads, engineering innovations find solutions to previous problems, and are adopted elsewhere, or improved upon.

Such are the differing natures of extraction and technology, and hence the more diverse suite of commercial tools open to renewable pricing.

One of these curves is not like the other - Cost profiles of Oil Extraction and PV Solar over time





Utility-scale solar PV generation costs to fall by another quarter over 2015-21; competitive tenders may result in even faster cost reductions

Renewables are thus being installed as a global technological substitute to the fossil-based energy groundwork in place. In this. they follow a long-term trend toward the electrification of energy.

The TS analysis - *History in Bunk* - is therefore highly skeptical of this transition taking the many decades of previous ones, as industry analysts predict. It is different in kind to the others, not just degree – and in any event, a tiny sample size of only 2-3 earlier transitions means any presumed model would be highly uncertain. Especially when the previous transitions have really been one extended development of carbon extraction.

Instead, they see a rapid and systemic change, on a far quicker time-frame than before – likely only a few years, rather than decades.

Because in this transition the future leaders will not require natural endowments of carbon-based resources – only the capability to efficiently ramp up the manufacturing of medium-complexity technologies such as turbines, solar panels and a range of electric grid hardware.

In this sense, it's a triumph of physics over chemistry; global-scale engineering conversion of photons and gaseous molecules replacing the geographic and thermodynamic limits of carbon extraction and combustion.

In turn, it's also a triumph of positive learning engineering cost curves, over the negative learning curves of extraction and high-cost project developments.

That, as they say, changes everything.

The Importance of Incremental vs Total Change – Renewables are already dominant

The IEA estimates the rise of renewables in electricity supply to be roughly 7%pa for the next 5 years, in contrast to about 1%pa for gas and flat for coal.

They go on to project that renewables will rise from 23% of total power energy to 28% by 2021. However, these are bulk numbers and should be compared with the structure of *incremental* change.

For those of a maths bent, incremental change is the first (or second) derivative of bulk change - it focuses on the latest shape of adjustments (increasing or decreasing). Bulk change will note if an overall variation has been up or down – incremental change will tell you if its slowing or accelerating, a first signal of future trends.

Does this matter much? To see why it does, and possibly a lot, its worth turning this example from the TS paper *History is Bunk* summarising recent experience in the EU electricity market:

Incremental Change and the Power Sector

"In 2007 European electricity demand was 3,400 TWh. Average annual growth since 2000 had been 1.6 per cent and renewables ex hydro accounted for just 6 per cent of total supply. The consensus view was that demand would continue to rise and that it was necessary to build new thermal capacity to meet it. Tens of billions of Euros were spent accordingly to build new gas generation stations.

Two developments emerged to shake the industry out of its complacency: Demand began to fall after the financial crisis – on average by 0.6 per cent a year; Renewables (which had been growing at 18 per cent a year) continued to grow – on average by 14 per cent a year.

The consequences for the industry have been dramatic. Dozens of thermal plants have been closed down, billions of Euros have been written off, and companies across the sector have split into smaller entities.

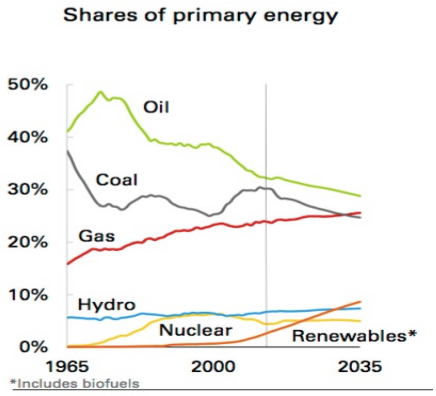
And yet the orthodox historian reviewing the numbers would say that the share of renewables simply rose from 6 per cent to 19 per cent and the share of thermal fell from 57 per cent to 44 per cent, while remaining the largest energy source.

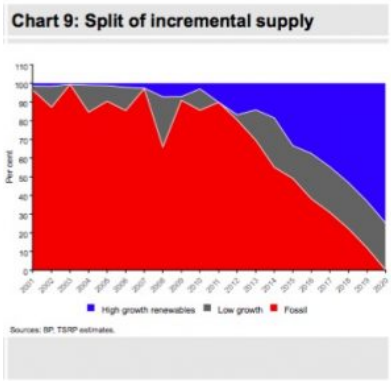
The point is simply that what seem to be small changes from a distance have, in fact, a huge impact on the ground."

Back to that IEA headline - renewables have now greater than 50% of net annual global power additions. The charts below show IEA and BP industry data, with TS analysis, based on total and *incremental*, primary energy change.

Total change suggests little difference, incremental highlights a major shift.

Total Energy Change and Incremental Change – Renewables at 100% by 2020





In a most likely scenario, renewables will account for almost 100% of incremental global energy supply growth by 2020, with a consequent major impact on existing energy infrastructure and demand.

Contrast this with the IEA comment that renewables will account for 28% of total bulk energy supply, up from 23% by 2021.

Whilst arithmetically correct, it is backward-looking, and misleadingly comforting, only focusing on the bulk. It mis-reads the fact that capital markets' primary function is to anticipate, and to re-allocate funds and investment accordingly, and will focus on rate of change, and future trends.

It's the same error that caused EU utility firms to over-invest in new capacity which was not required, having been reassured that overall percentages still favoured their type of energy.

Incremental Change and the Transport Sector

A further example of this thinking can be applied specifically to the oil rather than power market, by examining Electric Vehicle (EV) demand.

Received orthodoxy using bulk demand estimates is that EVs make up 0.1% of the global fleet today, maybe 2% at most in 2020, and possibly still less than 10-20% by 2040 – hence seemingly low impact on the incumbent auto and oil industry.

However, *incremental* annual global car growth (the growth of growth, a second derivative) is only around 2 million vehicles, of which today's 0.7million EV annual sales are 30%. If EV sales are 7million pa by 2020 as IEA scenarios propose, then annual demand growth for petrol cars will be in decline. Assuming a continuing 50% growth rate for EVs at this stage, a substantial associated downward impact on oil demand would occur by 2024, and then deepen.

Bulk estimates will still show the fleet dominated by petrol, but markets will anticipate the trend, pressuring automakers to disrupt their current model – recent actions by VW, Ford and GM,

stimulated also by Tesla and emissions litigation, seem to align with this.

A Smooth transition or Rapid change?

A growing interpretative mis-match is thus developing between industry analysts, pointing to slow and smooth bulk growth, and market analysts, highlighting rapidly accelerating front-end change. This will continue to cause major disagreements on the timescale for future changes in the energy market.

Conservative voices will insist that we have been here before, and never had a real breakthrough (and maybe never will due to solar and wind limitations).

Optimists will point to the reality of today's data regarding installed capacity – and the fact that leadership of the renewable technology transition is being taken on by the world's largest manufacturer, who also has a strong necessity to get it right.

CHINA

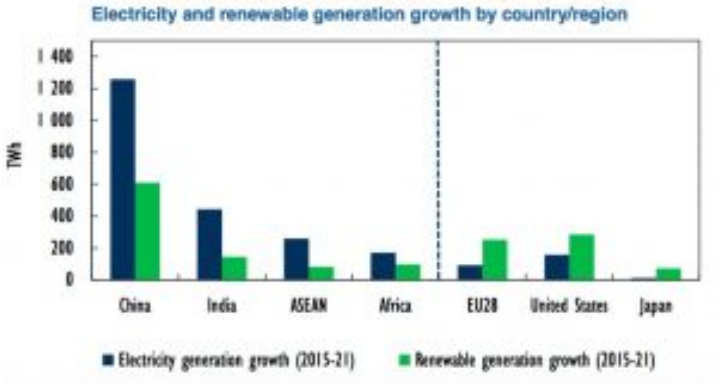
China will Lead Renewable Technology Development

Both the IEA, and a further TS paper China – leader of the new energy future, lay out why China is likely to dominate this transition.

Chiefly, this is because China has a deep necessity to move away fossil fuel import reliance, needs to quickly address very poor air quality issues, and already has a strong lead in the economics of new energy deployment, via its scale and resources. It also has a focused leadership who have pivoted in their latest Five Year Plan toward rapid growth of the renewable sector – for all the reasons discussed above.

The early trajectories are therefore already in China's favour: it is now the largest global manufacturer of new energy equipment (turbines and solar panels) and via Goldwind, a Hong Kong listed firm, now have the world's largest turbine manufacturer, deposing Vestas of Europe last year (although a proposed GE acquisition of LM Wind Power may change this again).

IEA power generation growth projections are shown below – China is forecast to drive at least 40% of global growth in renewable generation to 2021, outpacing the US and EU, as it attempts to meet its own energy growth demand from a greater diversity of (home-grown) sources.



Note how the world energy markets are now reconfiguring. In Asia and Africa, renewables are becoming the majority source of incremental power. In the EU, US and Japan, they are replacing incumbent fossil fuel energy sources as capacity outstrips demand.

And, as the IEA notes, China's competitors in this rise of renewables are losing ground:

EU - Policy Intermittency

The EU has had an historic leadership in renewable policy-setting and deployment. However, energy demand is falling across the EU, slowing capacity requirements. Programs to support renewable growth, despite Paris, have also faltered. More inward-looking governments, and policy reversals undermine potential leadership in equipment, services and technology.

As the UK Guardian newspaper recently commented, in the EU solar and wind intermittency is not the real obstacle, policy intermittency is far more challenging.

US – Strength of Fossil Fuels

In the US the growth of renewables has been impressive over the past decade, especially with progressive tax credits and policy support – over 60% of net new electricity capacity added in

2016 (26GW) will come from PV solar and wind power.

However, the US has a strong fossil-fuel sector and robust oil and gas reserves. Future growth will be the net outcome of pro-renewable and pro-fossil fuel lobbying and programs across key states – and that outcome remains unclear.

This likely cedes, for all its technical prowess, the renewables initiative to China's more direct central plans.

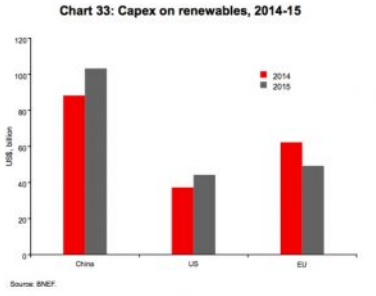
Analysts still look West

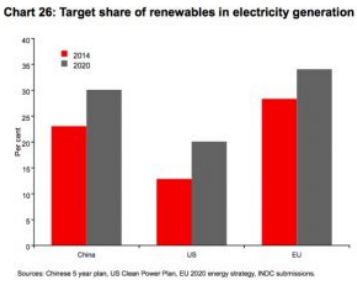
This may well cause western-based industry analysts to continue to overlook the pace of global renewable change. Headlines will stay focused on EU and US policy u-turns on renewables, and the actions of OPEC and oil producers calling for a "rebalancing" of oil prices to occur and provide the industry with more funds for global hydrocarbon investment.

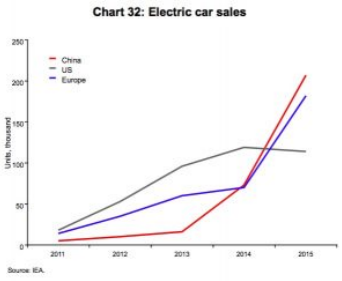
The narrative will assume global energy demand remains robust, driven by China and India, which can only be met by greater volumes of oil and gas. A lack of EU and US leadership in renewable technology and policy will be seen as evidence that renewables are not yet able to fulfill major energy requirements.

Meanwhile, the leadership of the transition may well be passed to China: manufacturing and design expertise in solar and wind equipment, electricity infrastructure development via grid, storage and charging, and efficient EV production.

The charts below, from the TS paper, show the pace and breadth of China's investment relative to the EU and US.





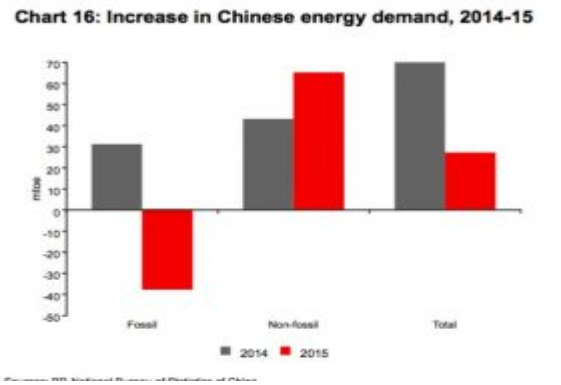


IMPACT

What this means – a Tipping Point in 2020

Overall global energy demand is slowing: its flat or decreasing in the US and Europe, and only Asia is driving overall growth.

Even China may now be going through a decline in energy demand from traditional fuels. Chinese energy demand grew overall in 2015, but it was met by increased reliance on renewables, and reduced dependence on fossil fuels –mainly coal



This is now the general shape of the energy transition. It repositions fossil fuels as a residual between slowing overall demand, and the rapidly increasing capability of renewables to fulfill it (an argument also applied recently to gas in a paper from Chatham House).

When fossil fuel supply stops growing globally because renewables are absorbing all required growth, this is the energy tipping point.

When might this be?

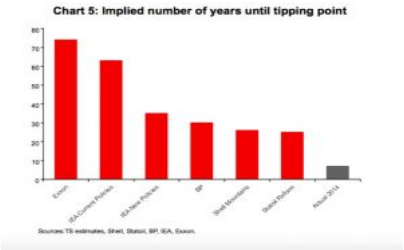
To do a quick calculation, you can simply take assumptions on underlying total energy demand (% pa) and the rise in renewables of mainly wind and solar (%pa) – the fossil fuel supply required is the residual between the two.

The tipping point is when fossil fuel supply growth drops below zero using these assumptions.

This can easily be calculated in terms of time, in years. The TS analysis below uses a range of oil industry and external analyst assumptions for the % pa growth of total energy demand and renewable growth, and plots them out.

	Global energy demand growth			
Solar and wind growth	0.5%	1.0%	1.5%	2.0%
5%	18	50	76	103
10%	6	17	25	31
15%	1	9	13	17
20%	1	5	9	11
25%	1	4	6	8

Source: TS estimates.



Industry consensus suggests this tipping point is about 30-70 years away; latest data and the TS assessment is that it is more likely closer to five years – by 2020.

To be clear, the tipping point indicates when fossil fuel supply growth declines, not when they disappear.

But given the anticipatory nature of financial markets, the speed of global communications, and the high-yield potential for corporate investment into novel technology and supply chain opportunities, a sharp restructuring of the global oil and gas industry is likely when it occurs.

As noted, most industry analysts still assume that the US and EU hold the key to renewable development, and so point to policy reversals and historical hydrocarbon infrastructure as major drags on progress.

But with China's necessity and leadership, and the transferable nature of technology, the pace of change is likely to continue and accelerate, and drive adoption and cost reductions globally.

As a best guess, 2020 looks far more likely as a tipping point, in today's world, than 2085.

If so, what happens at the tipping point?

A High Risk for Incumbents

Over-reliance on the consensus view

The oil industry has driven the consensus view of change in the energy market for many years via companies such as BP, Shell, Exxon and sector analysts such as IHS and IEA. If any tipping point is to occur, most of these analysts suggest, it is likely 30 years away.

Taking that logic, IHS, for example, note that oil company outlook and valuations are robust because they are based on 10-15 years of cashflow projections, which are unaffected by events in the distant future.

This consensus view may be a decent basis for planning, but it does little to prepare incumbents for any more rapid change. Business school literature is full of case studies of incumbents reacting too slowly to disruptive change – IBM and PCs, Nokia and smartphones, Peabody Coal and Chinese demand decline.

This paper has argued that renewables are growing rapidly, and have passed several key milestones in terms of costs and capacity in the past couple of years. In addition, the largest producer and user of renewables – China – has a clear plan to develop them quickly.

This should cause oil producers and especially multi-national oil companies to review their business forecasts of demand projections immediately.

As the simple table above shows, if global energy demand growth is less than 1%, as most analysts predict, then renewable growth would have to grind to a halt to allow fossil fuel supply growth to continue. Under any other scenario, fossil fuel growth declines soon.

When fossil fuels, starting with coal and then oil and gas become a residual, demand falls, and prices deflate. Competition among the residual suppliers will become more intense, primarily based on the cost to produce.

In this scenario national producers in OPEC and Russia will be forced to defend market share out of necessity as their revenue supports national budgets. International firms will have to totally re-shape their cost base to compete.

However, the primary business model of IOCs is high-cost, technologically demanding production of oil and gas from marginal fields. It's practically their raison d'etre.

So, the recycling of current industry cash-flow into long-cycle high-cost projects in this post-2020 world of declining overall demand is an increasingly high-risk strategy. It will impact today's market valuations considerably downwards based on anticipated profits in 2020-2030, contrary to the IHS analysis.

History an unhappy guide

History (bunk or not) suggests adequate contingency planning will not take place.

Previous transitions have in effect been the hand-off of one hydrocarbon to another, so incumbents have tended to remain in tact even after "transformations" have taken place. The skills and technologies required to extract and sell coal, oil and gas are similar, and so national and international oil companies have endured for many decades.

In many ways then, this energy transition is the first of its kind, and is truly disruptive.

This means the skills, technologies, assets and capabilities required will change substantially.

Whilst auto manufacturers will have to adjust to creating cars with electric power-trains, rather than internal combustion engines, their core skills of branding, distribution and manufacturing will still be valuable. Their increasing investment in doing so is testament to how serious they take the conversion.

However incumbent oil companies have no inherent competency in technology manufacture - PV solar array or wind turbine engineering, installation and servicing, for example.

Whilst some have invested in renewable firms, it is at a very modest scale, and often over-reported. As noted in the post *Oil and Gas and Creosote*, it will not reach significant scale due to the substantial requirements to service their core capital base of oil and gas extraction.

Time to act

Oil and gas resources will be required for many years to come, but the market structure that delivers them will change radically and quickly if this analysis turns out to be accurate. Oil companies do have the benefit, however, of global scale communication on the changes underway, and access to alternative analytical viewpoints that indicate how they might react to the transition.

As argued in this post, the need for a contingency Plan B is required quickly, and one was outlined in detail focused on strategic disinvestment, and retreat from capital infrastructure and exploration.

Whatever the case, its now time for the key protagonists, the oil and gas companies, to begin to react to the energy transition underway and protect the interest of their stakeholders.

For incumbents, a tipping point may be only months away – and this will be the subject of a post later this month.

A Major Disruption for Global Energy

The wider implications of a rapid transition to manufactured renewable energy also need to be understood in detail as they will be substantial, highly disruptive and deflationary.

They range from the geopolitical impact on oil and gas national producers in OPEC and beyond, through the commercial issues for incumbent and new entrant firms, and on to the broader effect of energy sources that reduce in cost with deployment, rather than the opposite.

Several of these issues will be addressed in upcoming posts.

CONCLUSION (and Counterpoint)

As per IEA's new study, renewables are the fastest and largest growing element of global energy, and are already pushing out fossil fuel demand by surpassing coal in terms of installed capacity.

They are also a technology – which means that for the very first time a manufacturing option has emerged to replace the centuries-old energy dominance of extracted carbon.

That changes everything.

It means that there is no need for hydrocarbon endowment to become a leader in global energy supply.

This in turn implies that China will lead the world of alternative energy, not only in this formative stage, but into the future due to the nature of technology.

As China has a high necessity to reduce dependence on fossil fuels, this transition is likely to be consistent and rapid.

The tipping point, when renewable growth causes fossil fuel supply to decline, is forecast to be soon, likely 2020.

It will impact incumbent private energy companies first, and longer-term the finances and stability of fossil fuel producers. Energy price deflation will be constant with the carbon monopoly on fuel supply broken.

Counterpoint - Back to Projection land

For those unconvinced by this whole thesis, the outline of Projectionland in the post Plan B: The Unwalled Garden indicates how a far slower, smoother transition may occur, largely due to policy failure.

This is still possible – although one key factor to be borne in mind is the likely leadership of China in driving renewable uptake.

In Projectionland, on top of policy breakdown, a key assumption is that renewable technology developed out of necessity by China never really transfers across their borders, or stimulates competition.

Given the nature of technology, it is left to the reader to determine whether they think that is realistic.