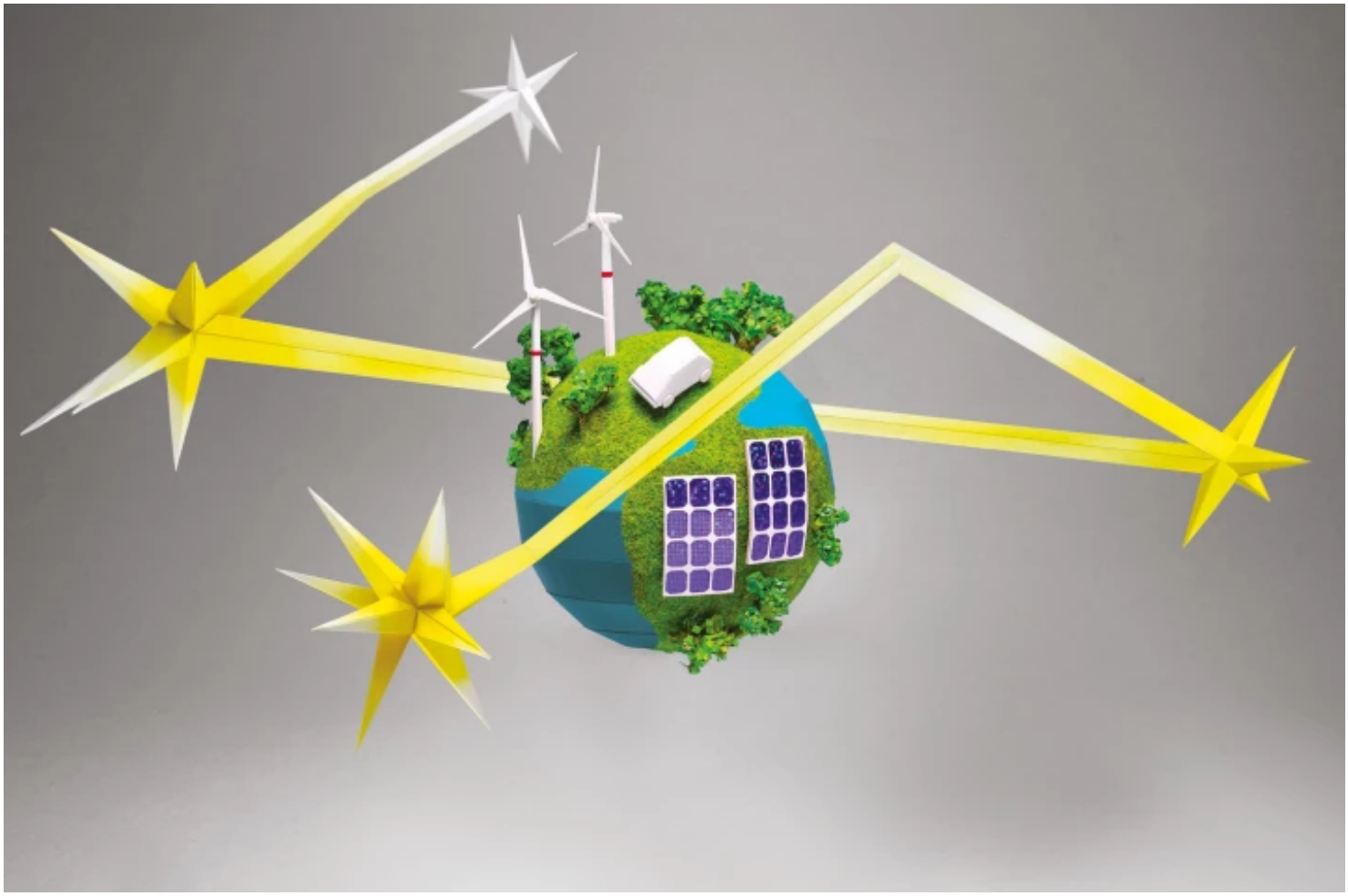
The Big Read **Renewable Energy**

The Big Green Bang: how renewable energy became unstoppable

The shift to cleaner power is disrupting entire industries. Will the 21st century be the last one for fossil fuels?



MAY 18, 2017 by: **Pilita Clark**

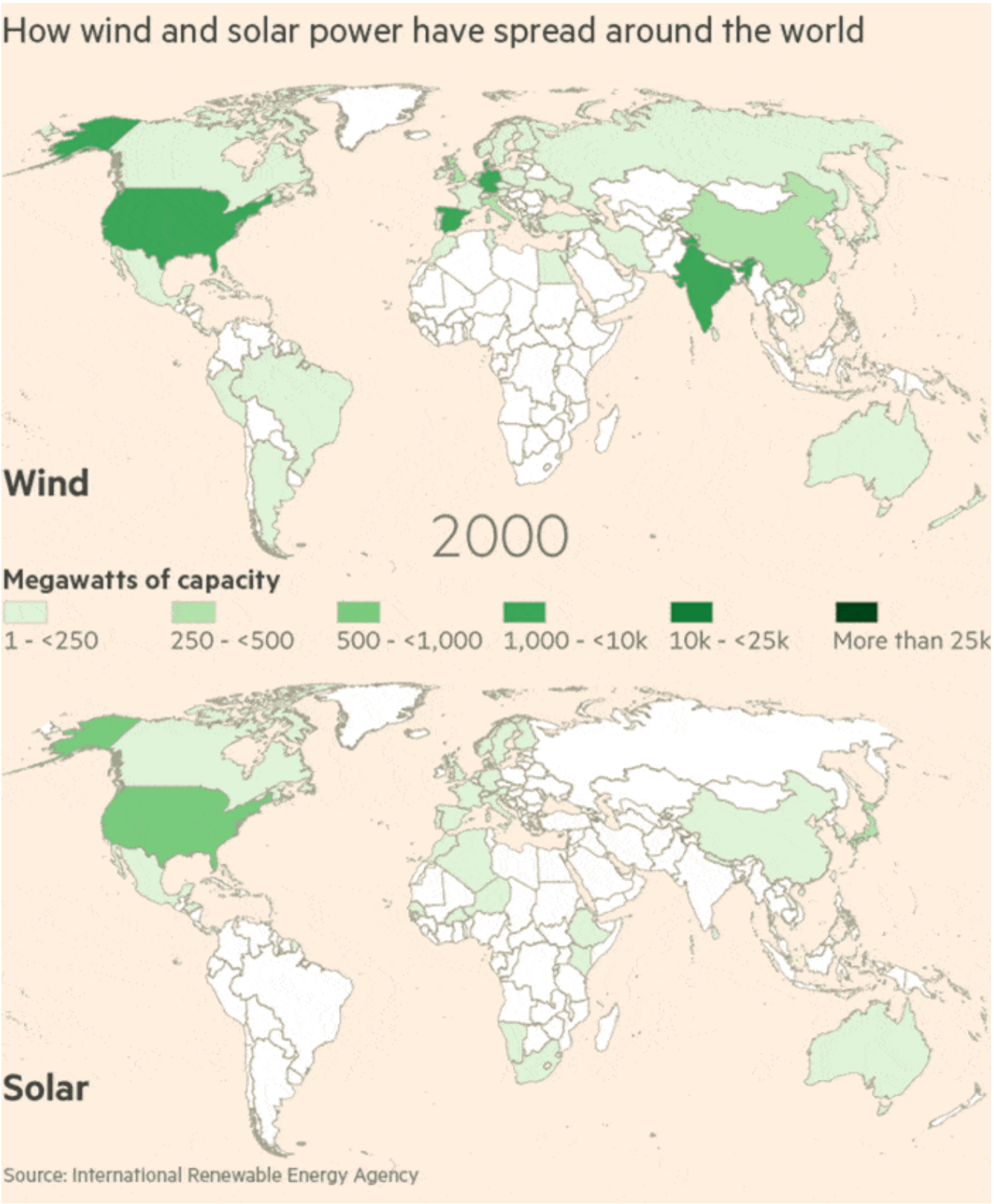
At the start of this year, a British businessman named Adam Robson received some awful news. Mr Robson runs an English company called Torotrak that invents fuel-saving contraptions aimed at solving one of the auto industry's great dilemmas: how to make a petrol car that is green enough to meet tightening pollution rules but does not feel like a lawnmower to drive.

One of Torotrak's most promising gadgets has long been the V-Charge, a smarter version of a turbocharger that took six years to develop. In the middle of last year, Mr Robson began pitching it to the world's top auto component and carmakers, including General Motors, Volkswagen and Toyota.

About a dozen said they were interested. But by January, things changed. Company after company turned him down. Suddenly, none wanted new products for cars running on fossil fuels.

"They all said, 'We think the shift to electric vehicles is accelerating and we have only limited R&D money to invest and we are going to put all of it into the electric car revolution'," Mr Robson says. "This is a colossal structural shift and it's come at a pace that has never occurred in people's careers before in this industry."

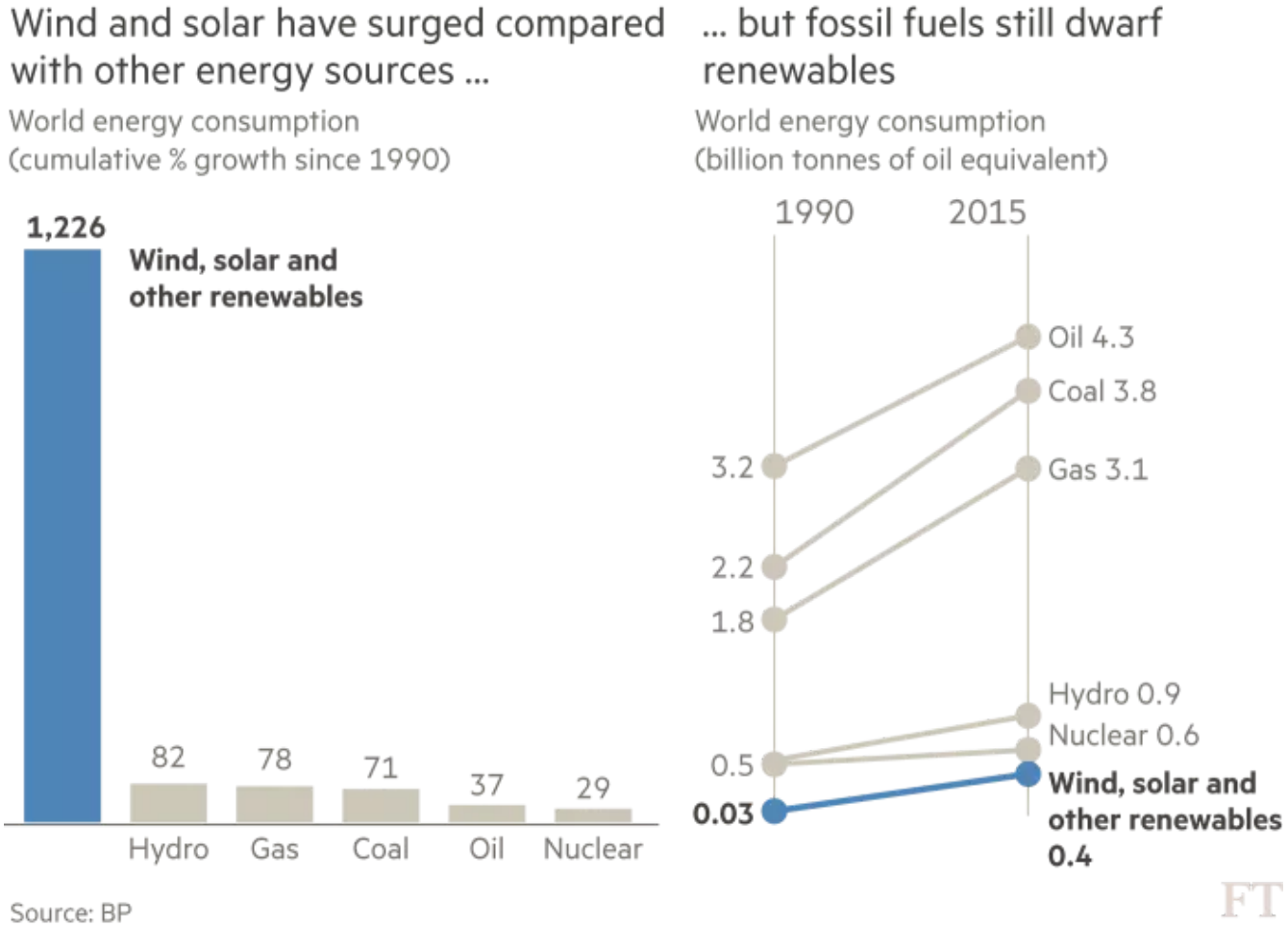
Torotrak was hit hard. Its shares plunged 40 per cent. It has shut down one of its main engineering sites, making about 40 staff redundant, and put the V-Charge on ice. It is now focusing on heavy-duty diggers and other gear it hopes will not go electric any time soon.



Mr Robson's experience is just one example of the disruptive impact of green energy on companies — and entire industries — around the world. After years of hype and false starts, the shift to clean power has begun to accelerate at a pace that has taken the most experienced experts by surprise. Even leaders in the oil and gas sector have been forced to confront an existential question: will the 21st century be the last one for fossil fuels?

It is early, but the evidence is mounting. Wind and solar parks are being built at unprecedented rates, threatening the business models of established power companies. Electric cars that were hard to even buy eight years ago are selling at an exponential rate, in the process driving down the price of batteries that hold the key to unleashing new levels of green growth.

“This clean energy disruption has just started and what is striking is how much of a financial impact it is already having on some companies,” says Per Lekander, a portfolio manager at London’s Lansdowne Partners hedge fund, who has tracked global energy markets for more than 25 years.



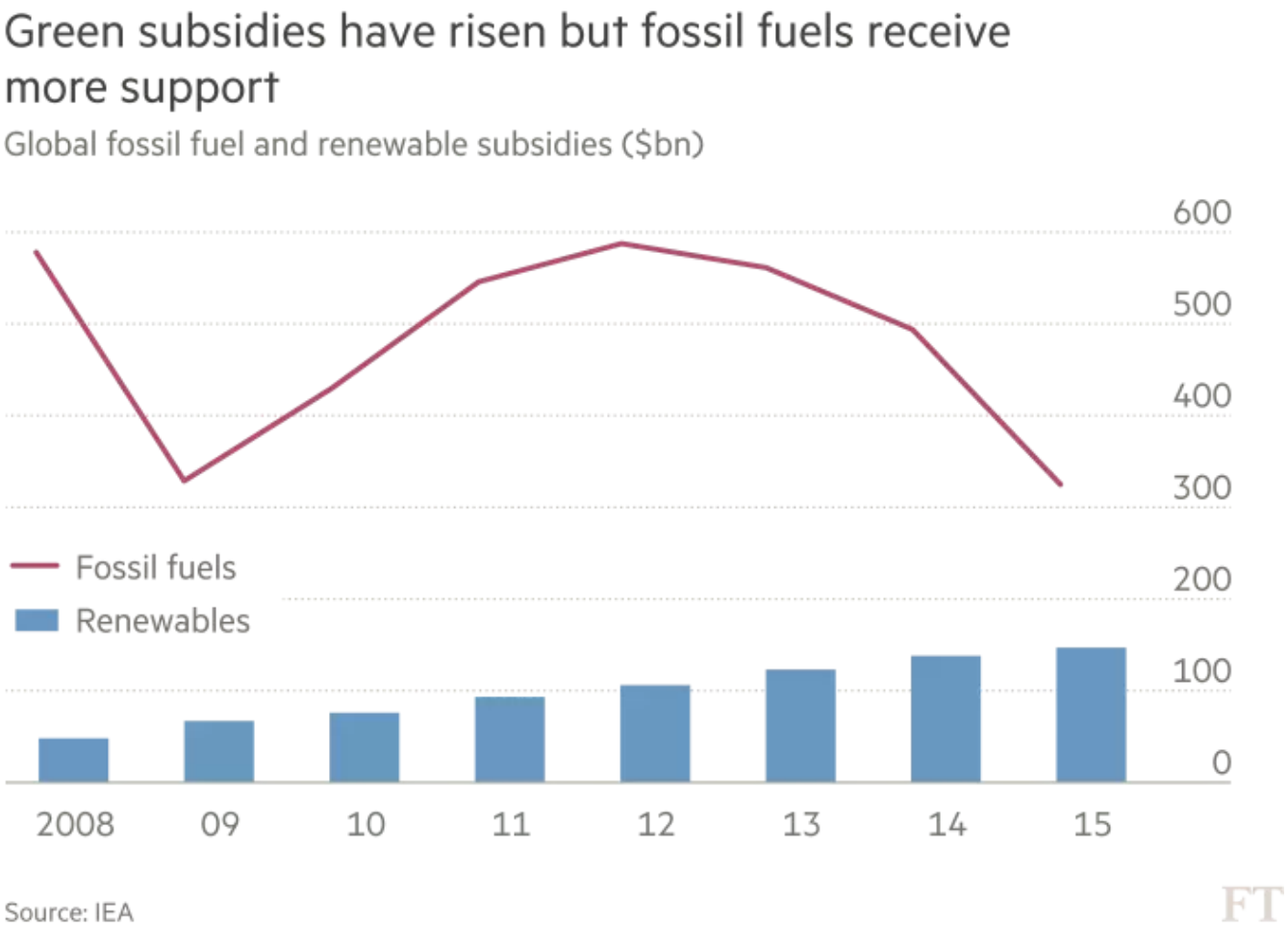
“It hit the electricity sector first, in Europe in 2013 and then the US two years later. Now it has spread to the auto sector and I think the oil industry is next.”

The shift has come as increased government efforts to curb climate change and smog have driven down costs and spurred technical advances, creating a green energy industry that looks nothing like it did a decade ago: expensive, sluggish and German.

Today, China and India have picked up the baton and are driving a sector that has spread to every continent. The result was a banner year for green energy in 2016.

Global renewable power generation capacity rose by 9 per cent last year — a fourfold increase from the start of this century — buoyed by the growth of newer sources such as solar power that shot up by more than 30 per cent. For the second year in a row, renewable energy accounted for more than half the new power generation capacity added worldwide. Sales of plug-in electric vehicles last year were 42 per cent higher than in 2015, growing eight times faster than the overall market. The storage capacity of big lithium ion battery systems more than doubled last year.

These advances have become too significant for the oil and gas industry to ignore. In the first three months of this year, the heads of some of the world’s largest oil companies have spoken of a “global transformation” (Saudi Aramco) that is “unstoppable” (Royal Dutch Shell) and “reshaping the energy industry” (Statoil). Isabelle Kocher, chief executive of French power and gas group Engie, calls it a new “industrial revolution” that will “bring about a profound change in the way we behave”.



None of this means the problem of climate change has been solved, or that fossil fuels will vanish in the near future. Oil, gas and coal still account for about 86 per cent of the energy keeping the world's lights on, cars running and homes warm — a share that has barely changed in 25 years. Coal and gas-fired power plants are still being built, especially in the developing world where 1.2bn people lack electricity.

Modern renewables, in contrast, are growing from a tiny base and are often less dependable than dirtier power generators that do not rely on the weather. Wind and solar power accounted for a puny 4.4 per cent of global electricity in 2015, and big battery systems can only store enough power to satisfy a few seconds of global electricity demand, says the International Energy Agency. Electric vehicle sales last year were just 0.9 per cent of all vehicles sold, according to the EV-Volumes consultancy.

But the emerging energy transition is already causing trouble for companies around the world, from writedowns and shrinking sales to sliding share prices and wholesale break-ups:

● In sunny Nevada, casino companies are unplugging from the state utility. NV Energy lost nearly 6 per cent of its customer base virtually overnight in October after MGM Resorts International and Wynn Resorts agreed to pay a combined $103m to defect and buy their power elsewhere. MGM cited "the sharp decline in the cost of renewable energy" as a primary driver of its decision. Caesars later did a $47.5m deal to quit.

● In Chile, shares in some of the country's electricity companies, including AES Gener and Colbún, slid in August after they lost out in an auction that pitted renewables against fossil fuel generators for 20-year power contracts. Among the winners was a solar scheme that undercut fossil fuel bids with a record low price of $29.10 per megawatt hour.

● In Australia, a $200bn investment splurge in liquefied natural gas projects has put the country in position to overtake Qatar as the world's largest LNG exporter. But new schemes have come online as LNG prices have collapsed amid fears of a supply glut that some economists say could linger as renewables become more affordable. "It just makes sense for countries to think about renewables as an alternative," says Jürgen Weiss of the Brattle Group consultancy.

● In Michigan, car parts supplier BorgWarner, which makes most of its money selling components for conventional combustion engine vehicles, made one of the largest acquisitions in its 89-year history in 2015, when it paid $950m in cash for US electric motor maker Remy International. BorgWarner's shares subsequently dived but analysts say the industry's shift to electric cars means the deal made sense. "Without Remy, the narrative of their long-term value would have been difficult to justify," says Adam Jonas, head of global auto research for Morgan Stanley.

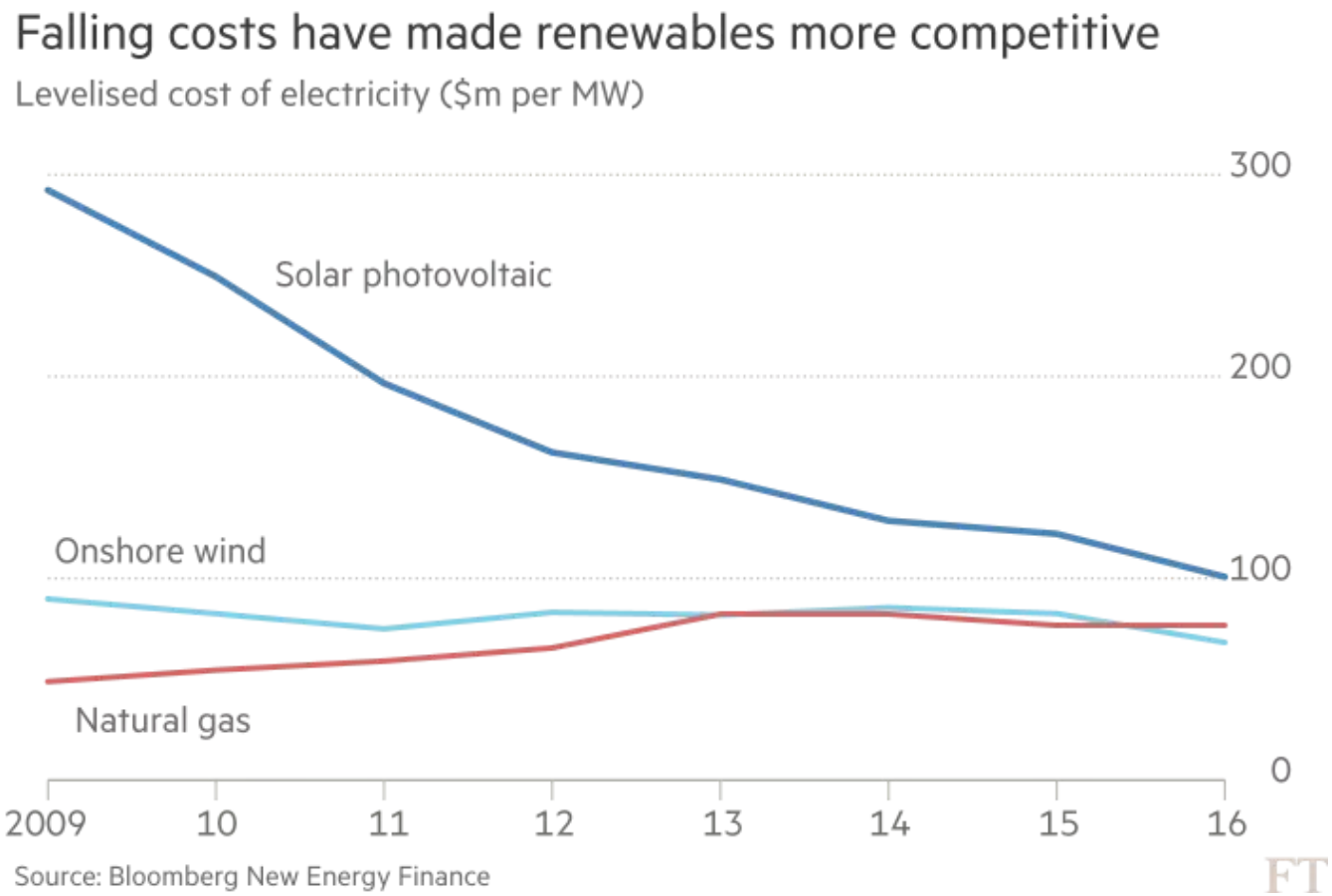
Isabelle Kocher, chief executive of French energy group Engie: "[This is] an industrial revolution [that will] bring about a profound change in the way we behave" © Leo Novel/FT

Thanks, Germany

When the definitive history of the energy transition is written, the taxpayers of Germany will deserve their own chapter. They bankrolled the green energy revolution known as the *Energiewende*, pioneering generous subsidies nearly 20 years ago that helped drive renewables up from 9 per cent of Germany's electricity mix in 2004 to 32 per cent last year.

As other European nations — and some US states — boarded the green power wagon, it kindled a wave of demand for wind turbines and solar panels that helped drive costs down worldwide. Solar's price fall was especially steep after a Chinese manufacturing boom spurred global over-supply.

The result was doubly miserable for conventional fossil fuel generating companies: renewables crowded them out while simultaneously driving down wholesale power prices, causing billions of euros in losses.



Germany's two largest power utilities, Eon and RWE, shook the industry last year when they split themselves in two, hiving off struggling fossil fuel operations from cleaner power businesses.

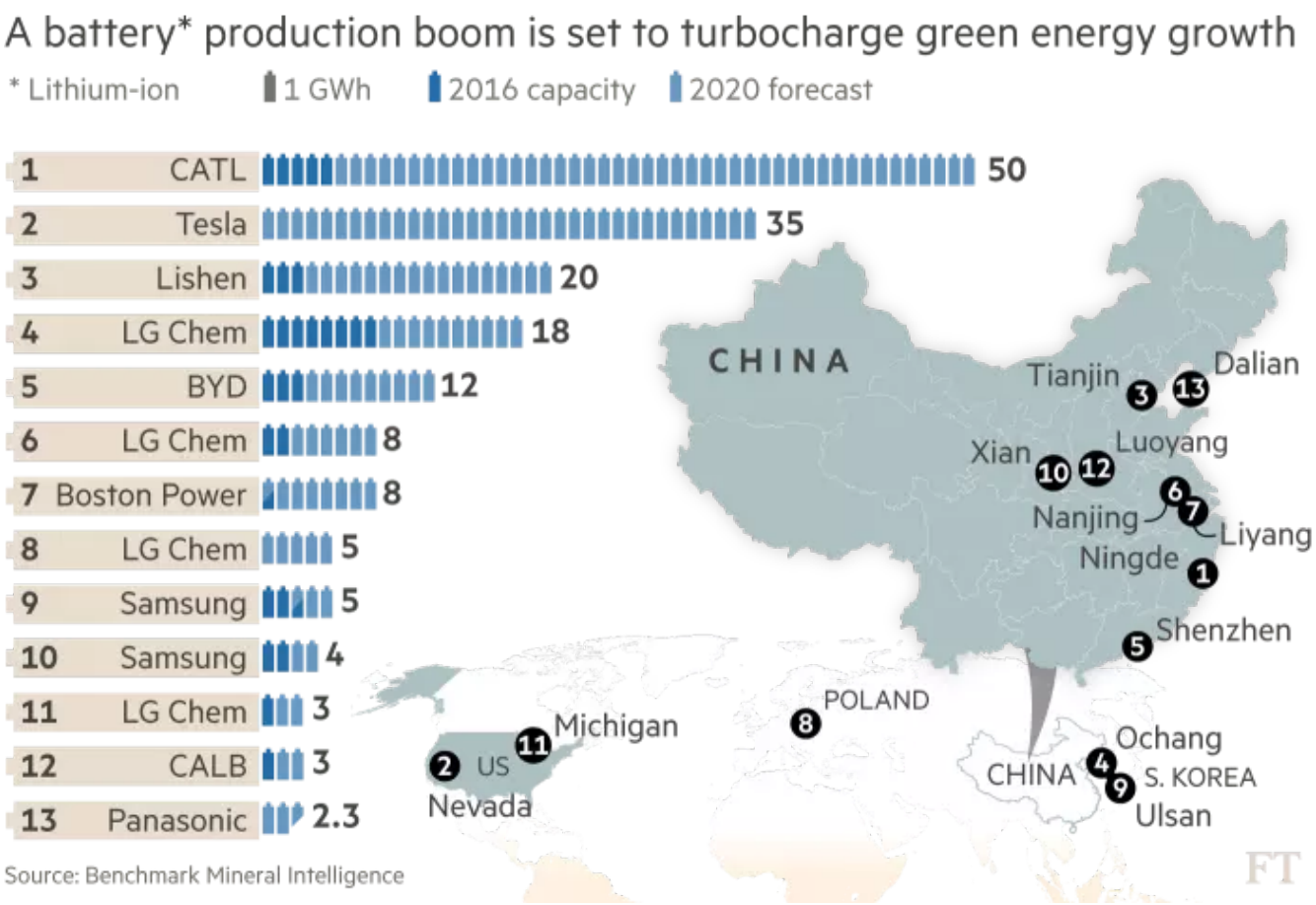
"For two real pillars of the German corporate world to radically break themselves up is something I cannot recall ever seeing in my lifetime," says Peter Atherton, a UK power analyst.

Yet a lot of places have begun to look more German this year — even the US, where President Donald Trump wants to unleash more fossil fuel production.

The US solar industry employs more than twice as many workers as the coal sector, a report showed in February. Manhattan has more Tesla charging spots than petrol stations, though many are in fee-paying parking garages.

And across the US, where power companies are facing lower wholesale prices thanks to cheaper natural gas, renewables are adding pressure too — even in unlikely spots such as oil-rich Texas.

Texas now has more installed wind power capacity than Canada and Australia combined. If it were a country, it would rank as the world's sixth-largest wind power, after China, the US, Germany, India and Spain.



NRG, the second-largest US power producer, has about a quarter of its generation capacity in Texas and has been reshaping its business so it relies less on squeezed wholesale power prices.

Mauricio Gutierrez, NRG's chief executive, warned in February that companies failing to do this would be rendered "obsolete" by the "unprecedented disruption" in the industry.

Brian Marrs, NRG's director of policy and strategy, says: "I think what we're seeing in the US now is the German postcard from the future finally arriving across the Atlantic."

Yet fast-growing industrialising nations are seeing some of the most profound changes. Towering over them all is smog-choked China, which has become a green energy juggernaut after designating renewables a strategic industry.

China has more than a third of the world's wind power capacity; a quarter of its solar power; six of the top 10 solar-panel makers; four of the top 10 wind turbine makers and more battery-only electric car sales last year than the rest of the world combined.

India is eager to follow: it built one of the world's largest solar photovoltaic farms last year; ranks fourth in the world for wind power capacity; and could become the world's third-biggest solar market this year. It also wants to boost its use of electric cars.

The big debate

The world has been through energy transitions before, often shaping the course of human history. The age of wood gave way to coal in the 1800s. Coal was in turn squeezed by oil and natural gas, transforming the fortunes of Middle Eastern desert kingdoms.

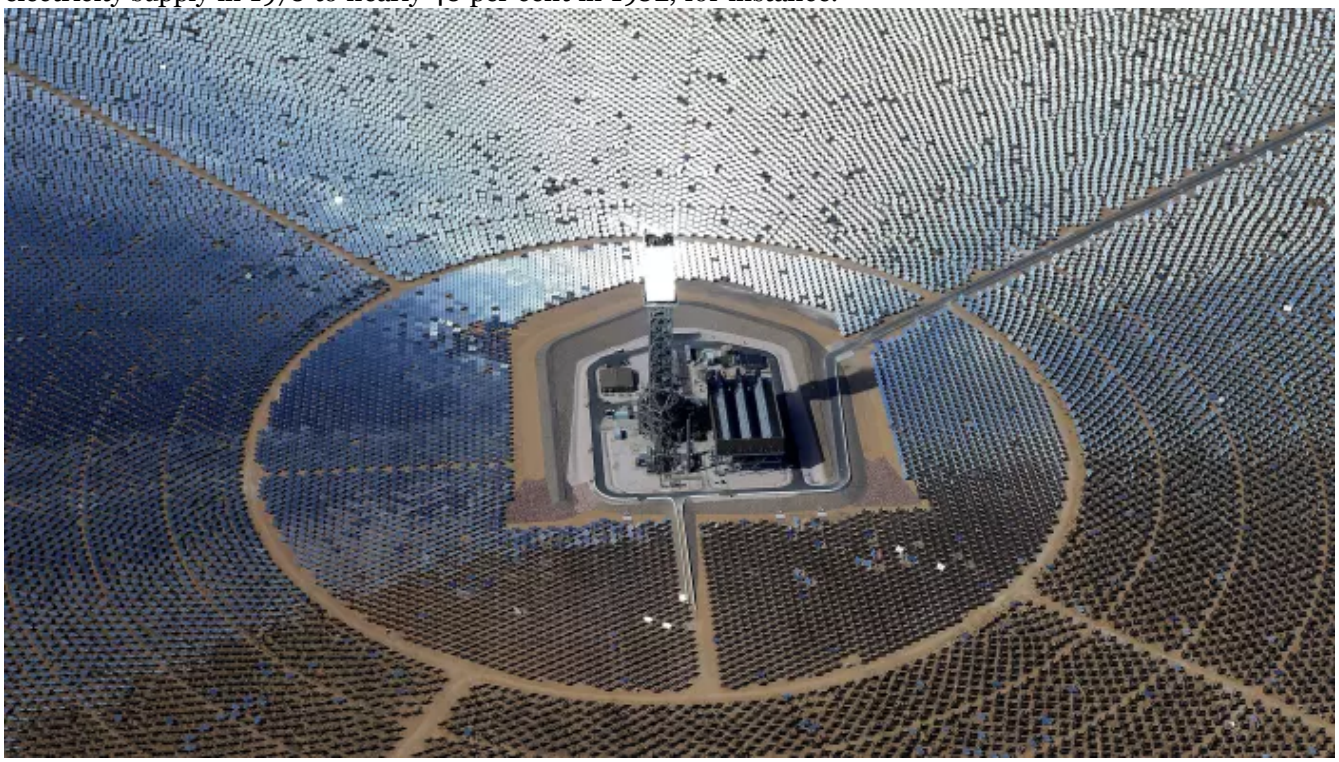
Such shifts usually take decades. But the growth of the latest one has prompted some to wonder if the age of fossil fuels might fade faster. Some mainstream thinkers are dubious.

Their view is embodied by Professor Vaclav Smil, an energy scholar whose fans include Microsoft co-founder Bill Gates. ("There is no author whose books I look forward to more," Mr Gates says.)

Prof Smil says "naive" people who are "enchanted" by the idea of a rapid end to fossil fuels ignore the fact that it has typically taken 50 to 60 years for a widespread shift from one dominant fuel to another. As coal gradually displaced wood, for example, it reached 5 per cent of all fuel energy in 1840 but was still only about 50 per cent by 1900.

“People want to be deceived,” he says in an interview. There is a dearth of green alternatives to the fossil fuels used to make steel, cement or plastics, he adds. And replacing a global fossil fuel energy system that took an estimated $25tn to create over the 20th century with today’s crop of renewables is a job that will occupy us “for generations”.

Still, a much-discussed paper published last year by Professor Benjamin Sovacool of the University of Sussex suggests energy transitions in some places can be speedier. Nuclear power in France went from 4 per cent of the country’s electricity supply in 1970 to nearly 40 per cent in 1982, for instance.



The Ivanpah Solar Electric Generating System in the Mojave Desert in California near Primm, Nevada © Getty

Others think the latest energy transition could be swifter because it is driven by deliberate efforts to curb climate change, rather than chance. Countries around the world have adopted more than 1,200 climate change laws, up from about 60 two decades ago, a study this month showed. Renewables now receive direct policy support in an estimated 146 countries, nearly triple the number in 2004.

That backing has seen the cost of wind turbines fall by nearly a third since 2009 and solar panels by 80 per cent, says the International Renewable Energy Agency. This underlines an advantage for renewables: unlike coal, oil or gas, every country has wind and sun.

As panel and turbine costs have fallen, “It is as if every country in the world woke up one bright morning to find that it had a North Sea at its disposal”, says London energy analyst Kingsmill Bond.

He says the more relevant point for investors is not the decades it may take for fossil fuels to be eliminated but the fact that small falls in market share can have a profoundly disruptive impact.

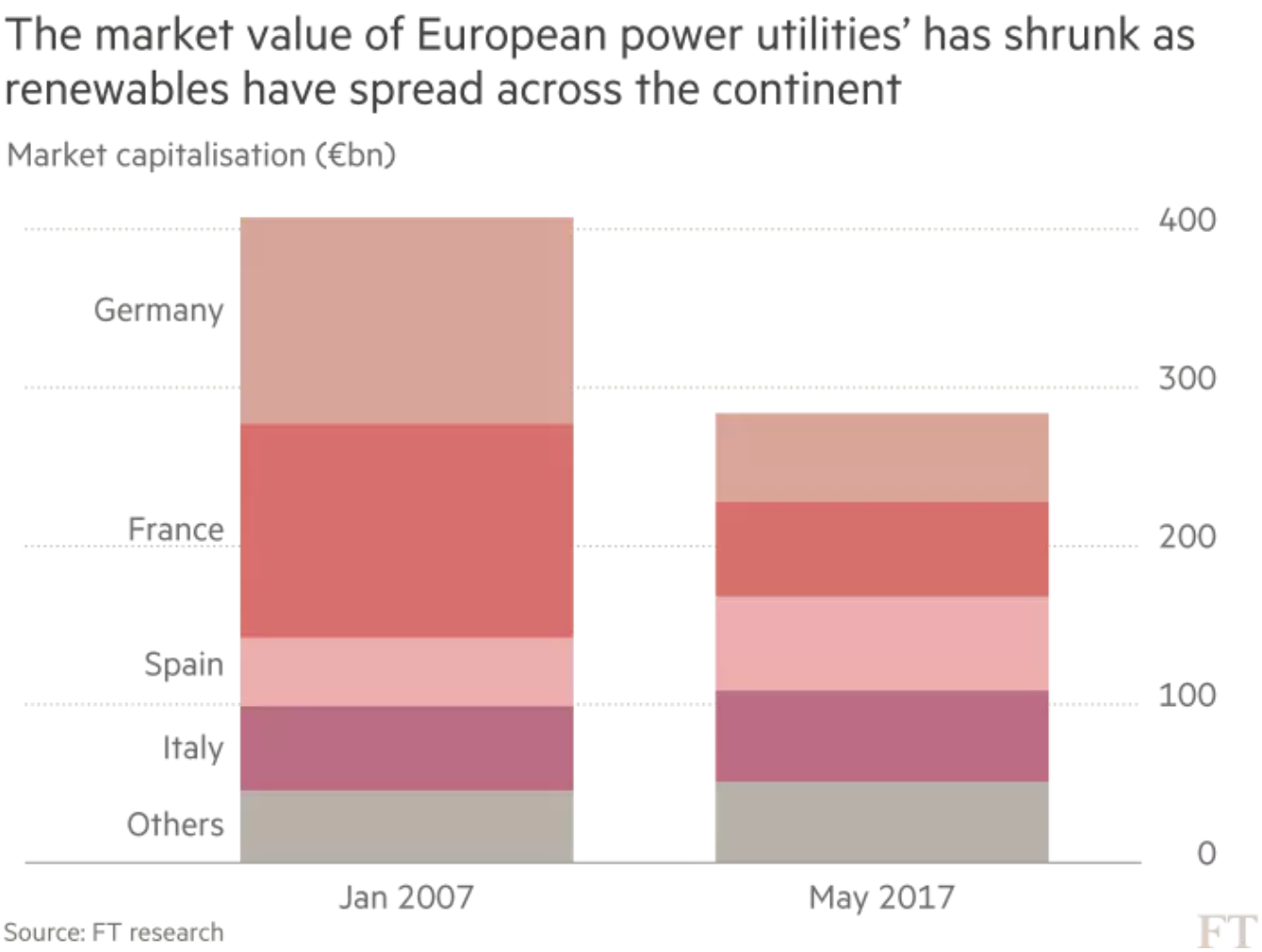
Exhibit one: most major carmakers are planning new electric models even though fewer than 1 per cent of cars sold each year have a plug.

The end of subsidies

There is another reason some energy industry watchers expect the green power sector to accelerate: the more costs fall and technologies improve, the less it needs conventional subsidies.

Costs are already lower than widely understood. “In 2010 we financed a 15 megawatt solar plant in southern California that cost $55m to build,” says Jim Long, a partner at Greentech Capital Advisors, a global clean energy advisory firm. “This year we have done another one the same size in the same area that has cost $15m and will produce at least 40 per cent more energy.”

This is one reason countries managed to adopt the global climate change agreement in Paris in 2015 after years of negotiations, says Christiana Figueres, the former UN climate official who helped seal the accord. “Switching away from coal no longer looked impossible, even in developing countries,” she says.



Costs are expected to fall further as countries spurn expensive subsidies guaranteeing set prices for generators in favour of competitive auctions or tenders. The amount of auctioned renewable electricity last year was triple that in 2015, according to Bloomberg New Energy Finance, while the average global price of auctioned solar power has plummeted fivefold since 2010.

One of the most striking auction results came in Germany in April when Denmark's Dong Energy, the largest builder of costly offshore wind farms, said it would build two new schemes without subsidies, relying instead on market prices alone. Advances in wind technologies — including the prospect of much more powerful turbines — were one reason for Dong's move, a step others are expected to follow.

"Renewables have reached a tipping point globally," says Simon Virley, head of power and utilities at KPMG. "A subsidy-free future is now in reach for a number of technologies and geographies."

Mainstream Renewable Power, an Irish wind farm developer, shows how new technology is making a difference. It was a winner in last year's power auctions in Chile, which require customers' demand for electricity to be met 24 hours a day. That means generators face the potentially pricey risk of buying power on the spot market to make up for any shortfalls.

Mainstream says more precise wind measuring technology makes it easier to predict how much extra power is needed, and therefore whether wind projects can be profitable.

Investors say important trends like this are obscured in countries where the existence of climate change is still so widely contested that the scale of the energy transition is under-estimated.

"I think it's happening much faster than most well-educated business people in America understand," says veteran investor Jeremy Grantham, co-founder of Boston asset manager GMO. "Because the science is being deliberately obfuscated in the US, the consequences are being obscured as well."

Even the experts have been caught out by the pace of the shift. In 2010, IEA projections suggested it could take 14 years before there was 180 gigawatts of installed solar capacity. It took less than seven years for the world to reach more than 290 gigawatts, nearly the entire generating capacity of Japan.

Still, some predictions have proved overblown. Former US President Barack Obama said that by 2015, the US could be the first country with 1m electric cars. Only about 400,000 materialised.

This time could be different

Some green energy veterans bruised by past setbacks think there is a reason to be more optimistic today: batteries.

"I have been early twice in financing the low-carbon energy transition," says Bruce Huber, co-founder of the Alexa Capital advisory group. "But we feel it's third time lucky."

One reason for his optimism is what he calls the "tectonic plate-shifting" in the car industry that is driving down the cost of energy storage. Storing clean power has long been a holy green grail but prohibitive costs have put it out of reach. This has begun to change as battery production has ramped up to meet an expected boom in electric cars.

Lithium ion battery prices have halved since 2014, and many analysts think prices will fall further as a slew of large battery factories are built.

The best known is Tesla and Panasonic's huge Nevada "gigafactory". Tesla claims that once it reaches full capacity next year, it will produce more lithium ion batteries annually than were made worldwide in 2013.

It is only one of at least 14 megafactories being built or planned, says Benchmark Minerals, a research group. Nine are in China, where the government is backing electric cars with the zeal it has directed at the solar industry.

Could this led to a China-led glut like the one that helped drive solar industry write-offs and crashing prices after the global financial crisis?

"It's something to watch," says Francesco Starace, chief executive of Italy's Enel, Europe's largest power company. The thirst for electric cars, not least in China, means "the dynamics of demand are completely different" for batteries than for solar panels, he adds.

Tesla Motors founder Elon Musk © Reuters

Still, Enel's internal forecasts show battery costs falling by about 30 per cent between 2018 and 2021 and it is among the companies already pairing batteries with solar panels to produce electricity after dark in sunny places where power is expensive, such as the Chilean desert.

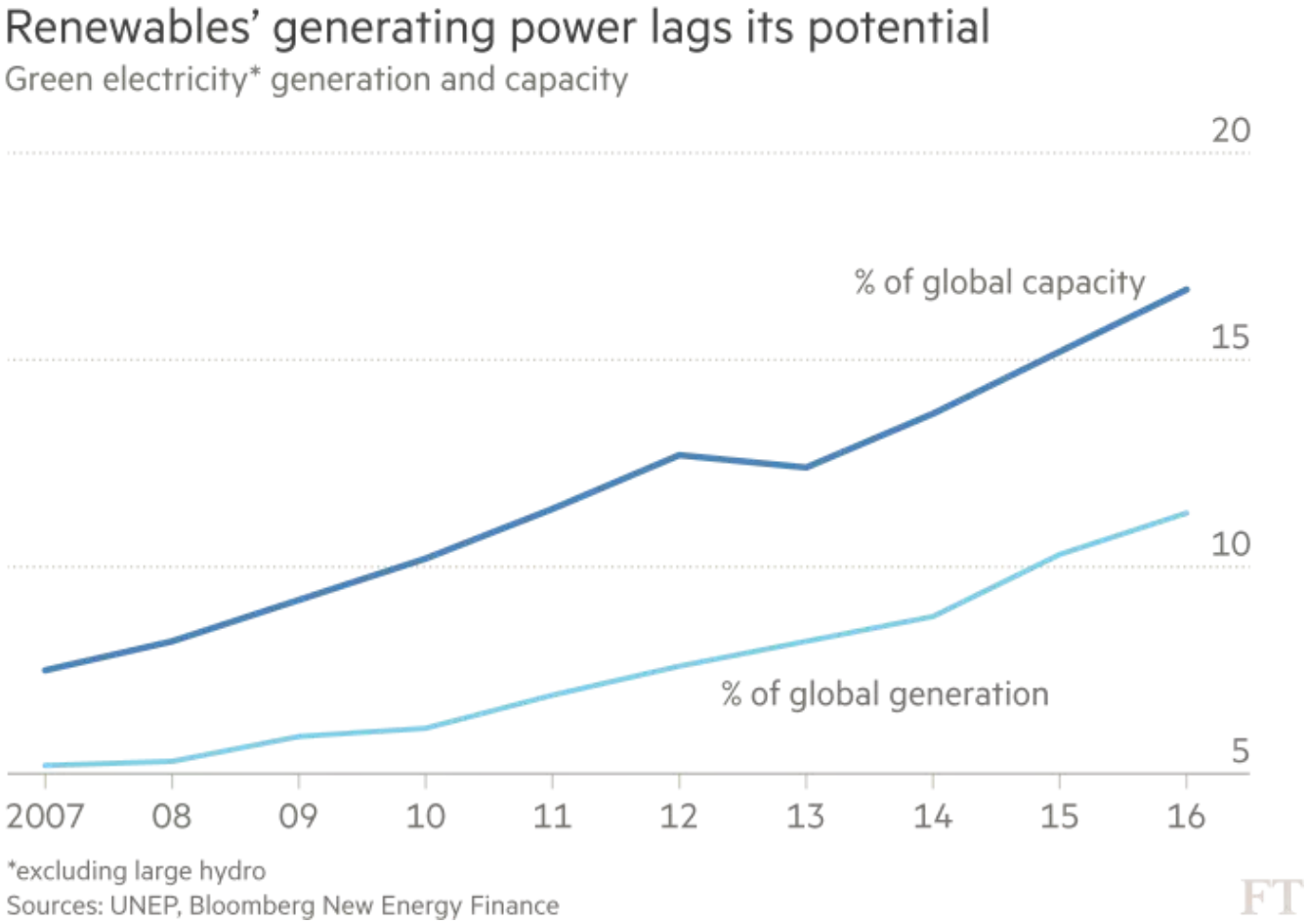
Tesla finished a similar system in Hawaii in October and its chief executive, Elon Musk, made a characteristically flamboyant offer this year — via Twitter — to build a much larger one within 100 days to help fix power outages in southern Australia.

For all the excitement about batteries, the technology is still not ready to let householders in any part of the world stick a solar panel on the roof, a battery in the garage and abandon grid power completely. It would cost hundreds of thousands of dollars in snowy places like Nebraska and probably require an extra garage to house all the batteries, the CLSA brokerage calculated last year.

However, other analysts say investors need to pay attention to the disruption that even partial grid defection could cause in places where batteries make more financial sense.

In Australia, where household electricity prices nearly doubled in the decade up to 2014 and rooftop solar levels are among the world's highest, more than 6,700 battery systems were sold last year, up from 500 in 2015, says the solar consultancy SunWiz. By 2020, about 1m homes could have batteries, according to Morgan Stanley analysts.

"We think most incumbent utilities downplay the earnings risks from solar and battery take-up," the bank said last year. "All utility investors should monitor Australian market developments" to anticipate how the market will evolve elsewhere, it added.



Battery companies flocking to Australia say it is only one example of a new breed of "prosumers", people using renewables and batteries to produce and consume their own power.

"We were doubted before," says Philipp Schröder, managing director of Germany's Sonnen home battery group. He says big utilities are copying his company's business model now, purely because "the economics are right".

In quake-prone Japan, a hotbed of battery technology, industry leaders say it is inevitable that home solar-storage systems will become commonplace.

"In future we think all new houses will generate and consume their own electricity and grid power will only be used for industry," says Hiroichi Yoshida, founder of Eliiy Power, a lithium ion battery-maker that specialises in solar storage systems.

When a powerful earthquake rocked the southern Japanese city of Kumamoto last year, black-outs plunged most homes into darkness for nearly a week. But the lights stayed on in at least 20 houses with solar-storage units, says Eliiy, which is planning to open a third battery production plant in 2019 as sales rise.

"I think even the industry has been surprised at the momentum it has gathered over the past two years," says IHS Markit solar analyst, Sam Wilkinson. "The possibilities this opens up are extremely compelling."

Hedging their bets

Meanwhile, some fossil fuel companies are starting to put serious money into green energy.

Seven oil and gas groups, including France's Total, Royal Dutch Shell and Norway's Statoil, have together invested almost $15bn in renewables over the past four years, according to the Oil and Gas Climate Initiative industry group.

Total bought France's Saft battery company last year for almost €1bn, having already acquired a controlling stake in a US solar company, SunPower.

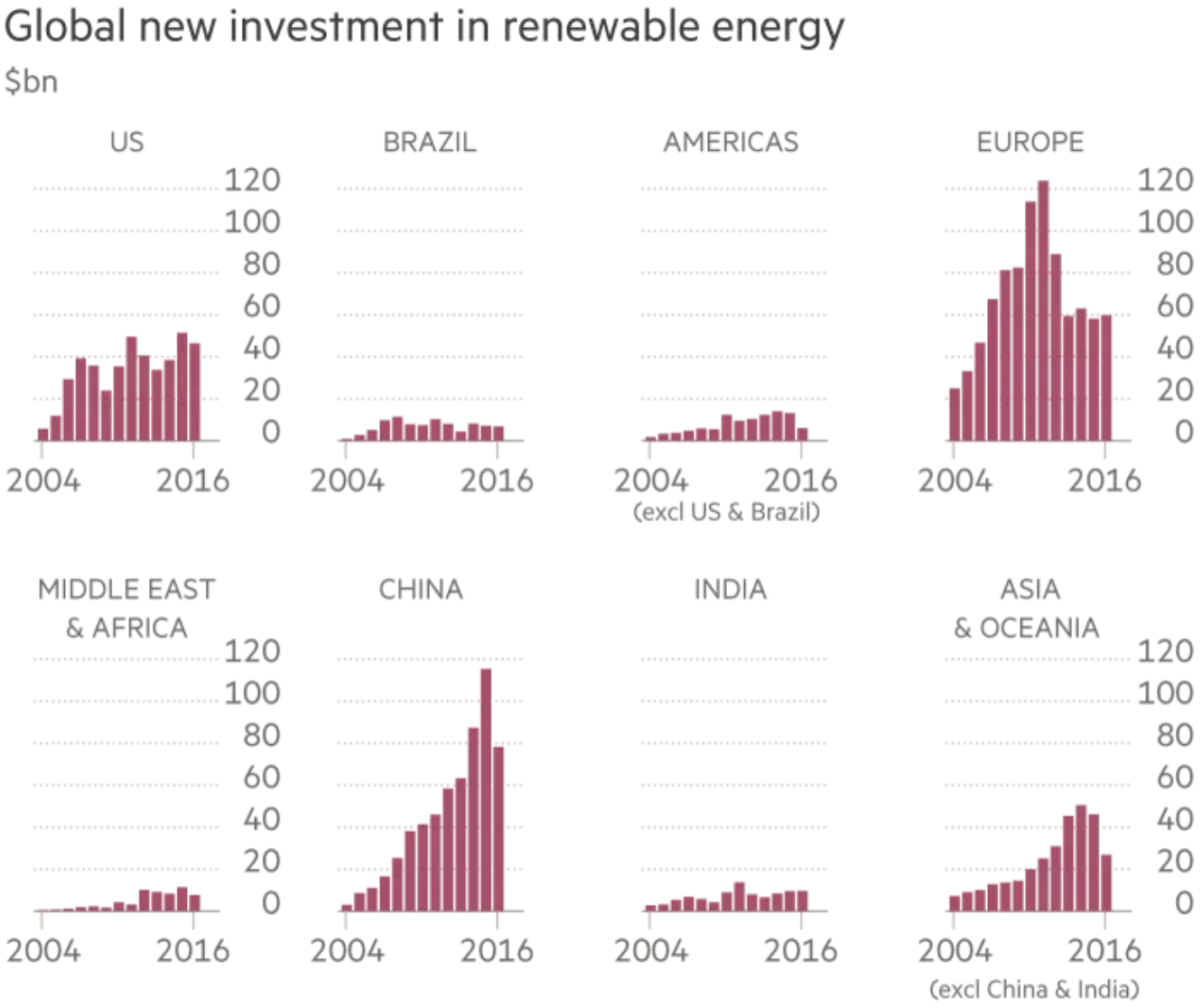
Norway's Statoil is spending $500m a year on clean energy projects and expects to spend even more after 2020, says Irene Rummelhoff, head of the company's "new energy solutions" unit.

"It is the first time we've devoted this much money to clean energy," she says, adding she expects to see more companies follow suit amid the "tremendous shift" of plummeting renewables costs.

"Clearly it is to some degree a threat but at Statoil we have chosen to see it as an opportunity," she says. The company has six offshore wind projects operating or in development, including an innovative floating wind turbine park off the coast of Scotland it plans to hook up to a battery system next year.

Royal Dutch Shell is also ploughing into offshore wind farms, to the point that Henrik Poulsen, chief executive of Dong Energy, says he now regards both Shell and Statoil as "competitors".

But oil and gas companies may need to act faster if the ambitious plans of other large energy companies succeed.



Sources: UN Environment; Bloomberg

FT

France's Engie, for example, is investing €1bn over three years on new energy technologies that could strike at the heart of fossil fuels. The company's head of research, technology and innovation, Thierry Lepercq, says this includes creating zero-emissions power plants that generate electricity for "the Rio Tinto price" — the price that the metals and mining company seeks when deciding where to build a new smelter.

Mr Lepercq thinks Engie will find a way to build such plants "within two years", partly because of "sinking and sinking" battery costs. Engie has no interest in technology requiring subsidies, he says. "It's a fundamentally business-driven approach."

None of this means the future of clean energy will be entirely smooth. Indeed, its very success poses a raft of questions for governments that some have barely contemplated.

Chief among them: what to do with power markets that were never designed for millions of people turning their rooftops into mini power stations?

How to pay for upgrading grids to cope with the influx of all this renewable power? What to do about incumbent companies calling for the brakes to be slammed on to protect them from green power incursions? Then there is Mr Trump, who is seeking to unwind the clean power policies of his predecessor.

In the rest of the world, however, the future of green power appears assured. So much so that an industry that has spent years on the defensive is beginning to show a rising sense of confidence.

"Fossil fuels have lost," says Eddie O'Connor, chief executive of Irelands's Mainstream Renewable Power. "The rest of the world just doesn't know it yet."

Graphics by Federica Cocco and Steven Bernard. Illustration by Ollanski

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FT Clean Energy Week, May 23-25 2017 — more details here
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