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Energy Transition: Happening As We Speak

IRENA's Adnan Amin: "We don't need a miracle; it's already happening"

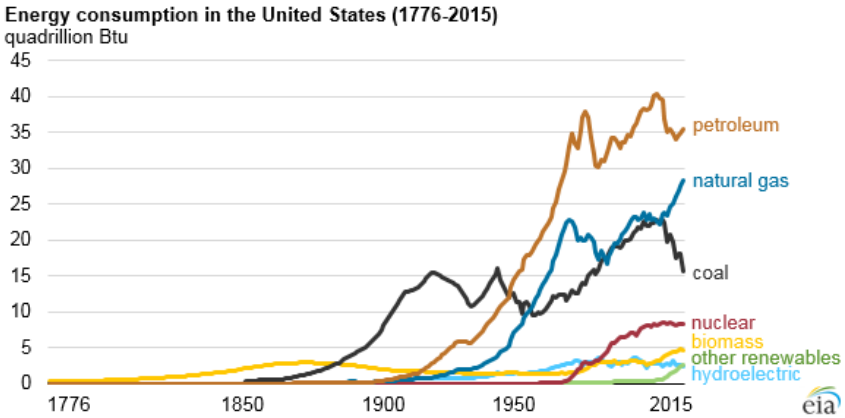
Energy transition. Until recently, that would have been a hollow cliché – yes, of course, everything is always changing. Now, however, it seems that energy transition is taking place at such an unprecedented speed that experts and non-experts are having a hard time observing, let alone absorbing or internalizing it.

Take, for example, the recent announcement at the **3 Amigos Summit** in Ottawa in late June 2016 where North America's leaders pledged to obtain half their electricity from *clean power sources* by 2025. In a joint communiqué, US President **Barack Obama**, Canadian Premier **Justin Trudeau** and Mexico's President **Enrique Peña Nieto** said "We believe this is an aggressive goal, but for all 3 countries, one that we believe is achievable, continent-wide."

Big deal? Indeed, considering that the proportion of clean power generation from the 3 countries currently is around 37% – give or take a little and counting nuclear in the mix, which is zero carbon. The political leaders are hopeful that **wind, solar, hydro, nuclear, carbon capture and storage** (CCS) and **energy efficiency** will allow the North American continent to reach the 50% goal in less than a decade. That *is* energy transition, and at rapid speed.

Could we kick the fossil fuel habit?

Petroleum, natural gas, and coal have provided more than 80% of total US energy consumption for over a century, according to EIA; 81.5% in 2015, the lowest in the past century. Under a business-as-usual scenario, it is projected to decline to 76.6% by 2040



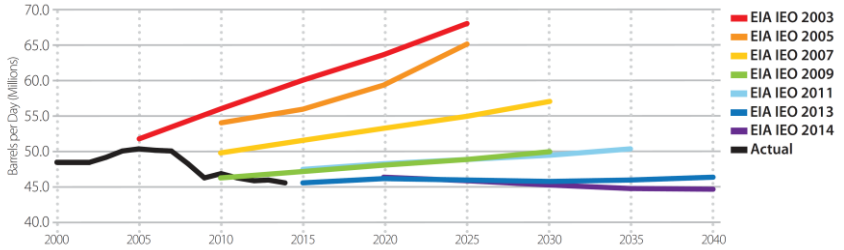
Source: U.S. Energy Information Administration, *Monthly Energy Review*

With over 27 GW of solar capacity, the US currently leads in solar installations compared to Canada's 2.5 GW and Mexico's 104 MW. Counting nuclear as *clean*, the US currently gets roughly a third of its electricity from carbon-free resources, less than 20% for Mexico. Canada, on the other hand, produces 81% of its electricity from clean sources, mostly through hydroelectric but also nuclear, and increasingly solar and wind.

Not a pretty picture if you are an oil company executive

EIA forecast of OECD oil demand shows flat or declining demand

Mb/d)



Source: Unconventional Risks, As you sow, 13 Jul 2016

Canada and the US, already well-connected, will need additional high voltage transmission lines. The ties to Mexico, virtually non-existent, will have to be built to facilitate cross-border trade. Plans for 6 proposed transmission projects with over 5 GW of capacity, such as the **Great Northern Transmission Line,** the **New England Clean Power Link**, and the **Nogales Interconnection**, will have to be accelerated.

The 3 Amigos, relatively young, appear committed to make climate change a priority. They said, among other things, they would adopt uniform **appliance energy efficiency standards** by 2019, making it easier for gadgets manufactured in one country to be sold in others.

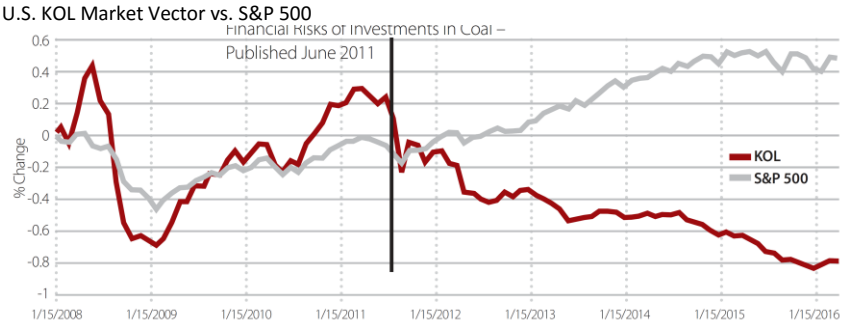
In the case of US, which has the lion's share of capacity and generation, the share of non-hydropower renewables – which increased from roughly 3% in 2008 to 7.3% by 2015 – must be further accelerated. Wind and solar, currently making roughly 5% of generation, for example, must nearly double by 2025.

North America, of course, is not alone in making a transition to low carbon energy. In early July 2016 **UK** adopted a new **carbon budget**, which requires CO2 emissions to be cut 57% from 1990 levels by 2030.

The new target is *higher* than the CO2 emissions target that the UK had to reach as part of the **European Union**, which was a more modest 40%. The decision, coming days after the **Brexit referendum**, eased concerns over the country's climate policy after leaving the EU. The UK had previously committed to cut CO2 emissions by 80% by 2050.

Coal is first fossil fuel to face the carbon headwind as reflected in commodity prices

U.S. KOL Market Vector vs. S&P 500



Source: Unconventional Risks, As you sow, 13 Jul 2016

Would such a target be feasible? Things are in fact changing, and rather fast. By sheer coincidence, it was announced that starting in May, **solar** generation in the not-so-sunny UK now exceeds that of **coal** – an utterly unimaginable outcome only a few years ago. In fact, in early July, the **UK Solar Trade Association** announced that the UK solar industry broke a new record in June 2016, generating nearly 24% of the demand. Another stunning feat that not many observers saw coming, and so soon.

Moreover, UK, which traditionally relied on coal for much of its electricity generation as in the US, is now planning to *phase out* coal by 2023. Several studies looking at the implications of such a move suggest that it *can* be done, no problem. No kidding.

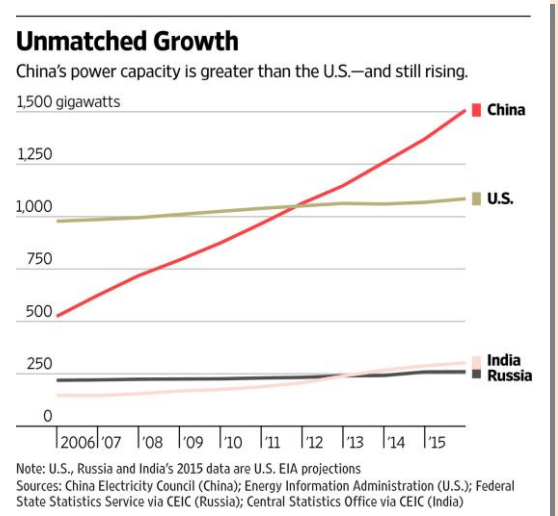
That's all fine. But what about the developing countries, craving energy to feed their growing economies, their citizens' aspirations for prosperity and getting out of abject poverty? Would they be able to afford clean and sustainable energy resources any time soon?

The evidence coming out of **China** is encouraging. To start with China's overall energy consumption is expected to peak by 2035 – if not sooner (box below).

Meanwhile in China ……..

In July 2016, the **Economics & Technology Research Institute** of **China National Petroleum Corp.** (CNPC) announced that it expects *total* energy consumption to peak at 3.75 Gtoe by 2035, from 3.1 Gtoe in 2015.

According to CNPC, China's total fossil fuel consumption should peak at 2.93 Gtoe and oil around 670 Mtoe by 2027 from 529 Mtoe in 2015. Oil consumption is predicted to *decline* after 2027, dropping 500 Mt by 2050. Gas consumption is expected to grow from the current 187 bcm to 510 bcm by 2030 reaching 710 bcm in 2050.



Source: The Wall Street Journal 31 May 2016

While coal remains the dominant source of energy, its share is projected to *decline* from 64% in 2015 to 37% in 2050. This is partly explained by the rising share of non-fossil energy from the current 12% to more than 30% by 2050.

For a developing economy as big as China to make such dramatic shifts over a relatively short time is quite impressive. And if China can do it, so can anyone.

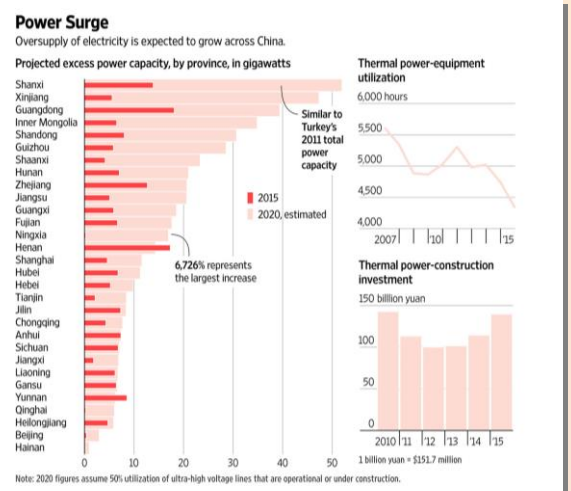
Moreover, facing a glut in coal-fired generation capacity, in March 2016 China announced a virtual *ban* on construction of *new* coal-fired power plants until 2018. This alone should cut coal's share of the overall energy mix to 58% from the current 64%.

And who knows, perhaps the ban on new coal can be extended if more renewables, more nuclear and lower electricity demand materialize, not a far-fetched scenario.

China's existing fleet of coal-fired plants are operating at a utilization rate 15% below the global average – which means reduced carbon emissions.

In the meantime, China, like India, is investing heavily in renewable energy. By 2020, a mere 4 years away, China's solar capacity is expected to reach 150 GW, 250 GW for wind, 340 for hydro and 58 GW for nuclear.

Add the numbers and you get nearly 800 GW of zero-carbon generation by 2020. That dwarf's the numbers projected anywhere else in the world, even allowing for some inevitable slippage in the numbers.



Source: The Wall Street Journal 31 May 2016

China's major challenge is not meeting the ambitious renewable targets but building sufficient transmission capacity given the long distances involved, and concerns about the reliability of the grid – a common phenomenon everywhere. Currently, much of the output of the renewable generation gets curtailed because there is insufficient transmission to move the power to where it can be utilized. ■

Renewables are indeed enjoying exponential growth trajectories globally, like a teenager on steroids. According to the **International Renewable Energy Agency** (IRENA), average costs for solar and wind electricity could fall nearly 60% by 2025. IRENA says solar PVs could account for 13% of global power generation by 2030. It projects further dramatic **solar** capacity expansion, from the current 227 GW to somewhere in the range of 1,760-2,500 GW by 2030 (article on page 21). Even the low end of the projected solar number would exceed total US installed capacity by a wide margin (first graph in above box) and 2030 is not far away.

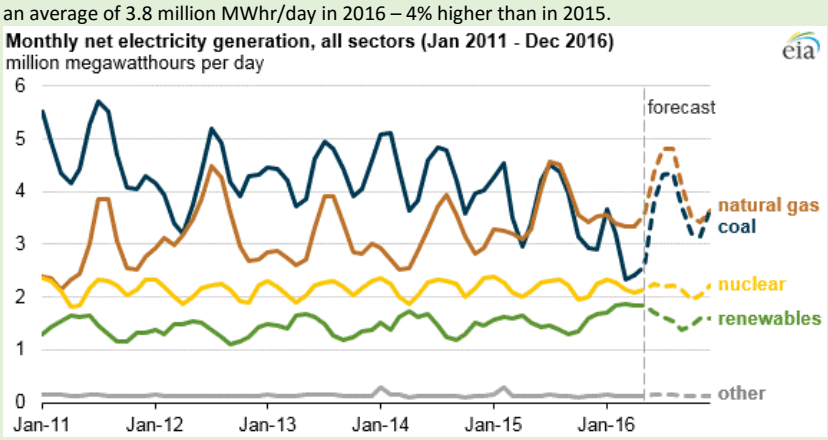
In an interview in **Energy Post** (15 July 2016), **Adnan Amin**, IRENA's Director-General said, "Everything we are seeing is pointing to transformational change in the energy sector," adding, "We don't need a miracle, it's already happening."

Another miracle is that, starting from a zero base, IRENA has become the world's *fastest-growing* intergovernmental organization with over 170 member countries. Watch out the **International Energy Agency** (IEA).

By contrast, fossil fuels, **coal** in particular, are expected to face additional headwinds as a *de facto* **carbon price** is beginning to emerge even if no one knows what it is. A report released with great fanfare in mid-July by **As you sow**, an environmental advocacy organization, titled **Unconventional Risks: The Growing Uncertainty of Oil Investments,** spells out the increased pressures that are likely to confront not just big oil but all fossil fuel investments in the coming years (article on page 24).

Energy in transition or more business-as-usual?
At a panel discussion at **IAEE Conference in Bergen in June**, CEO of **Statkraft**, **Christian Rynning-Tonnesen** (left), said his company, nearly 100% renewable, is expanding internationally on that business model. **David Hone** (extreme right), chief climate advisor to **Shell** presented a scenario that could reach 50% renewable in foreseeable future. **Lucy Craig**, VP at **DNV GL Energy** spoke about opportunities unleashed by rapid advances in technology. This newsletter's editor challenged all to step out of the box and accelerate the rapid energy transition already taking place in the electric power sector

Natural gas: Displacing coal in the US
Natural gas-fired electricity generation in the US is expected to reach a new record, providing an average of 3.8 million MWhr/day in 2016 – 4% higher than in 2015.



Source: U.S. Energy Information Administration, *Short-Term Energy Outlook* July 2016

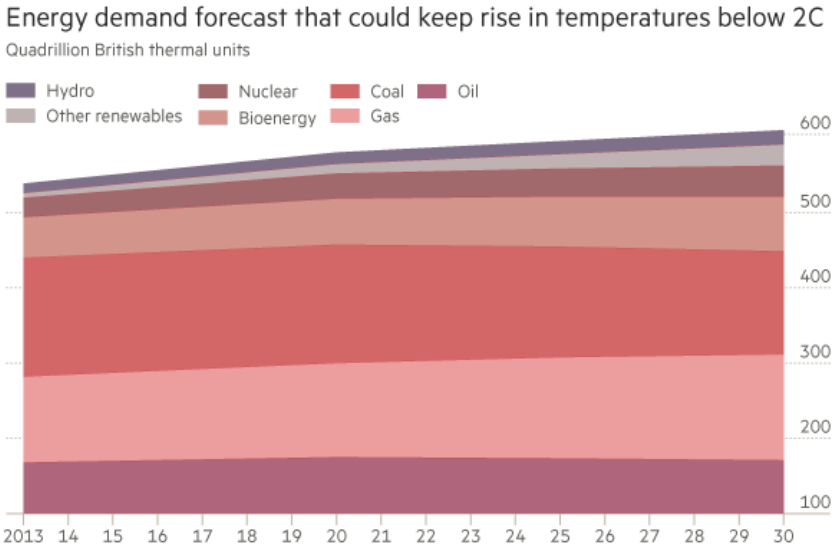
Perhaps this editor is misinformed or reads too much into a few anecdotal pieces of evidence to draw big conclusions. At a recent **IAEE Conference in Bergen** in June (photo above), for example, an academic colleague who follows developments in global oil and gas markets, summarily dismissed any notion of a transition *away* from oil and gas any time soon, if ever.

He said, "Let me give you two numbers," and there were

both more than a billion. He said that is how many *new cars* will be sold in **China** and **India** alone over the next decade. Demand for fossil fuels, in other words, will only *increase*, and by quite a lot. His advice: Don't be fooled by environmental activists and tree huggers. Fossil fuels are here to stay – I am, of course, paraphrasing his words.

I told him that I was not entirely convinced. As anyone who has been to **Beijing** or **Mumbai** – or for that matter **Jakarta, Lagos, Tokyo, Hong Kong, New York** or **London** – knows, buying a car, which is increasingly affordable in many developing countries, no longer improves personal mobility. You simply join millions of other cars on already congested roads and streets, with no place to go and no place to park when you finally get to your destination, setting aside the urban pollution that internal combustion engines cause.

Chinese and Indians, as my colleague predicted, may indeed buy more cars, but not as many as predicted by the extrapolation of historical trends. **Electrified mass transit, electric bicycles** and **mopeds** will increasingly be the way to get around in smart mega-cities of the future. Driverless cars, shared not owned, will also become ubiquitous, since parking will become even more of a headache for urban dwellers.



Source: Big Oil: From black to green, Financial Times, 28 June 2016 by Ed Crooks and Kiran Stacey https://next.ft.com/content/922add24-3d12-11e6-9f2c-36b487ebd80a

Future of mobility will increasingly be about moving people closer to where they work, shop, play, and socialize. Even **Los Angeles**, the city defined by automobiles and freeways, is experiencing a resurgence of interest in mass transit, commuter trains, light-rail and – hard to believe – urban living. For the young and upwardly mobile suburbs are so 1960s.

Who knows, but as reported by **Financial Times** (graph above) there are indications that at least some oil companies are beginning to have second thoughts about the wisdom of their *business-as-usual* investment and expansion strategies.

While the debate about the pace of energy transition and its impact on fossil fuels continues, some analysts are beginning to look at the unthinkable, a world with a diminishing role for fossil fuels. It is not as bad as it sounds.

Writing in 23 May issue of **Energy Post**, **Amy Myers Jaffe**, executive director of energy and sustainability at the **UC Davis Institute of Transportation Studies**, and **Jeroen van der Veer**, former CEO of **Royal Dutch-Shell**, actually see some gains in the transition away from fossil fuels (emphasis added):

> "A gradual move away from oil, will have *many benefits* for the global economy," adding, "a diminished role for oil means markets will become more stable and costly (oil) price subsidies can be reduced."

The authors, both members of the new **Global Agenda Council on the Future of Oil & Gas**, part of the **World Economic Forum,** urge oil and gas companies to explore how they can develop profitable alternative energies, noting that this will require "a change in the mindset of investors."

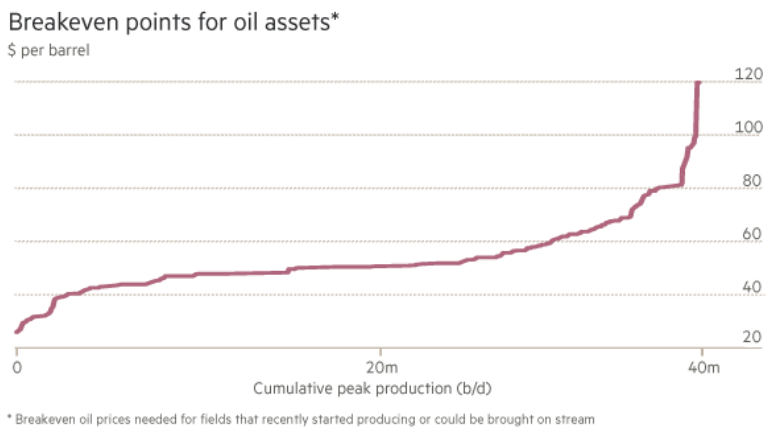
Full text of article at **http://www.energypost.eu/happens-demand-oil-peaks/**

Writing in the June 2016 issue of **EcoMotion**, **Ted Flanagan** says,

> "The **energy topping point** … it's in our face. All we hear about is more and more solar, and less coal. More renewables and less fossils."

Referring to **Malcom Gladwell's Tipping Point**, which chronicles what happens when good ideas become ubiquitous because they are significantly superior to the status quo, he refers to the classic example of wheels on suitcases. Once you saw one, you knew you had to get one. The rest, as they say, is history. Today, you will be hard pressed to find a suitcase *without* wheels, unless in an antique shop. Flanagan says, "And soon, it will be unlikely to see a home without solar. It's just too good an idea to pass." He adds,

> "The **Solar Energy Industries Association** (SEIA) projects that in 2016 the US solar industry will install 14.5 GW of capacity, a 94% jump over the 7.5 GW … installed in 2015. On the other hand, coal production in the first quarter of 2016 in the US was … the lowest … since a major coal strike in 1981."



Source: Big Oil: From black to green, Financial Times, 28 June 2016
https://next.ft.com/content/922add24-3d12-11e6-9f2c-36b487ebd80a

That is the equivalent of building 14 new nuclear reactors each with 1 GW of capacity in a single year. Can you imagine that ever happening in the US or, for that matter, anywhere?

"In 2015, renewables produced only 3% of the world's total energy consumption. While total energy growth slowed to a 1% … rate, the world's renewable energy capacity increased by 15% last year."

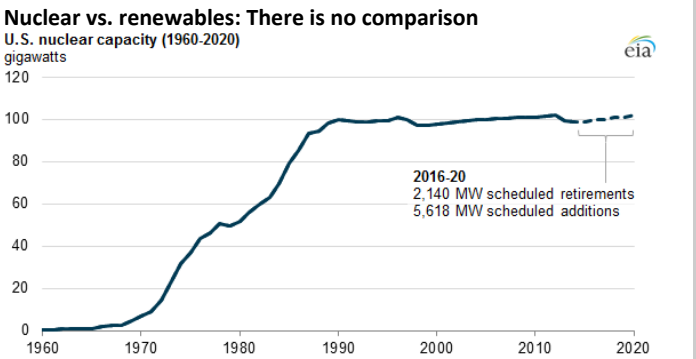
Like this editor, Flanagans of this world look at the evidence and see the transition happening. If not already here, the energy tipping point must surely be just around the corner. How many financiers would wish to invest in a new coal-fired plant in this environment? ■

Times Are Tough For US Nukes

Few signs of an end to premature closures of operating US reactors

Since 1990s, roughly 100+ nuclear reactors have provided roughly 20% of US generation, give or take a little. The US nuclear fleet out produced **France** – the country with the next highest nuclear generation – by more than 2-1; with Russia a distant third (graph below).

This feat has been the result of improved reliability and performance of the US fleet,



Source: Energy Information Administration, Monthly Energy Review

operating at ever higher capacity factors, in the 90%+ range. Which means that they operate nearly around the clock, 24/7, except for short periods required for infrequent maintenance or refueling.

There was even talk about a **nuclear renaissance**, with a new generation of safer and more reliable reactors coming on line, providing carbon-free electricity for the next generation. The existing fleet, now aging, would get refurbished and get relicensed, extending their useful life into 60-80 years and beyond.

The reality is rather different. Only a handful of new reactors are under construction in the US, all receiving generous federal loan guarantees, special state-level regulatory concessions and all are in states where there are no competitive wholesale markets, virtually guaranteeing that the utilities will recover their investments through rate of return regulations from captive customers. None are even contemplated in regions with competitive wholesale electricity markets.

The story gets even worse. Instead of seeking *extensions* of their operating license, at least a dozen US reactors are planning to shut down before their existing license expires. Few have already shut down and there are indications that more will follow.

Why has nuclear's story come to such a sorry state, especially when America – like every other country – is trying to transition to a low carbon future?

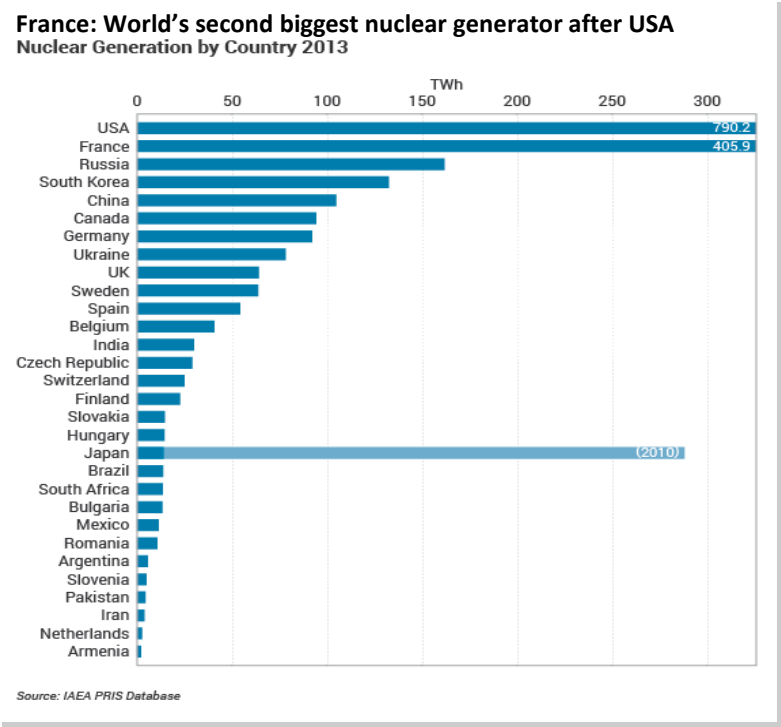
If you ask **Marvin Fertel**, CEO of the **Nuclear Energy Institute** (NEI), the lobbying arm of the US nuclear industry, the blame rests with **flawed wholesale electricity markets** that do not adequately recognize the full value of low-cost, carbon-free, base-load nuclear power.

The industry's woes got worse starting in 2013 when the **Kewaunee Nuclear Power Station** in Wisconsin shut down prematurely stating insufficient revenues. NEI blamed the flawed wholesale markets. The following year, **Vermont Yankee Nuclear Reactor** shut down. Fertel repeated his warnings to whoever would listen, to no avail.

In 2015, after **Entergy** announced it was closing **Pilgrim Nuclear Plant** in Massachusetts, Fertel repeated his message in stronger terms:

> "Today's announcement is more proof that the reforms urgently needed in competitive electric markets are too slow in coming. **Design flaws in wholesale markets** such as New England continue to result in artificially low electricity and capacity prices."

The result? Entergy announced it would close down the **FitzPatrick Nuclear Plant** in New York. Fertel warned again: "The fact that the FitzPatrick nuclear energy facility in New York is the industry's fourth nuclear power plant to prematurely close due to **uncorrected flaws in competitive electricity markets** is alarming."



Alarming or not, in early June 2016, **Exelon Corp.** the largest US nuclear operator, announced that it would shut down its **Quad Cities** and **Clinton** nuclear power plants in 2017-18. The two stations are said to have lost a combined $800 million during the past 7 years, despite being 2 of Exelon's best-performing plants.

This was followed by announcement that **Omaha Public Power District's** (OPPD) sole nuclear reactor at **Fort Calhoun** would cease operation and – surprise, surprise – the news that PG&E's **Diablo Canyon**, the *only* 2 remaining operating nuclear reactors in California, were slated to shut down by 2025 (see box). Fertel must be frustrated.

California nuclear free by 2025

In late June 2016, **Pacific Gas & Electric Company** (PG&E) reached an agreement with local environmental and labor organizations to shut down the 2 operating reactors at **Diablo Canyon** by 2025, replacing their output with **renewable energy, energy efficiency and energy storage**.

Diablo Canyon: Fantastic location for a future golf course

Source: PG&E

Part of the motivation – hard to believe but apparently true – is that base load power resources like Diablo Canyon are increasingly becoming a liability as renewable energy resources begin to dominate generation – in part in response to state's mandatory 50% RPS and the equally taxing climate bill, which requires state-wide CO2 emissions to be reduced to 1990 levels by 2020. What California sorely needs is not inflexible base-load generation but rather increasing amounts of flexible resources, demand-response and storage. Nuclear plants don't fit the bill moving beyond 2025.

As part of its agreement, PG&E has voluntarily committed to meet 55% of its retail sales from renewables by 2031, exceeding California's 50% renewable mandate by 2030. ■

Clearly, NEI's warnings are not being heeded. Wholesale markets, as everyone acknowledges, have flaws. But the demise of nuclear – and much more so for coal – can be explained in the context of broader developments affecting the US power sector.

For one thing, demand for electricity is no longer growing as it used to. With so much renewables coming on line due to mandatory **renewable portfolio standards** (RPS) and other policy-driven objectives, conventional thermal plants are gradually getting squeezed out of the dispatch merit order.

Moreover, the traditional dispatch merit order, consisting of low-cost base-load, followed by mid-range and peaking units, is beginning to break down. Zero marginal cost renewables are replacing base-load units with mid-range and flexible peaking units filling the gap left by variable renewables.

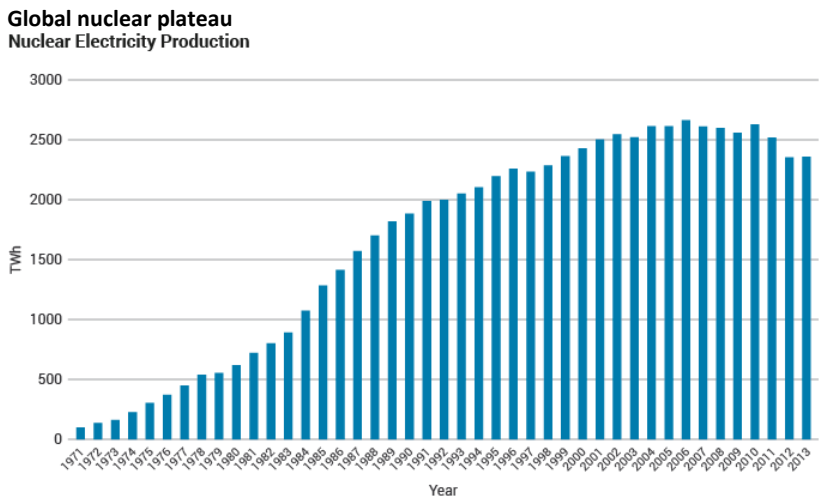
Even more stunning is the fact that base load units with little or no flexibility to adjust their output, as nuclear plans, are in fact becoming a *liability* since they cannot respond to fluctuations in load or variable renewable generation. What market operators will increasingly crave and pay for is **flexible generation**

and **load** plus **storage** and **demand response** (DR). Baseload nuclear is not as valuable as it used to be.

In case of California, **Tony Early**, the CEO of **Pacific Gas & Electric Company** (PG&E) stunned many when he pointed out the obvious realities of California's emerging electricity market:

> "Our analysis continues to show that instead of continuing to run all the time, there will be parts of the year where Diablo will not be needed," adding, "At a plant like Diablo, with large fixed costs, if you effectively only run the plant half the time, you've doubled the cost."

That plus the fact that **natural gas** prices are at historic lows, is eroding the viability of nuclear and coal. Without a specific and tangible **carbon price**, the market is simply not rewarding nuclear power's zero-carbon generation. Hard to fathom, but it is true. In competitive wholesale markets, nuclear power is no longer competitive.



Source: World Nuclear Association

That explains why since October 2012, 14 nuclear reactors have closed or announced closure. Only a miracle can reverse the inevitable, and even that may be too little, too late.

There was a sliver of good news as the **New York Department of Public Service** proposed subsidizing **zero-carbon electric generating stations**, namely nuclear power plants, as a way to prevent their closure.

Using estimates of the **social cost of carbon** (SCC), the DSP staff has proposed crediting nuclear power with a **zero-emissions credit** (ZEC) to be administered in six 2-year tranches, beginning April 1, 2017. The price to be paid for ZECs would be determined administratively by the Public Service Commission.

According to the staff's analysis, low natural gas prices are causing wholesale market prices to be significantly lower than the average operating costs of the nuclear units – precisely what the NEI has been saying for some time. ■

Who Will Disrupt Utility Monopolies

Speculation is ripe about who, how and when

For some time, there has been speculation about newcomers disrupting the utility monopoly business model. It is lucrative *and* ripe for disrupting. It is one of few remaining monopoly businesses around with significant inefficiencies. The incumbents are not generally well-liked by their customers. There is much un-utilized and under-utilized capacity in the infrastructure and the network that can be exploited. New technologies promise to make an increasing number of customers semi-autonomous from reliance on the grid, to list a few.

So what form will the disruption take, who will be the disrupters, and when will it begin?

One possibility is that customers – individually or in aggregation – will begin to *transact* with one another in a myriad of ways, facilitated by open platforms that brings buyers, sellers and **aggregators** together.

For example, two neighbors whose load profiles are uncorrelated may be better off if they could aggregate their combined consumption as a single customer. Another example is a customer with ample solar generation, offering some of the excess power to a green apartment dweller unable to put solar panels on the roof.

As previously reported in this newsletter, a number of such **peer-to-peer** (P2P) trading platforms have already emerged. It remains to be seen if they make good economic sense for the trading parties even if they make little or no business sense to the incumbent distribution utility that serves them. One example may be found in article on page 15.

Does this look like disruption to you?

Source: Timo Leukefeld from Christoph Burger, ESTM Berlin

While the concept of **P2P trading** and **transactive energy** are in their infancy, there is speculation that such schemes may take off once somebody figures out how to *monetize* the benefits and – crucially – gets around **regulatory obstacles** that make it illegal for customers to trade with one another. In most places, customers can only buy electricity from the monopoly franchise distributor.

A second fundamental issue – frequently left unanswered by the new startups – is who will pay for the upkeep of the distribution network while a proliferation of new products, services and business models begins to emerge. Most startups are likely to erode revenues of traditional distribution utilities, which are typically tied to volumetric kWh sales.

As the following 3 articles describe, beyond P2P trading – which can be quite disruptive depending on who is trading with whom – a number of established firms with brand recognition appear to be poised to make inroads into the traditional utility space. ■

What Next? Apple Energy

With a powerful brand, Apple's entry into energy space could be ominous

One possible form of disruption may come from an established company with a powerful brand to begin competing directly with utilities on their home turf, originally in limited ways, growing over time. **Apple** has quietly created a subsidiary called **Apple Energy LLC** and has applied to the **Federal Energy Regulatory Commission** (FERC) for a license that will allow

it to re-sell electricity directly to retail consumers.

While Apple has been mute on the subject, the trade press has had a field day trying to read between the lines. Could Apple Energy be disruptive? One can speculate along the following lines:

First, Apple relies on 93% renewable energy in all is operations, with a goal of reaching 100% soon. The company has contracts with solar developers around the world for 521 MW of capacity, making it one of the largest global solar energy users. Additionally, it is investing in **zero net energy** (ZNE) buildings including its massive new headquarter in Cupertino, CA (rendering above and below). The building, nearly completed, uses little energy and generates power from solar arrays integrated into the roof.

Apples' new headquarter: 100% renewable

Second, the company is in a position of having **excess renewable generation** much of the time, especially on cool sunny days of spring, when there is no air conditioning load to speak of. The excess energy can be sold back to the grid at wholesale prices – or much better – to other customers at prevailing retail tariffs, which tend to be 2-3 times higher.

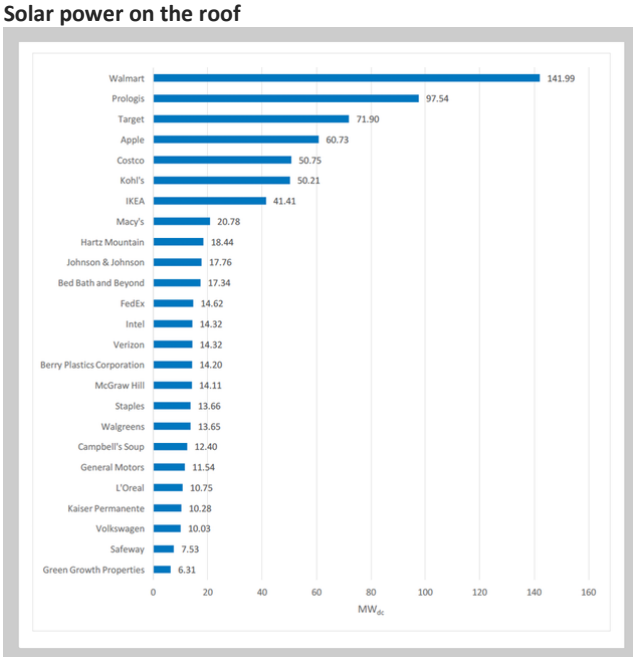
This explains why in early June 2016 Apple Energy applied to the FERC for a license allowing it to re-sell its excess supply of renewable energy to other retail customers. A reply is expected in early August and, if granted, will essentially makes Apple Energy a "utility" or a retailing company.

Third, who knows what Apple will do with its FERC license and whether it will make a dent in its overall numbers to make it a priority. But Apple has been quietly working on **autonomous electric vehicles** (AEVs) for some time – as is everyone else including **Tesla**, **Google** and major automakers.

Having excess renewable generation to charge Apple car batteries would come handy. This may ultimately be the killer app for Apple, selling its 100% renewable electricity to charge its own fleet of driverless electric cars – when that eventually happens. Not surprisingly, **Tesla** (following article) is thinking along the same lines.

Fourth, is Apple's valuable **brand**. Consumers are likely to buy anything that has Apple's **ubiquitous logo on it or behind it, electricity** included, especially if it is 100% renewable. Apple's existing customers will most likely be first in line.

Solar power on the roof



Finally, with sales of its incredibly successful **iPhones** and **iPads** flattening out due to market saturation – anyone who is going to buy one has already got one if not more – Apple needs to find other products and services to offer its loyal customers. Why not Apple electricity or autonomous Apple EVs charged with 100% renewable electricity? ■

Tesla's Complete Picture

Will Musk's EVs, PVs and storage be the killer product?

An even more likely and menacing threat than **Apple Energy** may come from **Tesla**, who ironically wants to create the equivalent of a one-stop Apple store for transport, solar self-generation and storage.

In a much publicized blog posted in late June 2016 and a second in July, **Elon Musk**, the Mercurial CEO of **Tesla** announced that he wants to acquire **SolarCity Inc.,** the largest US solar PV installer, for $2.86 billion. He is already a major shareholder of the company that is run by his cousin. The big question is why it took him this long?

Unlike Apple's reserved **Tim Cook**, Musk tends to brag about what he intends to do and enjoys the ensuing free publicity (Box below). Needless to say, what he says gets noticed.

What does Musk plan to do with SolarCity?

The proposed merger between Tesla and SolarCity was announced in a blog by no other than the founder and CEO **Elon Musk**, who said it was time to "complete the picture" and become the world's first vertically integrated company specializing in end-to-end customer products," adding,

> "This would start with the car that you drive and the energy that you use to charge it, and would extend to how everything else in your home or business is powered."
>
> "With your **Model S, Model X**, or **Model 3**, your solar panel system, and your **Powerwall** all in place, you would be able to deploy and consume energy in the most efficient and sustainable way possible, lowering your costs and minimizing your dependence on fossil fuels and the grid."

Would a nice guy like this disrupt your monopoly business?

Source: The Wall Street Journal 2 May 2015

In a follow up encounter with the media and analysts, Musk described the deal as a "no-brainer," emphasizing that it made sense for customers who could walk into a Tesla store and "with a few clicks" buy an EV, a solar system *and* an energy storage system.

> "Instead of making 3 trips to a house to put in a car charger and solar panels and battery pack, you can integrate that into a single visit," Musk told reporters. "It's an obvious thing to do."

Aside from the obvious benefits for the consumers, there are major advantages for the two companies who can integrate their offerings. If Musk's proposal gets approved, SolarCity's products will be sold from the same Tesla stores and by the same sales people.

As Musk envisions it,

> "You'd walk into the Tesla store and say: 'I'd like a great solar solution with a battery and an electric car,' and in 5 minutes you're done," adding, "It's completely painless, seamless, easy and that's what the customer wants."

Integrating their offerings would allow the combined enterprise to cut **customer acquisition costs** while increasing the sales per square foot in Tesla stores. It would also cut down on visits to customer homes for each product. ■

Musk is betting that in the near future, the cost of solar-generated electricity with back-up storage will meet or beat retail electricity tariffs in many places. Why not integrate the three products into a package? It makes perfect sense.

Fill them up from solar on the roof

Have you got one on the roof?

Moreover, like Apple stores, slick Tesla showrooms are popping up in some of the most expensive shopping districts in major cities around the world. Once a receptive customer walks in to look at the latest new Tesla model, why not sell more than a car? Like Apple, Tesla's brand name is priceless. And so is retail space.

Analysts have been speculating what a Tesla/SolarCity combination plus storage could potentially do to vulnerable incumbent utilities, especially in high retail tariff areas with ample sunshine. The short answer is *potentially* quiet a lot.

Going beyond the obvious, it is easy to speculate how Tesla/SolarCity/Powerwall combination may morph into an **integrated energy services company**. According to **Hugh Bromley** an analyst with **Bloomberg New Energy Finance** (BNEF), "Musk's intentions are larger than simply adding a third product category. The future of Telsa Energy could be in energy services."

This type of scenario might materialize once Tesla begins to aggregate the load profiles of thousands of customers with rooftop solar systems, batteries and electric cars. With such data, it can buy power from the grid when it is plentiful and cheap to charge the batteries, or the opposite when the reverse is true.

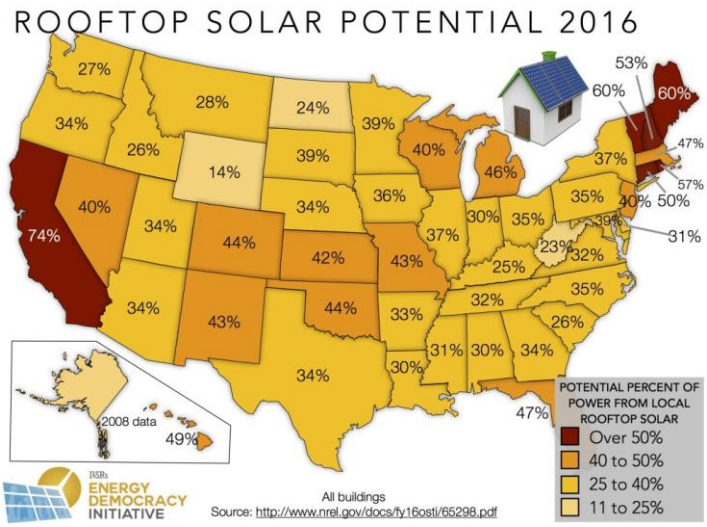
It can conceivably do far more. The **distributed storage** can assist the local distribution company by balancing supply and demand, regulating voltage and frequency, or storing distributed energy in response to big swings in upstream renewable generation – all highly valuable services.

Combined or otherwise, 3 main challenges confront Tesla and SolarCity:

- **Customer acquisition** costs for SolarCity;
- **Cost of storage** for Tesla's Powerwall; and
- **Regulatory risks**, mostly for SolarCity, but also the combined enterprise.

Regarding the first, one reason solar PVs in the US cost as much as they do – reportedly $3.20/W in the US vs. less than $1.70/W in **Germany** or **Australia**, according to BNEF – is the relatively high cost of acquiring US customers. Perhaps the Tesla showrooms can help.

Lot more energy on the rooftops



Source: John Farrell, Institute for Local Self-Reliance

SolarCity'a stock prices have had a beating, mostly due to its ambitious expansion pace and high customer acquisition costs.

SolarCity has recently announced that it is investing $750 million on its own PV Gigafactory in Buffalo, New York with 1 GW of solar panel capacity per annum starting in 2017.

Regarding the second, Tesla's Powerwall battery currently costs about $3,000 for a 6.4 kWh unit, and that does not include the cost of the inverter or installation. That is a lot of money for little storage. Which explains why Tesla is investing 5 billion in a massive Gigafactory outside Reno, Nevada, slated for completion soon (photo below).

Tesla is hopeful it can reduce the cost of battery packs down to about $100/kWh. That would not only be crucial for the Tesla's mass-market **Model 3** electric car due in 2017 but also for the future of storage for customers with solar PVs.

Tesla's Gigafactory, Reno, NV

If it succeeds, the marginal costs of including a battery with a typical $25,000-40,000 rooftop solar system would become trivial. Once that happens, it makes sense for nearly all solar customers to include batteries. The combination of Tesla car, solar PVs and storage would become a *no brainer*, as Musk has observed.

Regarding the last challenge, and the toughest to predict or plan for, is the fate of **net energy metering** (NEM) rules, which currently require electric utilities to buy the *excess* rooftop solar generation from customers at *retail rates*. This is by far the most generous form of solar subsidy imaginable. It essentially offers customers the option to use the grid as a free battery.

It remains to be seen how much longer the prevailing NEM laws will be in effect. Moreover, if Tesla begins to aggregate loads and operate as a *de facto* utility, it may also come under the scrutiny of regulators, who may dictate what it can and cannot do and what prices it may charge.

Tesla's Model S

Everyone, of course, is asking why Musk has decided to acquire SolarCity now, while he is facing stiff competition from virtually all major automakers, who are trying to beat him in his own game.

One explanation is the one given by Musk, namely that now is the time to complete the circle. Others suspect that the depressed share price of SolarCity may have something to do with the timing of the announcement.

SolarCity's stock price has recently slid to around $20. Musk, the largest shareholder in both Tesla and SolarCity, has been buying the company's stocks when they are in need of capital. Why not merge the two companies and get it over with?

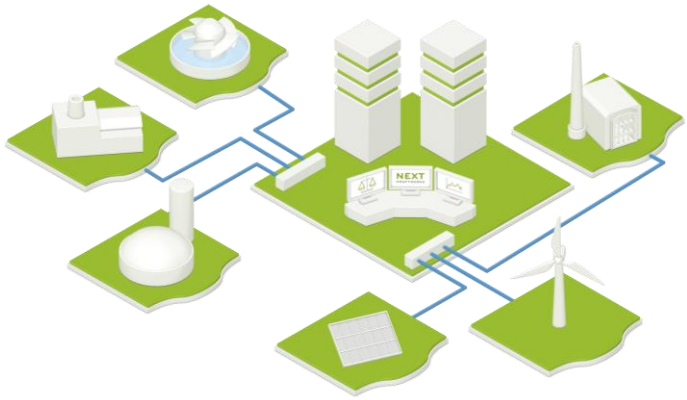
Tesla's stock dipped below $200 after the announcement, while SolarCity's jumped. If Musk succeeds in combining the two, he can start disrupting the auto *and* power industries from the same bunker. ■

Watch Out For Virtual Utilities, Virtual Power Plants

Startups are figuring out ways to beat incumbents in their own game

Among the threats facing incumbent utilities are **virtual** or **digital utilities** who offer similar services but at lower costs and/or with more desirable characteristics. But that is not all. Clever startups are popping out offering new products or services not traditionally offered by utilities, or anyone else, for that matter. The new offerings are in response to the emerging needs of the market, and increasingly focused on aggregating the growing number of *prosumers* who may have excess generation, storage, flexible loads or a combination of the above and are willing and able to be proactive and price responsive.

Aggregating and dispatching flexible resources without owning any
Graph below illustrates how Next Kraftwerke's control center aggregates the capacity of its distributed generators and consumers to participate in the wholesale market



Source: Next Kraftwerke

One example of the latter is German-based **Next Kraftwerke**, a company that currently aggregates the load and generation of over 3,600 distributed power producers and consumers while optimizing their combined portfolio to take advantage of prevailing prices in the wholesale market.

Next Kraftwerke, whose generation portfolio is nearly 100% renewable, is keen on aggregating flexible resources such as **biogas, hydropower, CHP plants, distributed generation** and **flexible industrial and commercial loads**. These flexible resources/loads can be adjusted to balance wide fluctuations from wind and solar on the upstream of the network, which are increasing in frequency and magnitude, and not just in Germany (see article on page 19).

During windy or sunny periods, for example, when wind or solar output floods the grid, Next Kraftwerke can ramp up power *consumption* among its 3,600+ members to stabilize the grid – or ramp up *generation* when there is little wind and no sun. The company claims it already has sufficient ramping up and down capacity equivalent to 2 big coal fired plants. That is what this editor would call a **virtual power plant** (VPP), and a highly flexible one at that.

As a **virtual utility**, the company does not *own* any of the resources it manages – just as **Uber** doesn't own any cars or **Airbnb** doesn't own any rooms. Moreover, it does *not* only sell a commodity – *electricity* – but it also sells services – in this case *flexibility* to the grid. The company's business model is similar to those covered in the July 2016 issue of this newsletter.

Not surprisingly, Next Kraftwerke faces a lot of pushback from incumbents who are not happy to see a new entrant playing in their sandbox. It is no different than the resistance from taxi drivers or major hotels when Uber or Airbnb start to take customers away. Also regulators were initially skeptical, but after the concept had proved its merits with the German TSOs, the prequalification period shortened for each new European market they entered. The company is now spreading its successful business model beyond Germany (see company profile below right).

Like it or not, however, the variability of renewable resources, notably solar and wind, is a growing challenge to the stability and reliability of the grid. And flexible loads plus flexible generation and storage will increasingly be needed to keep supply and demand in balance.

Next Kraftwerke in a nutshell

- Sales: 184 million euros (2014)
- Volume of Power Trading: 9 TWh
- Units: 3,672
- Networked Capacity: 2,112 MW
- Staff: 121
- Operating Countries: Germany, Austria, Belgium, France, Netherlands, Poland
- Prequalified Tertiary Capacity Reserve: 785 MW
- Prequalified Secondary Capacity Reserve: 648 MW

Source: Next Kraftwerke website

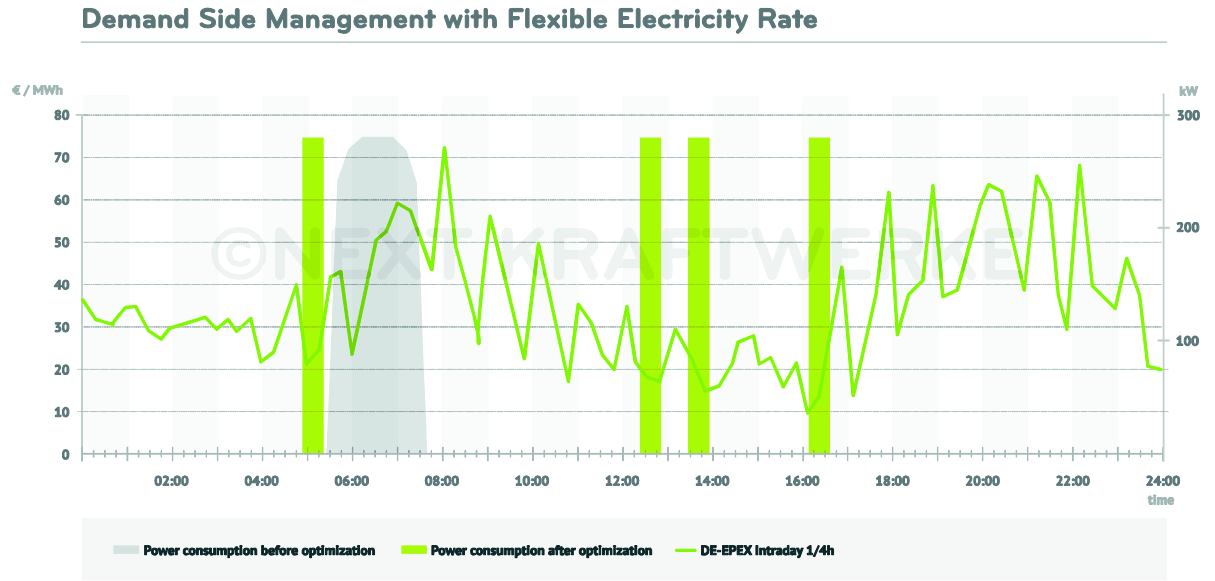
In Germany, renewables already provide more than 35% of electricity generation, a percentage that is rapidly growing as the country phase out its remaining nuclear plants by 2022. California, for example, is marching towards a 50% new renewable target by 2030. With such high levels of variable electricity production, baseload power plants and flat electricity tariffs where power costs the same at all times and all over the network are a thing of the past, or soon will be.

Increasingly, it is recognized that the value of electricity, whether it is consumed or generated, isn't the same at all nodes on the network or at all times. Flexible producers feed power into the grid when the sun doesn't shine and the wind doesn't blow. Flexible consumers, on the other hand, take power out of the grid when the sun and wind flood the system. And that is precisely what companies such as Next Kraftwerke are planning to provide.

Among the valuable services Next Kraftwerke offers its members are the lowest-prices available at any time – allowing them to *take* electricity from the grid when it is cheapest – which happens to be the times when electricity is produced in abundance by solar and/or wind. For members with decentralized

Managing supply and demand, optimizing prices

Graph below illustrates how a consumer with flexible demand can respond to price signals. Example is a pump whose job is to keep a tank filled with water but not to over-spill. It can do the pumping at intervals when power is cheapest. The control system makes sure that there is always enough water in the tank but it does not spill over. Many industrial and commercial loads can be optimized in this way



Source: Next Kraftwerke

generation, the reverse applies, namely they can decide when to inject their excess generation into the grid. It is a classic case of win-win-win, for the aggregator, for the participants and for the grid operator.

Next Kraftwerke claims that *consumers* on average can save up to 30% on their electricity bills if they respond to the price signals. Those with distributed generation can earn even more if they produce electricity in times of scarcity. According to Next Kraftwerke's CEO, **Hendrik Sämisch**,

> "Since many energy markets in the world will be based on wind and solar in the long-run, our flexible electricity rates and the technology behind them could be key elements of future energy markets."

Next Kraftwerke's business model is straightforward. The company monitors the wholesale markets in real time and sends signals to its members through **machine-to-machine** (M2M) communication, asking them to ramp up or down depending on supply and demand conditions. It is an efficient and highly automated form of **demand response** to stabilize the grid.

It may sound complicated, but it is not rocket science. The big question is why more companies aren't doing the same.

Further details may be found at company's website https://www.next-kraftwerke.com/ ■

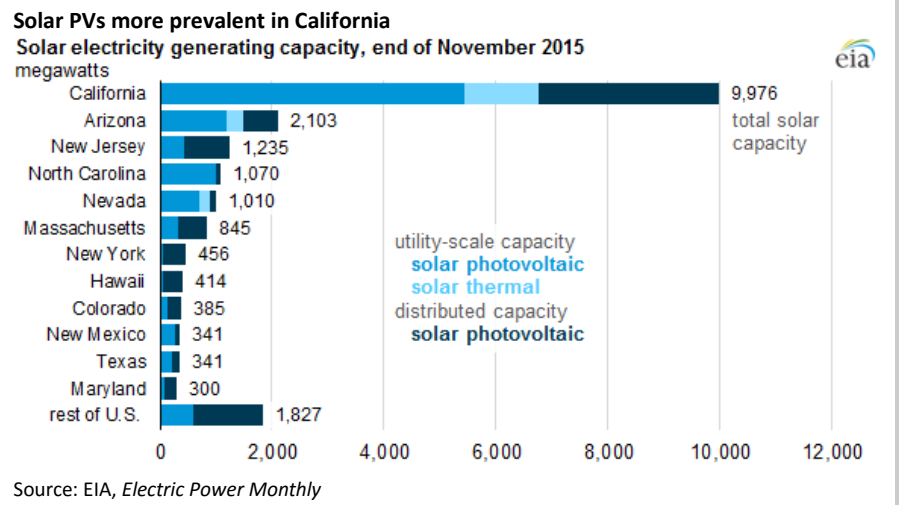
California Utilities Approach NEM Cap

What happens after you reach the cap

In June 2016 **San Diego Gas & Electric Company** (SDG&E), the smallest of California's 3 investor-owned utilities, announced that it has hit its **net metering cap**. SDG&E is the first major utility in California to reach the cap, which was originally set by the regulator, **California Public Utilities Commission** (CPUC) as a milestone to limit **distributed generation** – notably solar PVs – which are eligible for **net energy metering** (NEM) regulation.

The CPUC, not knowing how fast or how much solar PVs would be installed by customers when it initially established NEM in 1996, set the limit at 5% of each utility's **peak demand**. The idea was to review the situation once that milestone is reached.

And the time has obviously arrived. Reportedly, the other two major California utilities, **Southern California Edison Company** (SCE) and **Pacific Gas & Electric Company** (PG&E), aren't far behind SDG&E in reaching their own net metering caps.



As of mid-June, PG&E was about 289 MW away from reaching its 2,409 MW cap. SCE was about 621 MW away from its 2,240 MW cap when it last reported its NEM uptake in April 2016.

The 5% cap applies to each utility's peak demand; the bigger the utility, the bigger the cap. The statewide cap for the 3 IOUs is **5,200 MW** – and at current growth rates, it is expected to be reached in 2016. Other utilities in the state, municipals, cities, cooperative etc., are *not* subject to the same CPUC regulation but have also experienced dramatic uptake of solar PVs due to California's relatively high retail tariffs, ample sunshine and the prevalence of solar leasing options, which allow customers to enjoy lower monthly bills with little or no up-front investment (see typical advert on right).

Like all regulators, CPUC has been under intense pressure from the 3 big IOUs to modify or eliminate the generous NEM regulation, which allows solar customers to export all excess generation, that is *net* of internal consumption, to the grid and receive a credit equal to the prevailing retail tariff.

Since retail tariffs in California are tiered – that is they rise with higher consumption – the incentive to go solar for customers with big roofs and big bills is substantial, which explain the rapid take up. California is host to roughly half of all US solar PV installations, utility-scale as well as decentralized rooftop (graph on page 17).

As previously reported in the March 2016 issue of this newsletter, in January 2016, the CPUC examined the fate of NEM laws past 5% cap, and decided to essentially extend the generous provision with only minimal modifications.

After each IOU reaches the 5% cap, *new* NEM customers will continue to receive **full retail rate credit** for the net energy exported to the grid, but will have to pay a one-time interconnection fee of $75 to $150, a **non-bypassable charge** ranging in the range of $0.02 to 0.03/kWh, and – most important – will be placed on **time-of-use** (TOU) rates.

Coming next: Solar hosting & sharing
Sunshine delivered from host to recipient is only a few clicks away

Source: Yeloha website

The intent of these modifications is to make solar customers pay a minimum amount towards the so-called non-bypassable charges, lessening the cost shifting that affects non-solar customers. The TOU rates are supposed to be more cost-reflective of how much the electricity is worth at different times and seasons of the year but have not been spelled out in detail by each utility yet.

It is a small step in the right direction, but falls short of what will ultimately be needed. As further described in the following article, what California increasingly needs is more flexible generation, flexible loads, and far more storage.

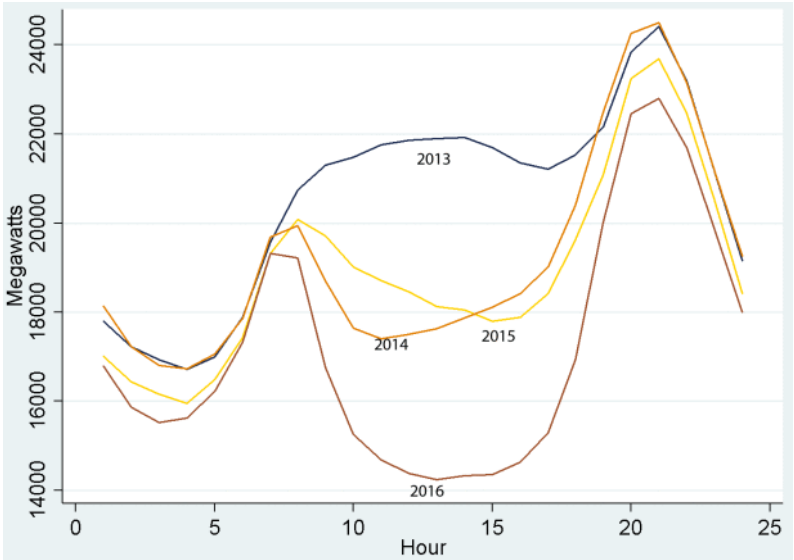
Distributed solar on customers' roofs is a blessing. But like everything else, when you get too much of it at the wrong time, and in the wrong place, it could be a nuisance. ■

What Does CAISO Crave The Most? Flexibility

The traditional baseload, intermediate and peaking paradigm is passé

Last month, this newsletter reported that **California's Duck Curve** has arrived at least 4 years earlier than expected, and with a bulging belly (graph below). And as current trends continue – more utility-scale renewables, more rooftop solar PVs, more energy efficient appliances and buildings, more **zero net energy** buildings and so on – the California duck curve will be more of a challenge for the grid operator, **California Independent System Operator** (CAISO) to manage.

The duck has landed



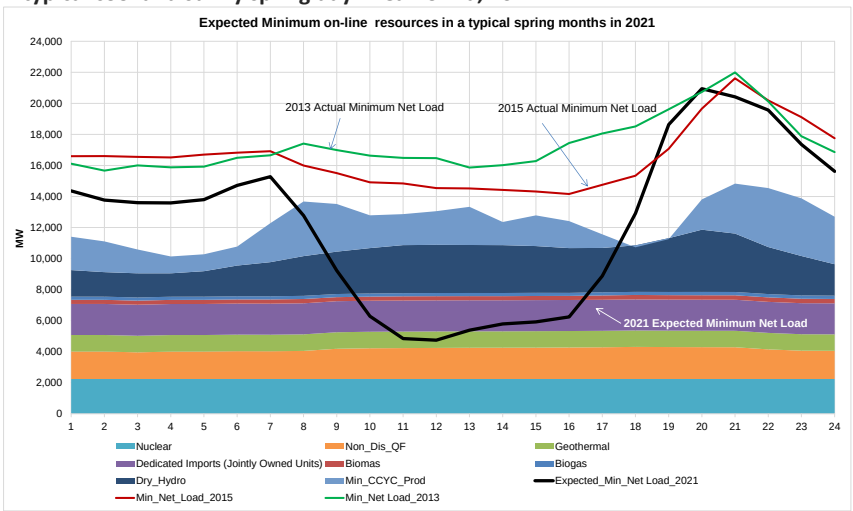
Data taken from CAISO website. Graph summarizes hourly data, 28 March – 3 April, 2013-16
Source: Blog posted by M. Fowlie, 2 May 2016

At an April 2016 CPUC workshop on **resource adequacy**, CAISO presented a graphical representation of the scale of the problem it now routinely faces in managing the so-called **net load** – that is what it must deliver once exogenous generation has been taken into account. Looking at a typical cool and sunny spring day forecasted for 2021 it is not a pretty picture for at least 2 reasons (graph below).

First, of course, is the dramatic drop in **net load** as the sun rises in the morning, followed by an even more dramatic rise in the net load to meet the evening's peak. Nearly all thermal plants with any degree of flexibility must go to minimum generation or completely off in the middle of day, while the very same units will be needed at full blast for the evening's peak. This so-called ramping problem is well-known.

Second, and less appreciated, is the **minimum net load** problem. As the proportion of solar generation continues to grow over time, it increasingly dips into the *forbidden zone*, displacing baseload units that cannot cycle down, so-called **reliability-must run** (RMR) resources that cannot be shut down for reliability, stability or operational reasons, and other resources that operate as if they were RMRs due to contractual reasons.

A typical cool and sunny spring day in California, 2021



With the rapid transition taking place in the power sector (see lead article), baseload units are no longer

needed as they used to. In fact, as the graph above illustrates, *inflexible resources* such as nuclear plants become a nuisance in this context, precisely because they cannot be turned down or curtailed.

This is among the most compelling reasons for shutting down California's last two remaining nuclear reactors (see box on **Diablo Canyon** on page 8). A low-cost, carbon-free resource that is already built, mostly paid for, and which can probably operate safely and reliably for another 20 years or more is being shut down prematurely because of the growing net load problem, among a host of other reasons. At least that is the story one gets from the press releases.

The growing size of the ramping forecast by CAISO is illustrated for next year shows that during a 3-hour window, CAISO needs as much as 14 GW of flexible resources, with Nov-Jan being the worse months, July and August the best. This is mostly explained by California's temperature-driven air conditioning load. With virtually no cooling during the winter months – heating in California is mostly done with natural gas – the minimum load becomes most pronounced.

CAISO projects nearly 6,000 MW of behind-the-meter solar for 2017, a figure that is expected to grow over time. As explained in article on page 17, California is projected to reach its 5% cap later this year, 5,200 MW of rooftop solar.

The distributed solar is not only big and growing, but it is entirely hidden from CAISO or its control. It is not directly measured or monitored. CAISO only sees the effect in terms of diminished net load as the sun rises on any given day.

What can be drawn from CAISO's forecasts and the California duck? Flexible loads, flexible generation, and more storage are good. Inflexible thermal plants, nuclear or otherwise, will become less desirable, and eventually doomed as they turn into worse than worthless over time.

As described in article on page 15, the increased need for flexibility is already driving startups and entrepreneurs to develop business models that can deliver the sorts of flexibility that will increasing be needed in the years to some, and not just in California or **Germany**, but virtually all over the world. ■

Want Half As Much Carbon By 2030? No Problem

Low carbon future feasible and apparently not that dear

In 2006, long before the **December 2015 Paris Accord**, California passed a law mandating state-wide emissions to be reduced to 1990 level by 2020, followed by an **executive order** with a target to further reduce them to 80% below 1990 level by 2050. The **California Air Resources Board** (CARB) is in charge of implementing this aggressive target, with or without any other state, the US as nation or anyone else doing so. The aim, of course, is to demonstrate that it can be done, and without ruining the state's flourishing economy, the 6th largest globally.

Reaching the 2020 target, while difficult, is a picnic compared to what must take place *after* 2020 to get to the 2050 reduction levels. The **low carbon grid study** (LCGS), a collaborative effort funded by a large number of stakeholders, examined the needed trajectory to achieve the 2050 target by asking what it would take to cut California's grid-related emissions in half by 2030 – roughly the mid-way point.

The collaborative study, which was modeled by the **National Renewable Energy Laboratory** (NREL), **GE Consulting** and others, concludes that (emphasis added):

> "California's electric sector can cut its carbon footprint in half by 2030. Using conservative

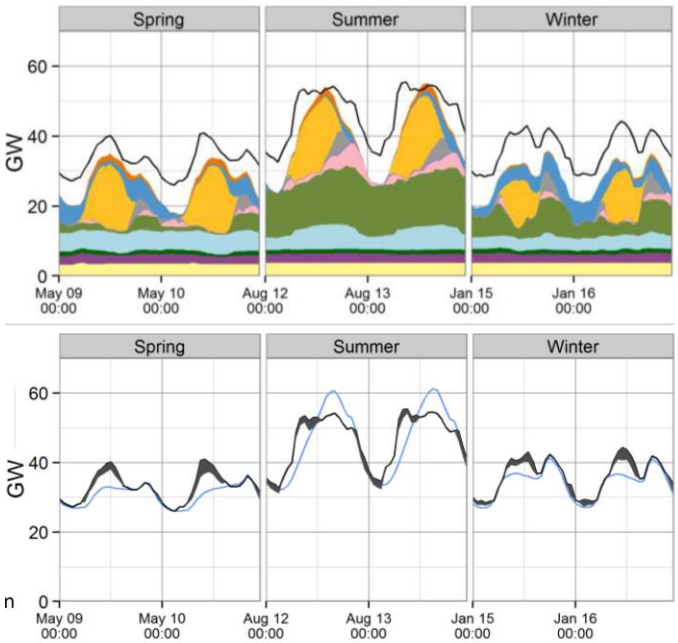
assumptions and proven technology, the study identifies the grid's ability to achieve these reductions *with minimal rate impact*, *minimal curtailment of renewable energy*, and *without compromising reliability*."

If you believe the numbers, what is there not to like? It is like being able to eat all the fries, beer and cheesecake with whipped cream on top every day without gaining any weight.

The LCGS analyzed California's grid with the carbon reduction target as the main driver. It included flexible loads, regional cooperation extending beyond California's borders, efficient use of natural gas, and a diverse and growing renewable portfolio over time.

Using such a portfolio of options, the study concluded that California's electric sector can indeed reduce its GHG emissions by more than 50% below 2012 levels by 2030.

Half as much carbon by 2030? No problem



Source: Low carbon grid study, Feb 2016

That should come as no surprise. If you can land a man on the moon with 1960's clunky technology, you certainly should be able to cut California's electricity sector emissions in half.

What, however, *is* surprising is that LCGS concludes that such a feat can be achieved

- With minimal rate impact on electricity consumers;
- Without compromising the grid's reliability;
- With minimal curtailment of renewable energy; and
- With a fleet of flexible gas plants that can be dispatched with minimum amount of cycling.

And that is the good news even if you don't believe the complicated modeling that produced the results. ■

Renewables: You Ain't Seen Nothing Yet

Mass production and technology innovation will further reduce costs

Everyone knows that the cost of wind generated energy and solar PV panels have dropped significantly over the past decade or two. The question is how much more can they drop, especially now that they are being deployed on massive scale across the globe?

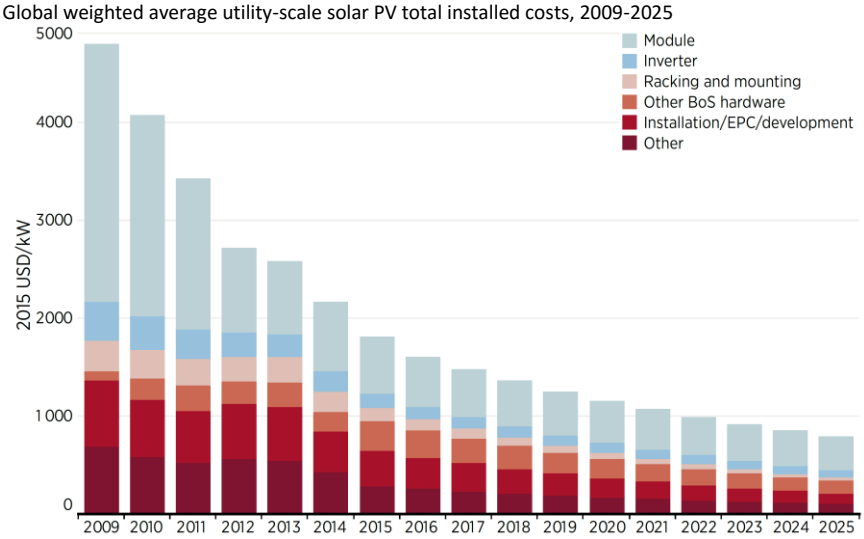
According to ***The Power to Change: Solar and Wind Cost Reduction Potential to 2025***, a report released by **International Renewable Energy Agency** (IRENA), the global weighted average cost of electricity could fall by 26% from **onshore wind**, 35% from **offshore wind**, 37% from **concentrating solar power** (CSP) technologies, and 59% from **solar photovoltaics** (PVs) by 2025 relative to 2015 prices. IRENA says,

"Increasing economies of scale, more competitive supply chains and further technological improvements will continue reducing the costs of solar and wind power. The same factors will also boost the availability of these key renewable power sources at night and in varying weather conditions."

"By 2025, the global average cost of electricity from solar PV and onshore wind will be roughly 5 to 6 US cents/kWh" (table below).

Lot more costs to cut

Global weighted average utility-scale solar PV total installed costs, 2009-2025



Source: The Power to Change: Solar and Wind Cost Reduction Potential to 2025, IRENA

IRENA believes that solar alone can supply 13% of global power mix by 2030 thanks to capacity expansion, from the current 227 GW to 1,760-2,500 GW. That is a mere 14 years away, dismissing claims by those who say the energy transition will take a very long time.

It says average annual solar PV capacity additions could more than double in the next 14 years. In 2015, solar PV accounted for 20% of total *new* capacity additions and solar installations have soared from 40 GW to 227 GW in the last 5 years alone.

Industry trade groups expect solar PV installations to exceed 60 GW worldwide in 2016 with grid-connected capacity to reach 516 GW by the end of 2019 and 716 GW by 2020. China could install 87 GW of new solar capacity by 2020 to reach 130 GW dwarfing those of the US, +59-85 GW, India, +52-57 GW, and Japan +29-63 GW.

As a case in point, the **Australian Energy Market Operator** (AEMO) projects that rooftop solar PVs in the **National Electricity Market** (NEM), which covers the populous East Coast of the Australian continent, will reach 17 GW by 2030.

Renewable costs coming down even more

Global weighted average solar and wind power investment costs, capacity factors and LCOEs, 2015 and 2025

	Global weighted average data								
	Investment costs (2015 USD/kW)		Percent change	Capacity factor		Percent change[2]	LCOE (2015 USD/kWh)		Percent change
	2015	2025		2015	2025		2015	2025	
Solar PV	1 810	790	-57%	18%	19%	8%	0.13	0.06	-59%
CSP (PTC: parabolic trough collector)	5 550	3 700	-33%	41%	45%	8.4%	0.15 -0.19	0.09 -0.12	-37%
CSP (ST: solar tower)	5 700	3 600	-37%	46%	49%	7.6%	0.15 -0.19	0.08 -0.11	-43%
Onshore wind	1 560	1 370	-12%	27%	30%	11%	0.07	0.05	-26%
Offshore wind	4 650	3 950	-15%	43%	45%	4%	0.18	0.12	-35%

Source: The Power to Change: Solar and Wind Cost Reduction Potential to 2025, IRENA

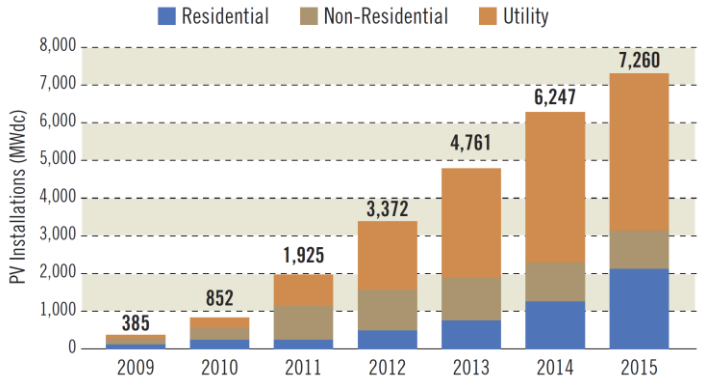
At prices projected by IRENA, why would anyone be interested in fossil or nuclear generated power – except as back-up to renewable generation?

Commenting on the report, IRENA's flamboyant Director-General **Adnan Amin** said,

"We have already seen dramatic cost decreases in solar and wind in recent years and this report shows that prices will continue to drop, thanks to different technology and market drivers," adding, "Given that solar and wind are already the cheapest source of new generation capacity in many markets around the world, this further cost reduction will broaden that trend and strengthen the compelling business case to switch from fossil fuels to renewables."

More solar PVs to come

U.S. Solar Photovoltaic (PV) installations – 2009-2015



Source: Benchmarking Utility Clean Energy Deployment: 2016, Ceres, June 2016

Since 2009, prices for solar PV modules and wind turbines have fallen roughly 80% and 30-40%, respectively. With every doubling of cumulative installed capacity, solar PV module prices drop 20% and the cost of electricity from wind farms drops 12%, due to economies of scale and technology improvements.

Projected cost reductions to 2025 will depend increasingly on **balance of system (BOS) costs** including inverters, racking and mounting systems and installation costs. Consequently, IRENA advises policy makers to focus in reducing these costs.

Ceres, in a report released in June 2016 titled ***Benchmarking Utility Clean Energy Deployment: 2016*** provides how the global transition toward renewable energy is playing out in the US electric power sector (graphs above and on right).

It illustrates that some utilities, notably the 3 investor-owned utilities in California, are leading the nation in going green in a hurry. Four companies – **Sempra Energy, Pacific Gas & Electric (PG&E), Edison International** and **Xcel Energy** – account for more than half of all renewable energy sales in the US. But as time goes on, more utilities are expected to follow. ■

Renewable heavy US utilities

Renewable Energy Sales as a Percentage of Retail Sales (2014)

Holding Company	Rank	Percentage	Mean: [10.31%]	MWh	Mean: [4,902,738]
Sempra Energy	1	36.45%		6,002,000	
PG&E	2	25.90%		19,456,767	
Edison International	3	23.15%		17,558,000	
Xcel Energy	4	20.63%		18,495,000	
PSEG	5	13.28%		2,599,898	
National Grid	6	13.19%		3,881,856	
Eversource Energy	7	13.08%		3,058,302	
Berkshire Hathaway	8	12.99%		14,114,750	
OGE Energy	9	11.59%		3,129,474	
Exelon	10	11.49%		4,793,000	
Ameren	11	11.22%		5,179,826	
FirstEnergy	12	10.31%		5,810,517	
Puget Sound Energy	13	10.29%		2,116,470	
Pinnacle West	14	10.22%		2,819,880	
Alliant Energy	15	10.11%		2,642,000	
Pepco Holdings	16	9.79%		1,888,311	
CMS Energy	17	9.36%		3,114,000	
We Energies	18	9.03%		2,194,000	
DTE Energy	19	8.74%		3,662,195	
Portland General Electric	20	8.46%		1,489,000	
American Electric Power	21	6.00%		6,738,000	
AES Corporation	22	3.82%		688,722	
Duke	23	2.79%		5,477,000	
Dominion Resources	24	2.18%		1,741,787	
Entergy	25	2.06%		2,285,411	
SCANA	26	1.81%		404,525	
PPL Corp	27	1.02%		413,000	
ConEdison	28	0.94%		208,714	
FPL	29	0.17%		177,000	
Southern Company	No Data				

Mean: 10.31%

Source: Benchmarking Utility Clean Energy Deployment: 2016, Ceres, June 2016

IRENA

Ceres - June 2016

Unconventional Risks Of Conventional Oil

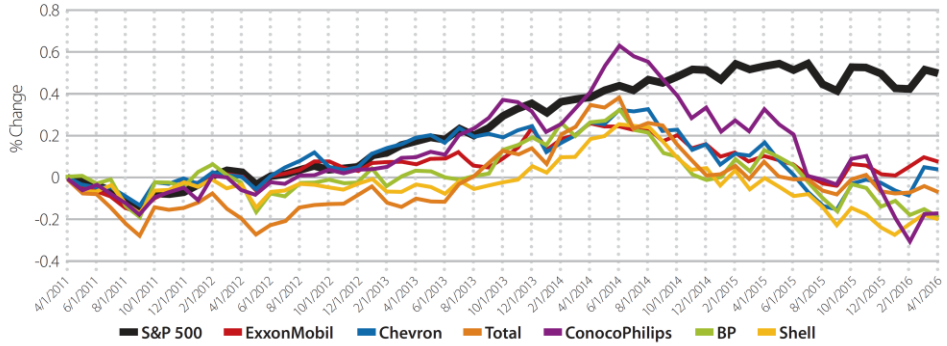
Arguments against big investments for oil gain momentum

The **December 2015 Paris agreement, COP21**, is likely to be remembered as a major milestone in the annals of fossil fuel industry. As **Patrick Pouyanne**, the CEO of **Total** has eloquently observed, "COP21 was definitely a watershed. There will be a 'before' and 'after' COP21." Total has certainly picked up the message; not so with many of its peers.

For those that have not noticed, the "after COP21" message for oil majors – in fact all fossil fuel industry – may be found in a report titled **Unconventional Risks: The growing uncertainty of oil investments**, released in mid-July by **As you sow**, an environmental advocacy organization. It portrays a sobering message for longer-term prospects of oil.

How likely will be an oil turnaround?

Stock Performance (Adjusted Closing Price) of Oil Majors vs. S&P 500: April 2011 to April 2016



Source: Unconventional Risks: The growing uncertainty of oil investments, As you sow, 13 Jul 2016

To begin with, it points out that big oil has not had a grand time since the recent collapse of oil prices (graph above). That much we already know. The report goes on to argue that the future is likely to be even more grim, even if oil prices recover modestly, as they have done in recent weeks.

Looking at the big names in terms of market capitalization, it is clear that great fortunes will increasingly be found in greener pastures, in other industries or business sectors, not oil as illustrated in table below. Oil majors, once dominating S&P's top 10 list of the most valuable companies as recently as 1980 are absent from the list in 2016 with the sole exception of **ExxonMobil**. One reason ExxonMobil is still on the list is that it is actually the combination of two large oil majors, **Exxon** and **Mobile**, both of which were on the list as separate companies in 1980.

Like the big railroad companies of yesteryears, big oil will not be so big in the future as information technology and other businesses grow in dominance. Apple, Microsoft, Facebook or Amazon are all relative newcomers to the list.

Only one oil major remains among the top 10

Top Ten Companies of S&P 500 1980-2016

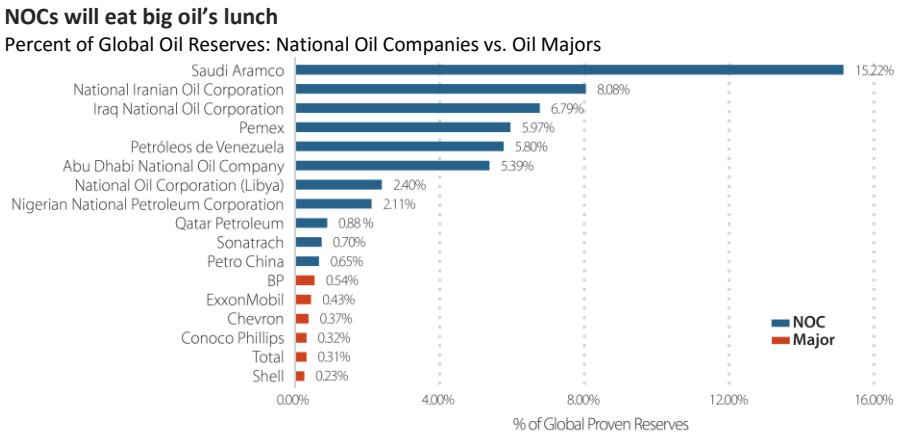
1980	1985	1990	2000	2005	2010	2016
IBM	IBM	IBM	General Electric	General Electric	ExxonMobil	Apple
AT&T	Exxon	Exxon	ExxonMobil	ExxonMobil	Apple	Microsoft
Exxon	General Electric	General Electric	Pfizer	Microsoft	Microsoft	ExxonMobil
Standard Indiana	AT&T	Phillip Morris	Citigroup	Citigroup	Berkshire Hathaway	Johnson & Johnson
Schlumberger	General Motors	Royal Dutch Petroleum	Cisco Systems	Proctor and Gamble	General Electric	General Electric
Shell Oil	Royal Dutch Petroleum	Bristol Myers Squibb	Walmart	Walmart	Walmart	Berkshire Hathaway
Mobile	duPont	Merck	Microsoft	Bank of America	Google	Facebook
Standard California	Amoco	Walmart	AIG	Johnson & Johnson	Chevron	Amazon
Atlantic Richfield	Bell South	AT&T	Merck	AIG	IBM	AT&T
General Electric	Sears and Roebuck	Coca-Cola	Intel	Pfizer	Proctor and Gamble	JPMorgan

Source: Unconventional Risks: The growing uncertainty of oil investments, As you sow, 13 Jul 2016

Making matters worse, as time goes on, the report argues oil majors will face increased competition from

national oil companies or NOCs (graph below), who have far more reserves, mostly conventional, and at much lower production cost. Expensive to exploit *unconventional oil* will become riskier and decidedly less profitable, hence the title of the report.

As the rate of demand growth for oil decreases, as it is widely expected, these big boys – the NOCs – will increasingly eat the oil majors' lunch, so to speak.



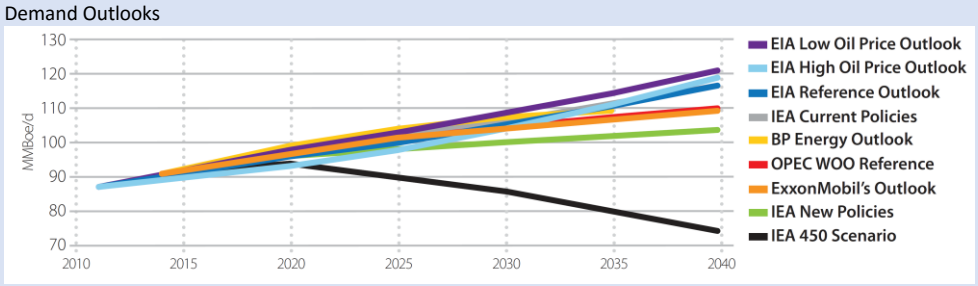
Source: Unconventional Risks: The growing uncertainty of oil investments, As you sow, 13 Jul 2016

According to **As you sow**, there are a myriad of other reasons compounding to make life gradually more miserable, unprofitable, and eventually risky for the listed oil companies.

With COP21, carbon liability is likely to be added to the woes of the industry, and NOCs are not spared from this either. To meet the required targets of the Paris accord, oil consumption – all fossil fuel consumption and CO2 emissions – must be curtailed as suggested by IEA's 450 scenario (black line on lower end of projections below).

But what will substitute for fossil fuels – executives of major oil companies frequently ask? More energy efficiency and more renewables, what else?

As the article on page 21 suggests, renewables will become less expensive and prevalent over time, increasingly competing with fossil fuels. This may be accelerated by passage of a **carbon tax** and/or withdrawal of all remaining **subsidies for fossil fuels**, still in place around the world.



Source: Unconventional Risks: The growing uncertainty of oil investments, As you sow, 13 Jul 2016

The fuel that will feel the heat first, of course, is **coal**. It's decline in the US has been pronounced in the last few years (Fig on page 4) – a fate awaiting other advanced economies, and then the developing ones.

Oil demand, already down from historical growth rates, may be next (Fig on page 2).

The report's bottom line? Don't say we did not warn you. In its conclusions, **As you sow** says, in part,

> "This paper does not argue that any future is foretold for oil majors or the larger community of independent oil producers — only that acknowledging signs of change and planning appropriate

action is imperative. Oil majors have options to respond to coming changes if they begin to act now; however, there is tremendous opportunity cost in delaying responsive action."

While you may not agree with the conclusions drawn, few would disagree with the basic facts.

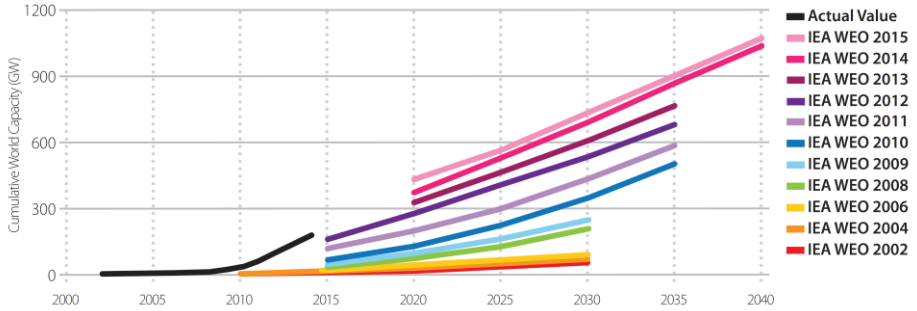
The report offers a number of interesting insights and quotable quotes. The most memorable, no doubt, is the famous one attributed to **Sheik Ahmad Zaki Yamani**, the former Saudi Oil Minister, who prophetically said,

> "Thirty years from now there will be a huge amount of oil – and no buyers. Oil will be left in the ground. The Stone Age came to an end, not because we had a lack of stones, and the oil age will come to an end not because we have a lack of oil."

The age of fossil fuels is being stunned not because we are running out of coal, oil or gas, or because they are too expensive but because we simply cannot afford to get more of the stuff out of the ground to burn without pause for the consequences.

Revised annually upward yet still short of target

IEA Global Solar Capacity Projections Over Time



Source: Unconventional Risks: The growing uncertainty of oil investments, As you sow, 13 Jul 2016

Some oil majors, **Total** among them, are beginning to think about a Plan B, while others stick to the grindstone, exploring, digging, refining, and pumping oil as if nothing has changed. ■

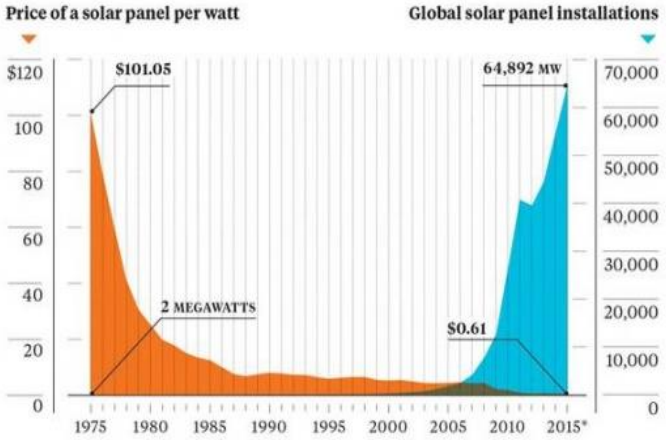
If You Can't Beat Them, Join Them – In A Hurry

Utilities are recognizing that the world is moving faster than they can blink

Utilities in the US and elsewhere are learning that they'd better join their competitors before it is too late. In mid-July 2016, **Pacific Gas and Electric Company** (PG&E), California's biggest and one of the biggest in the US, announced that it was launching a multiple of technology demonstration projects in its service area to, among other things, demonstrate the integration of **distributed energy resources** (DERs), such as **solar PVs**, and **battery storage**. If it sounds similar to what **Elon Musk** intends to do (article on page 12), welcome to the party.

Future different than the past

With falling prices, solar panels are increasingly cost-competitive on global scale



© Earth Policy Institute/Bloomberg

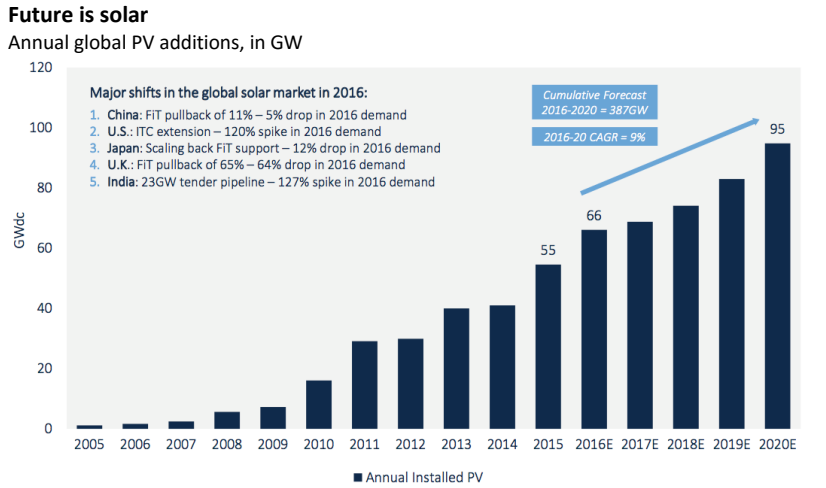
PG&E said it was teaming with **GE** to demonstrate a **distributed energy resource**

management system (DERMS), with **Enphase Energy** to test **smart inverters**, and with **SolarCity**, its nemesis, to test distributed solar PVs, smart inverters and battery storage systems.

It said the demonstrations will evaluate to what extent the DERMS technology enhances the stability and power quality of the grid and optimizes solar generation and power-flow management, as more customers adopt solar.

In making the announcement, **Geisha Williams**, president, PG&E Electric, said,

> "The rapid growth of distributed energy resources has ushered in a new era of electric distribution, and we're seeing the smarter grid emerging as a reliability, storage and interconnection system that compliments the new energy technologies that our customers are using in their homes. As this dynamic, two-way operating environment develops, PG&E continues to embrace and test innovative technologies that improve electric reliability and equip our customers with valuable services and products that support their choices to adopt clean energy."



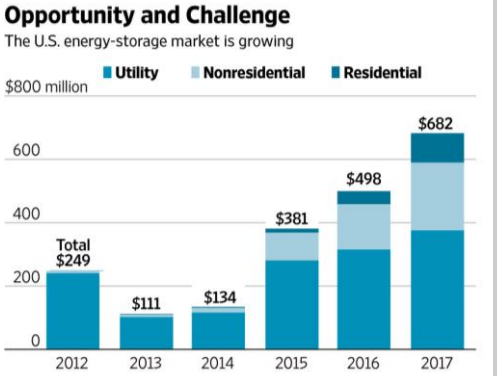
Source: Global Solar Demand Monitor: Q2 2016, GTM Research, May 2016

You might say it was only a matter of time. PG&E has more distributed solar than any other utility in the US, currently around 250,000 with 6,000 new ones each month – that is one every 7 minutes.

Likewise, one in 5 **electric vehicles** (EVs) in the US is registered in PG&E's service area – more than 200,000 in California and over 85,000 in PG&E's service area.

EVs make perfect sense for PG&E and California since nearly 60% of PG&E's energy emits no **greenhouse gases**, a percentage that is expected to grow to approximately 65%.

As far as storage, time has arrived to embrace the technology. According to a recently released report by **Navigant Research**, the global annual deployments of **residential energy storage systems** (RESSs), such as solar-plus-storage, are expected to grow more than 3,800% in 10 years – a hard to digest number albeit from a miniscule base today. And guess what, most of that will be in places such as California.



Source: The Wall Street Journal, 22 Feb 2016 based on GTM Research data

Initially, a handful of countries including the US, Australia, Germany and Japan are expected to account for more than 80% of the global market for RESS.

According to Navigant's **Alex Eller**,

> "While the economics of RESSs to save customers money only pencil out in certain markets, the involvement of utilities in this space opens

significant new opportunities for market growth."

PG&E's announcement and the Navigant report nearly coincided with Tesla's proposal to offer customers an end-to-end energy production, distribution and storage solution.

Utilities are increasingly recognizing that the world around them is moving faster than they can think, or even blink■

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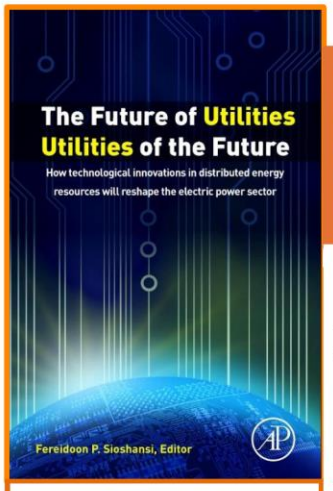

Future of Utilities - Utilities of the Future

How technological innovations in distributed generation will reshape the electric power sector

Edited by: ***Fereidoon P. Sioshansi,*** President, Menlo Energy Economics, San Francisco, CA, USA

Rapid technological advancements plus falling costs of **distributed energy resources** (DERs) – which includes **energy efficiency** improvements plus **distributed generation** – is turning an increasing number of **consumers** into ***prosumers***, eroding utility revenues and threatening the historical business model.

Equally important are rapid advances in **energy storage**, **electric vehicles**, **micro-grids**, **intelligent home energy management**, **demand aggregation**, and **demand response**, all pointing to a different future with a different role for the incumbents.

Future of utilities: Utilities of the future, which includes contributions from experts with different perspectives from different parts of the globe, examines the implications of these developments on the electric power sector.

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PAGES: c. 466

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