2018 Global Outlook:
6 Trends in Energy & Sustainability

Schneider Electric's 2018 Global Outlook includes six trends that explore the most significant regional, national and international shifts in energy market dynamics and sustainability initiatives – from planning to policy and production to purchase.

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Introduction

In November 2017, we brought together 16 experts from across several teams – Operations, Research, Analytics and Risk Management – to debate the following question: *"What trends will have the greatest impact on energy and sustainability strategies in 2018?"*

Experts discussed geopolitical tendencies, consumer behavior, policy evolution, technological innovation, economics and gut reaction to events in 2017. After much debate, the team settled on the trends most impactful to our clients this year:

1. Geopolitical Market Changes Globally: Political Division, Energy Trends Unite
2. Current & Future State of Coal: Policy Shifts & Energy-specific Developments
3. Rise of Electric Vehicles
4. Regulation, Deregulation & New Technologies: Impact on Renewable Energy Purchasing
5. Decarbonizing Heat: What Hydrogen, Arnold & Denmark have in Common
6. Increased Momentum on Science Based Targets

Mihaly Bor
General Manager - Budapest

Robbie Fraser
Commodity Analyst

Matt Sanders
Sourcing Director

Tom Bardwell
Sustainability Consultant

1. Geopolitical Market Changes Globally:
Political Division, Energy Trends Unite

Politics and energy have a tendency to intertwine, and it seems 2018 will be no exception. Global energy is in the midst of what has been characterized as radical transformation – a world where Saudi Arabia invests in wind and solar, and Tesla Motors has a higher valuation than Ford. Similarly, the world's political order is in flux behind a surge of populist sentiment in the west and China's continued rise shifting the global balance of power further east. That both arenas are amid profound shifts is not coincidence.

Several prominent energy trends shaping politics in 2018:

- In the US, a Republican-led overhaul of the tax code will have major implications for energy over the next decade.
- In Europe, with one eye still on managing borders and the financial cost of the Brexit divorce, Germany is negotiating the formation of a coalition government. This coalition would determine critical targets to phase out coal and lift renewable capacity in Europe's largest economy.
- In China, Xi Jinping is using climate change to boost China's leadership on the global stage.

In each case, 2018 should cement a central theme: global energy is becoming more renewable, less carbon-intensive, and more resilient. Let's look at several significant regional trends that support this theme:

United States

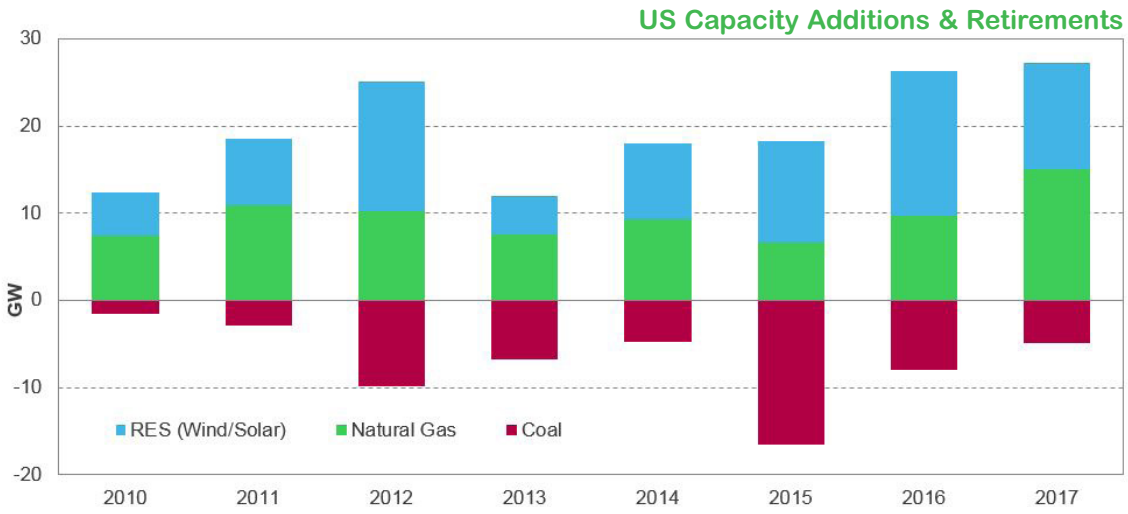
President Donald Trump is, by all accounts, a political outsider who disrupts the status quo as a matter of policy. In this context, energy has been in the spotlight. President Trump questions the validity of climate change and advocates for increased production and consumption of coal and other fossil fuels. This reverses the Obama administration's approach and departs from the global consensus on energy policy. Let's look in on the Clean Power Plan (CPP) – one of our 2017 mentions – to see where we stand today:

As expected, the Obama administration's Clean Power Plan is all but finished. While hearings continue, it is clear the Environmental Protection Agency has little interest in enforcing the plan, which would set carbon emission targets for states and likely result in the closure of many coal-fired power plants. With states no longer obligated to plan for CPP implementation, the projected number of coal retirements has indeed declined from expert projections.

Still, that's a far cry from a coal rebound. Fewer plants retiring has not brought new plants online, nor has it stopped plant retirement. In Q4 2017, future power prices in Texas jumped on the news that Luminant would close three large-scale coal units in DOE Secretary Rick Perry's home state.

In response, the DOE cited grid reliability concerns and ordered a review of proposed changes to deregulated energy markets that would essentially subsidize coal and nuclear generation. That initial proposal was rejected by the Federal Energy Regulatory Commission, but a broader review of policy options continues. Effectively, any approved measure is capable of slowing – but not altogether reversing – the pace of coal retirements in the years ahead.

That said, the move could dampen the rate of new renewable projects coming online, though it would not halt an ongoing rise in renewable capacity.



Despite an evolving regulatory environment, renewable capacity has grown as coal capacity has been steadily phased out of the generation mix. (Source: *EIA, Schneider Electric Global Research & Analytics (GR&A))*

Other regulatory efforts may yield similar results in 2018. With the Republican tax reform plan now signed into law, it will undoubtedly trigger certain changes across the energy sector that include:

- Drilling in the Alaska National Wildlife Reserve (ANWR) would open up a large and largely untouched region for oil and gas development
- The mitigation of benefits from investment tax credits or production tax credits for renewable projects
- Senate inclusion of a base erosion anti-abuse tax (BEAT) that will, despite certain energy provisions, reduce the level of tax equity financing for new projects

In the end, the tax bill's final form is a metaphor for US policy at-large. The bill removed the more severe ITC/PTC measures and watered down the BEAT impact of energy tax credits. It also failed to include nuclear tax credits, and exploration and production activity in ANWR is expected to have little tangible impact on US oil and gas production over the next several years. The bill simply slows the pace of opposing trends that continue to favor renewables over traditional brown power based on economics.

Nonetheless, tax reform and other regulatory changes are still likely to have a more fundamental impact than another issue that captured more global attention – US withdrawal from the Paris Climate Agreement. While Donald Trump's planned exit garnered international headlines, it has no direct impact on actual energy policy. That said, US withdrawal does signal a relinquishment of a leadership role in climate action.

US withdrawal (from the Paris Climate Agreement) signals a relinquishment of its leadership role in climate action.

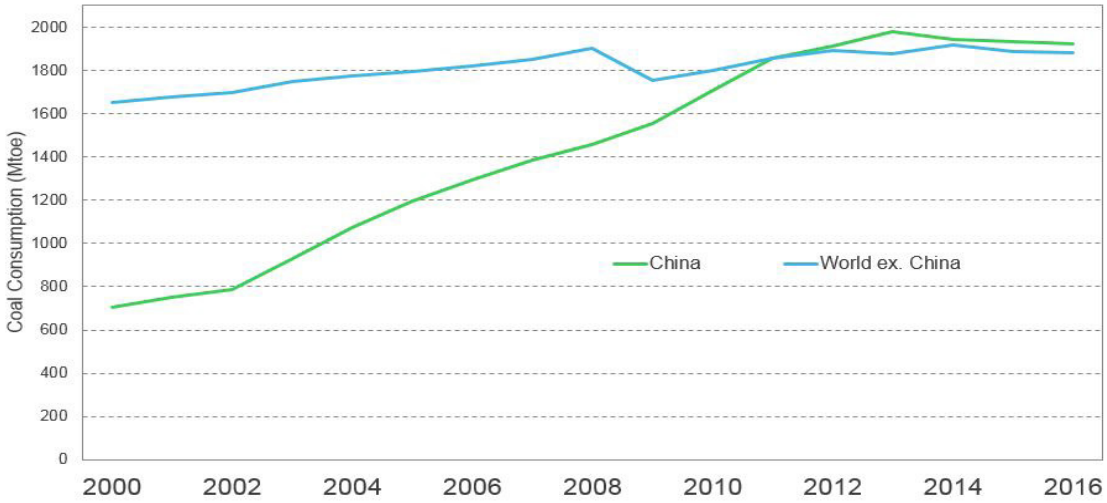
China

The European Union and China have emerged as the two power blocs ready to fill the void created by the US's withdrawal from the Paris Climate Agreement. As China takes on a greater role on the global stage, there are signs of tension as the world's most prominent "emerging market" seeks level footing with the EU's traditional economic power.

The idea of treating rich and poor countries differently is called "bifurcation." (The Paris deal papered over the issue by calling on everyone to slash greenhouse gases as they are able.) Case in point: developing countries often contend wealthy countries should bear more of the emissions cuts. The most active debates have been over transparency and accounting rules. This isn't necessarily new, but China's seat at the negotiating table means the argument for developing markets carries far greater weight.

In the meantime, both China and Germany have their own issues related to climate change. Undoubtedly, they have made tremendous investment in renewables, even as each maintains a more-than-significant coal industry. Both are still among the largest polluters in the world.

Global Coal Consumption



While global demand for coal has flattened, China's consumption grew from 2000-2014. (Source: *EIA, Bloomberg, GR&A)*

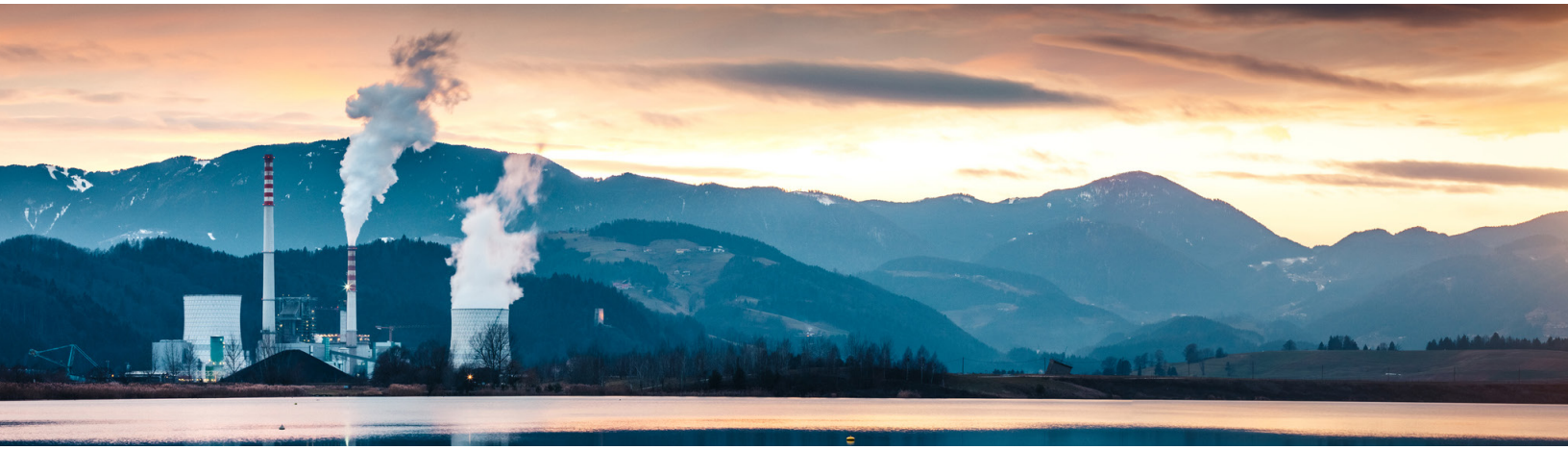
Today, China is burning an incredible amount of coal to generate electricity, which accounts for roughly half of total global demand. But those statistics obscure large-scale efforts to create a more climate-friendly generation mix. In 2015, 72% of China's power was coal-generated, but the country is already working toward a target reduction to 58% by 2020. And, while China produces roughly 20% of the planet's CO_2 emissions, per capita emissions are slightly below EU and significantly below US emissions.

China's efforts to address emissions and climate change during its stage of rapid growth mark a shift from efforts made by the EU, the US and more established economies. Consider China's recent commitment of $363 billion toward renewable power capacity by 2020. They may, in fact, be the model for the emerging and developing world.

India

For the first time ever, 2017 saw the number of newly-installed renewable energy projects outweighed those of fossil fuels in India. Between April 2016 and March 2017 alone, 12GW of renewable energy capacity was installed, though, this only represents 3% of its capacity target for 2022.
Much of the Indian market's growth has been centered on roof-top solar PV, which achieved a four-year compound growth of 117% in 2017. Despite government support for renewable energy as a cost-effective means to provide electricity to its 1.3 billion residents, most of this capacity increase has been limited to commercial and industrial sectors.

Primary drivers include falling costs in technology and finance, along with favorable government policies. Auctions are the central tool for adding new renewable energy capacity to India's power system and an increase in their frequency is planned. Despite significant progress, the intense level of competition in the Indian market is creating problems, including increased project risks, reduced quality, questionable PPA contract terms and a 70% import duty proposed on solar PV panels. While these problems are far from insurmountable, the Indian market is certainly one to watch during 2018.



Germany

Germany is the largest coal producer and user of the combination of lignite and hard coal in the EU. It finds itself under increased scrutiny with the new coalition negotiations in Berlin. For years, Germany's *Energiewende*, or renewable energy transition, was considered a best practice for other nations to adopt. In just 15 years, Europe's biggest economy would turn a third of its electricity generation green by subsidizing investments in solar energy and wind power. In the meantime, they would phase out nuclear energy by 2022 even as the economy would post record growth and trade surpluses.

In Germany, 2030 targets are planned to be met and... the share of renewables is targeted at **65% by 2030.**

As of now, Germany's carbon emissions haven't declined for nearly a decade. The German Environment Agency (GEA) calculated it emitted 909.4 million tons of CO_2 in 2016 — the most in Europe — vs. 902 million in 2015. Germany is now in serious danger of missing its 2020 and 2030 emissions targets.
The German Climate Action Plan 2050, presented and approved by the German cabinet in November 2016, maps a path to carbon-neutrality by 2050 in line with their 2015 Paris Agreement obligations. The plan, however, lacks any specific timeline. The German government will need to address that gap in 2018, and it's why ongoing coalition negotiations are integral to Germany reaching its environmental targets.

After the elections last September, winning CDU/CSU (Christian Democrats), Greens and Free Democrats (FDP) negotiated to form the so-called "Jamaica coalition" (named for the colors of the parties). Talk of decommissioning the country's coal-fired generation was a positive sign of compromise on the maximum capacity of coal power Germany could phase out in the short run. The parties agreed retiring seven gigawatts (roughly 25%) of installed coal capacity wouldn't threaten supply security.

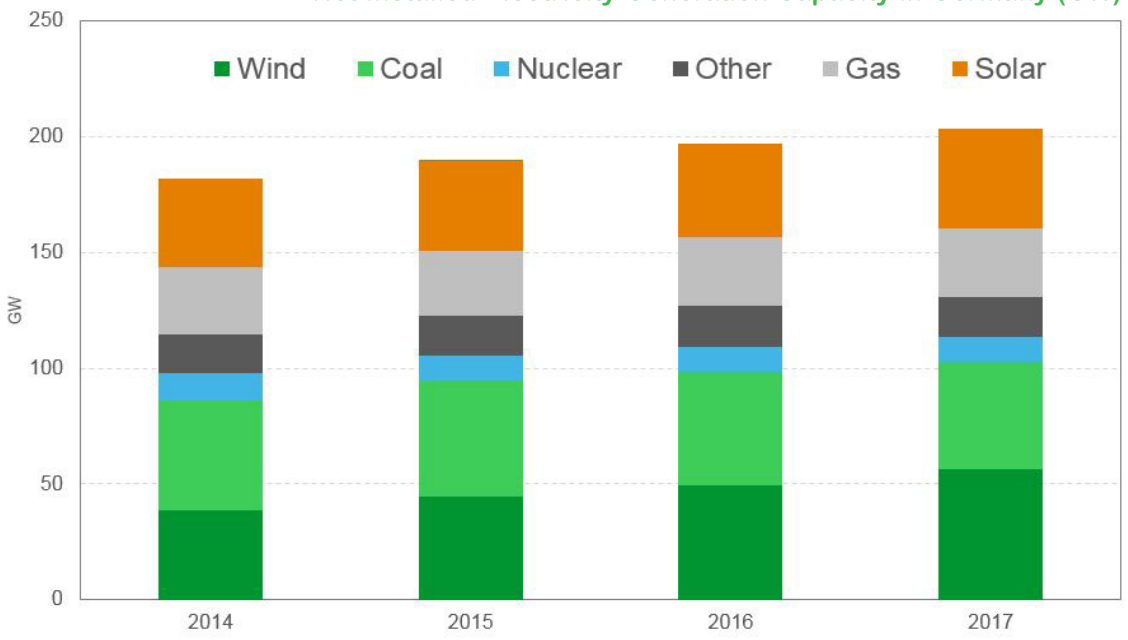
Coalition talks, however, fell apart when the Liberal Party pulled out. Another election or a minority CDU/CSU government was likely after negotiations collapsed, but Angela Merkel has since engaged election runner-up SPD (social democrats) to form a grand coalition. Party leaders hope to reach an agreement in February.

The GEA calculated it emitted **909.4 million tons** of CO_2 in 2016 vs. **902 million** in 2015.

Despite its worst election results since WWII, SPD is suddenly a key player again and its leader, Martin Schulz, now has a party mandate to broker a deal. He has engaged in formal talks with the CDU/CSU and reports suggest that, by the time you read this, he already would have agreed on energy and climate change-related matters. While previous 2020 emission targets seem to be given up, 2030 targets are planned to be met by all means and additionally, the share of renewables is targeted at 65% by 2030 (as opposed to previously planned 2040).

Without specifying a timeline, Schulz previously confirmed Germany must ultimately phase out coal to reach climate change targets, but any impact to energy or job security is a non-starter. He also referred to lignite mining jobs (~20,000) in the economically hard-hit western Rhineland and eastern Lusatia regions – SPD strongholds – and the powerful clout of the mining and energy lobbies, not least Germany's third-biggest union: IG Bergbau, Chemie, Energie.

Net Installed Electricity Generation Capacity in Germany (GW)



(Source: *Fraunhofer ISE)*

While SPD's view is important, CDU/CSU remains the strongest power, and Merkel has a track record of reaching favorable compromises. In general, CDU/CSU seems to favor a slow coal phase-out. Merkel, meanwhile, disappointed environmental campaigners last November in Bonn by refusing to establish a decommissioning deadline for coal-fired plants. This was somewhat unexpected after French President Emmanuel Macron, as well as Canada, Italy, Britain and other countries, announced they will stop using coal in the next few years.

It's important to add these countries use far less coal: <10% of the generation mix in the UK and Canada, and ~15% in Italy. Merkel did commend "America's Pledge" – an alliance of U.S. states, cities and businesses – that committed to reduce emissions in spite of the Trump administration. She also sought to reassure poor countries that a $100 billion fund to help them respond to climate change will be filled despite Trump's threat to withhold U.S. federal contributions.

All in all, be it a grand coalition or a minority one, it is unlikely a fixed cut-off date to coal-fired generation will be announced. While both large parties are committed to climate change, political stability has clearly taken priority and neither will risk confrontation with the strong trade unions or the large energy companies who have massive investments in coal-fired units.

The EU's target share of renewable energy in 2030 was left at **27%** – as it had been since being agreed upon in October 2014.

European Union

While Germany's energy policy is primarily determined by local politics, it is also intrinsically linked to developments within the European Union. Europe has a focus on creating a common energy market through physical and financial connectivity. As such, it has already created an environment where wholesale gas and power prices are closely linked across most EU countries. This means no single country can truly chart its own energy market path.

Setting the stage for 2018, EU energy ministers met at the close of 2017 to explore common positions for four major energy policy areas prior to their consideration by the European Parliament and Commission. The ultimate aim would be to "ensure long-term policy coherence and stability in the climate and energy sector, provide certainty to investors and enhance coordination between member states."

These 4 areas are:

1. Regulation on governance of the Energy Union
2. The Directive on renewable energy
3. The Regulation on electricity
4. The Directive on electricity

In what were lengthy – and not always cordial – discussions, 2 main topics emerged:

- **Renewable Energy** > The EU's target share of renewable energy in 2030 was left at 27% – as it had been since being agreed upon in October 2014. Given the Paris treaty and falling costs (and possibly as a counterpoint to the Trump administration), some had been hoped the target would increase to 30%. (Some quarters proposed 35%.)

- **Coal** > Various capacity markets exist already and the means by which "standby power" can be assured is a sensitive issue relative to coal's future. Arguments to restrict coal's role in standby power mechanisms created much division. As such, suggestions to delay restrictions beyond 2020 (to 2035 in some instances) were heavily criticized by environmental and climate groups.

In short, no one was completely satisfied. The EU may not match the US for its policy acrimony, but there is still plenty of disagreement on how to legislate climate change efforts. In fact, there is little clarity around Brexit's legislative impact on both the EU and Great Britain over the past 18 months, particularly on environmental issues. Still, some legislative activity bears mention:

- The EU Energy Efficiency Directive, responsible for the UK's Energy Savings Opportunity Scheme, is unlikely to change since it is enshrined in UK law
- Climate change legislation is most likely to remain in place – particularly since the UK established its own legally-binding Climate Change Act 2008, and much of the drive for renewables is being led by international organizations
- Although withdrawing from the EU impacts product compliance – such as Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) and Classification, Labeling & Packaging Regulations – it is likely that these, or similar schemes, will remain in place so UK business remains commercially competitive and can access the EU market

These topics, as well as renewable energy targets and coal capacity, illustrate this tension between larger economies in Northwest Europe and smaller, more coal-reliant states of the EU's Eastern Europe contingent. While the EU has an established position in climate change efforts, division within the EU ranks could undermine that position, particularly as China takes a greater role in global climate leadership. To avoid that, EU energy efforts need to avoid a widening of any east-west rift.

> SOURCES

Daniel Waters
Commodity Analyst

David Hunter
Director of Market Studies

2. The Current & Future State of Coal:
Policy Shifts & Energy-specific Developments

In 2017, the coal market saw a rebound as global coal prices rose steadily through the year and volumes of seaborne trade were higher. Even in the US, where coal jobs and coal production has been downward for years, 2017 marked a year of increased production, higher exports and even an up-tick in coal mining jobs.

While there is speculation of a coal resurgence, 2018 will return the energy industry to a stark reality: coal is moving out of the global generation mix. Last year was unique, not because it marked coal's revitalization, but because it reminded us that coal will eventually be the fuel of last resort as the globe transitions toward other fuel sources. To understand the 2017 rebound, we need to first look back:

- In 2011, the coal market was growing with trade prices above $100/tonne.
- By 2016, the price of seaborne coal had fallen to an average of $57/tonne.
- A wave of coal companies in bankruptcy and an overall decline in coal production helped prices advance to an average of $84 in 2017.

In the US last year, natural gas prices rose from 2016 lows, again lifting coal atop the generation mix. At the same time, increased Chinese imports and a demand up-tick from other East Asian countries helped lift the global price of coal. Exporters took advantage of the bullishness to expand mines and production.

On top of these market forces, recent headlines signaled coal's resurgence. President Trump had all but killed the Obama-era Clean Power Plan (CPP), which would have resulted in dozens of coal plants coming offline. Meanwhile, Chinese plans for a national carbon market have been in the works for years, yet the planned 2017 start date had come and gone. But, 2017 may actually be an exception that proves the rule for global coal.

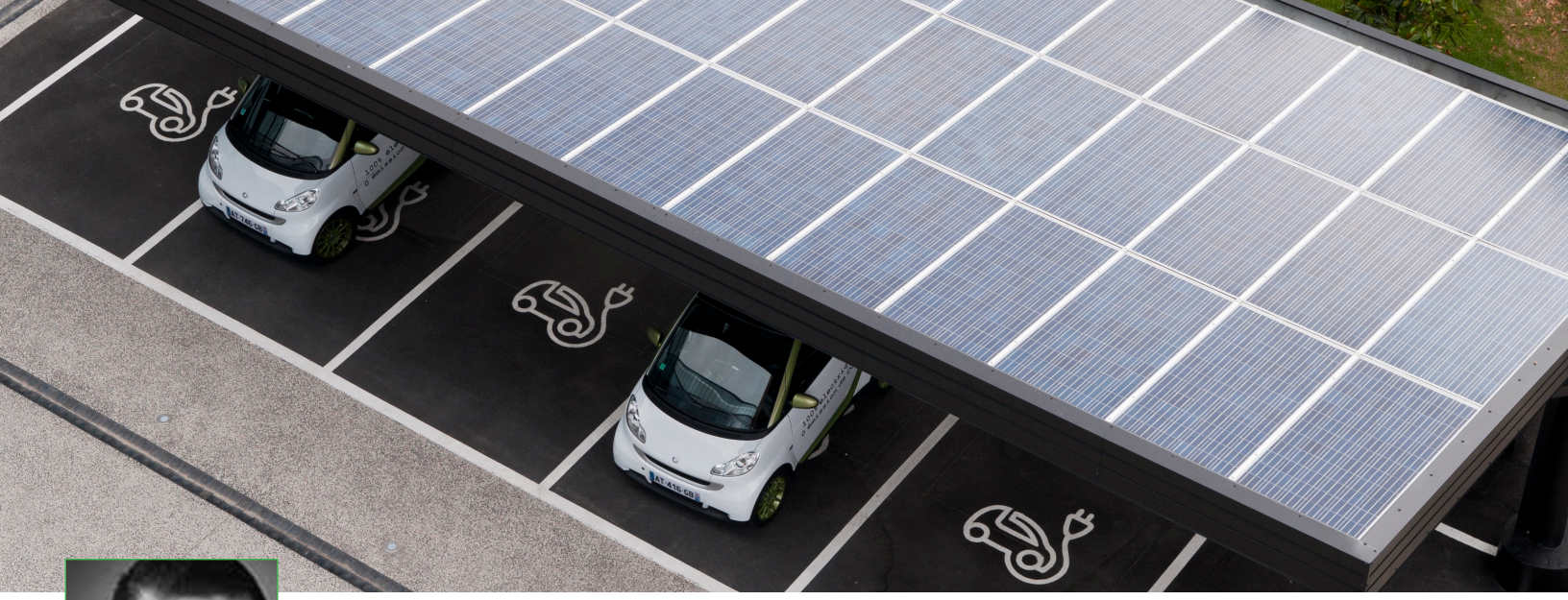
The delay in the Chinese carbon market should only be temporary. Even though little detail has been released regarding the structure and operation of the new scheme, the initial plan includes eight sectors: petrochemicals, chemicals, building materials, steel, ferrous metals, paper-making, power-generation and aviation. While questions about the project's ambition and feasibility remain unanswered, China is still poised to announce the arrival of the world's biggest carbon trading scheme this year.

We focus on China because the country consumes about half of the world's coal and that consumption has declined each year since 2014. Additional factors in China should contribute to bearishness in the coal market, including a 58% quota for coal as part of the country's energy mix in 2020 – down from ~64% in 2015 – and a general expansion of renewables within that generation mix.

Moving west to Europe, energy efficiency has halted power generation growth in recent years. On top of energy efficiency, political momentum toward a coal phase-out continues in many economies. At the UN climate summit in Bonn, the UK and Canada led 23 other countries in announcing a "Powering Past Coal Alliance". (The Alliance may have more than 50 signatories by the 2018 UN climate summit.)
With regard to the US, expectations are that continued low prices in the natural gas market and further renewables growth will also structurally squeeze the coal sector.

What is most interesting about the aforementioned trends in coal is that these run counter to the overall trend in energy. Globally, we expect total energy demand to continue to rise for the next several decades while coal is set to play an ever-shrinking role. In 2018, we may well see many coal plants around the world generating their last kilowatt-hours.

> SOURCES



Robbie Fraser
Commodity Analyst

David Hunter
Director of Market Studies

3. Rise of Electric Vehicles

With an EV transition already underway, what do rising oil prices, falling battery costs and government policy changes mean for global energy markets in 2018?

In recent years, the emergence of unprecedented trends have redefined the energy landscape, such as:

- The US shale boom
- The decoupling of global GDP and carbon emissions
- The emergence of carbon pricing mechanisms

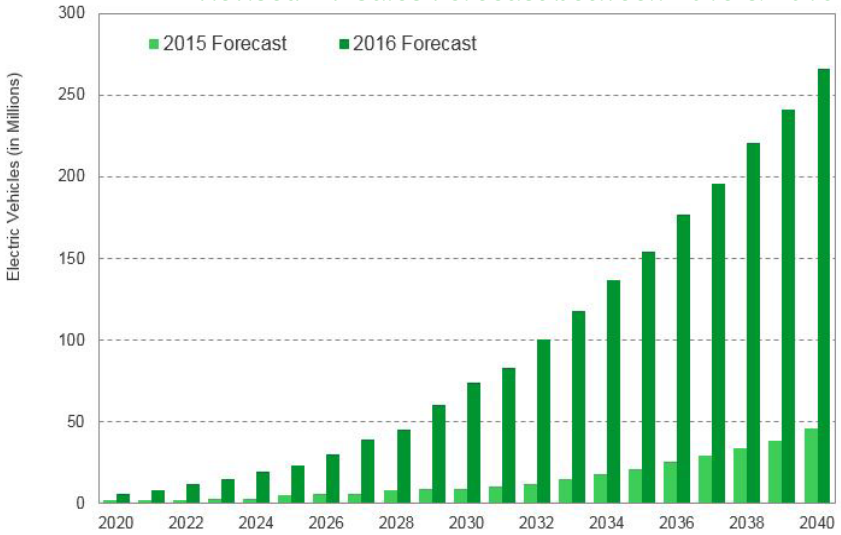
Perhaps the greatest trend has been the convergence of supply and sustainability. For energy, that often means wind, solar and other renewable resources competing with traditional fossil fuel generation and a fundamental shift in the adoption of renewable energy based on the bottom line. Now, moving into 2018, another piece of the global energy market looks to make that same leap.

Electric vehicles (EVs) aren't new, but their ability to compete with traditional vehicle sales is. EVs are on the verge of redefining energy's role in transportation as they challenge the economics of internal combustion engine vehicles (ICEVs). However, the rate of adoption will be guided by certain factors beyond the control of EV manufacturers – from oil prices, tech innovation and regulatory changes.

State of the Market

To anticipate the rate of this adoption, OPEC regularly publishes a dense report of market conditions and expectations, OPEC didn't just raise its forecast last year – it multiplied it exponentially.

Revised EV Sales Forecast between 2015 & 2016



(Source: *OPEC, GR&A)*

On the leading edge of this transition are some clear winners. Tesla Motors is the most prominent example. The all-electric vehicle automaker is working to transition from high-priced electric luxury cars toward affordable family vehicles. Already expectations of future revenue have propelled Tesla to a valuation $3 billion higher than Ford's, causing traditional automakers to look at ways to counter:

- Ford has shaken up its leadership and spending structure to focus on the industry's electric future.
- Volvo announced plans to produce electric vehicles exclusively only two years from now.

Meanwhile, in the world's two largest economies - the United States and China – EVs represent less than 2% of the vehicle market share. That disparity leads to two conclusions for 2018:

- There is enough confidence in EV growth for energy groups to reforecast and trigger billions of dollars in research and restructuring by companies looking to benefit.
- That confidence logically stems from expected changes in EV economics that would allow broad competitiveness.

So much investment in EV tech suggests those expected changes are neither theoretical nor particularly far away. This brings the conversation back to three areas best positioned to reshape EV economics moving forward: **oil prices, technological innovation,** and **regulatory change.**

Oil Prices

To determine the economic competitiveness of EVs, the actual cost of ownership is only one variable. Whether they make financial sense requires more than just knowing whether EV costs are rising or falling relative to the competition – in this case, traditional ICE vehicles.

The initial purchase price of a vehicle represents the known cost. The ongoing price of energy to operate the car is at least partially unknown: for EVs, it's electricity vs. gasoline or diesel for ICEVs. Ultimately, a primary cost of vehicle ownership is the cost of its energy source.

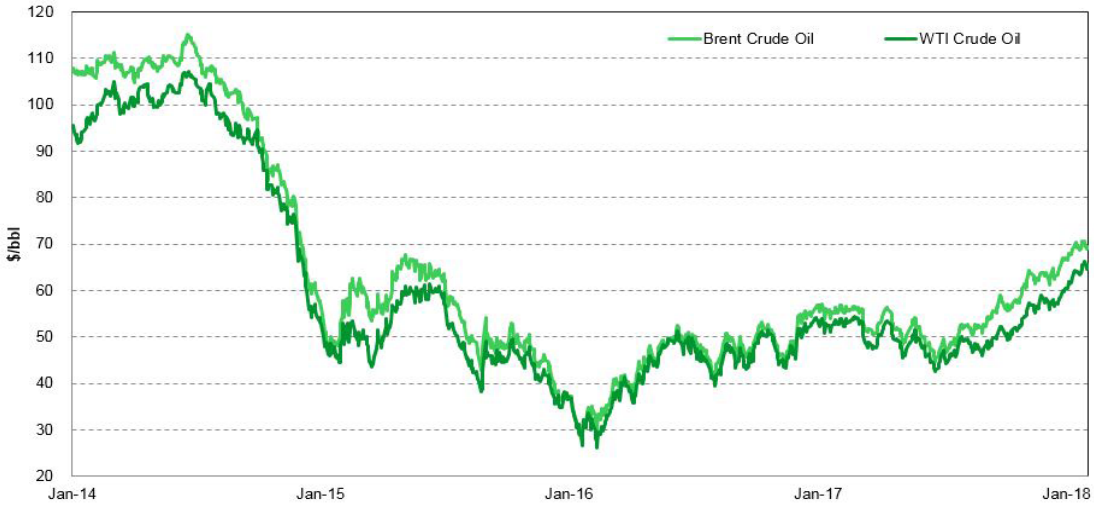
Based on recent oil prices, any growth from the EV sector is impressive. Before late 2014, the oil market enjoyed an extended stretch of trading above $100/bbl. However, those higher prices eventually helped trigger the US shale boom and an OPEC push for market share that briefly pulled prices below $30/bbl by early 2016. With the cost of gasoline and diesel almost completely dictated by the price of oil in deregulated markets, that trend translated to a multi-year decline in the cost to drive traditional vehicles.

Now, while prices remain well below their $100+ peaks, oil costs have risen consistently over the past year. With OPEC's generally successful production cut and global demand steadily rising (thanks to China and

India), oil has good reason to feel bullish. Some have even voiced concerns that lower prices in recent years have led to little exploration and development, a reality that could bring on a large-scale shortage and return prices to pre-2014 peaks.

If oil prices surge, it could buoy EV adoption.

Brent Crude Oil vs. WTI Crude Oil



A steady rise in the cost of oil since early 2016 has boosted the economic competitiveness of EVs. (Source: *Bloomberg)*

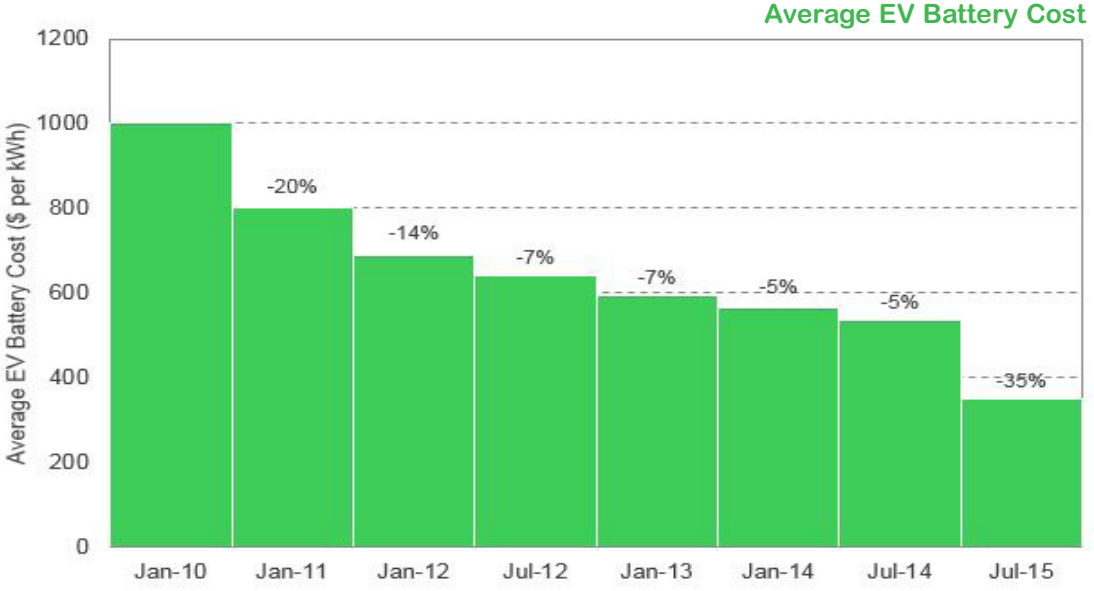
For now, oil price increases are opposed by US production growth, which finished 2017 at all-time highs and with plenty of momentum. However, if the US oil industry falters, an OPEC push for more expensive oil will meet little resistance. If oil prices surge, it could buoy EV adoption.

In some markets, higher oil prices may be enough to flip EVs to the lower cost option in combination with incentives and subsidies. And, for many consumers, the cost of an EV doesn't necessarily need to be cheaper than an ICEV, just competitive. Higher oil prices could create this parity.

Technological Innovation

Innovations in battery tech are another key factor in the overall cost and viability of alternative EVs. Similarly, innovations in battery storage technology can improve vehicle range and performance helping close any gap in the cost of ownership between ICEVs and EVs.

Average EV Battery Cost



Declines in EV battery costs are accelerating. (Source: *Bloomberg)*

A price point of $100/KWh is often cited as the cost threshold where EV batteries become truly price competitive with ICEVs. (Various automakers estimate battery costs are in the $115-200/KWh range .) Evidence from manufacturers indicate these costs are in decline, which is expected given the known improvement to battery storage technology. Most interesting, Tesla's recent forecast for the battery cost of its truck fleet is between $75-90/KWh by late 2019.

Whether batteries can scale to compete with ICEVs globally remains a significant question mark. The cost of elements closely linked to battery storage such as lithium and cobalt have soared at times. Technological improvements that lowered costs for battery storage could eventually be offset -- or even reversed -- by a rise in the cost of related commodities. Though the supply of those commodities hasn't yet been a major limitation, EVs are only a small fraction of the total market. For EVs to challenge ICEVs, input commodity supply could still be a major headache.

Regulatory Change

To understand the impact government regulations can have on vehicle market share, let's look at Norway. There, aggressive government regulations have pushed EV market share to nearly 30% of new car registrations! (Compare that to only 4% in neighboring Sweden.), Though an obvious outlier, Norway achieved adoption of EVs almost entirely through a combination of tax breaks, incentives, and exemption from various tolls.

In China, vehicle registration fees are based on emissions and fuel economy, which discounts battery and plug-in hybrid vehicles **as much as $8,500.**

Other governments have also outlined regulatory targets to promote EV adoption. The Netherlands recently announced plans to ban sales of ICEVs by 2025, with the UK and France targeting 2040. Meanwhile, China stands out as a potential behemoth and trend-setter in the EV market:

- The Chinese economy is still growing rapidly. While leading western economies struggle to maintain 2% growth rates, China has seen its economy consistently expand at a rate of 6-7% annually.
- Economic expansion has generated a swelling middle class that is buying personal vehicles for the first time – as many as 3 million new vehicle registrations per month according to recent data!
- Third, China is serious about making major environmental strides now rather than later.

As the country continues to grow into a fully modern economy, regulatory framework has already been deployed to boost EV viability. Vehicle registration fees are based on emissions and fuel economy, which discounts battery and plug-in hybrid vehicles as much as $8,500, sometimes more locally.

Additionally, EVs in China benefit from restrictions in select major cities that otherwise limit the days and times residents can use their vehicles. As a result, in 2016, China led the world in EV sales with more than 300,000, nearly equaling combined sales in the US and EU.

China's emergence as a leader in the regulatory push towards EV adoption has major implications for developing markets. In India, the government is exploring various restrictions on diesel vehicles and using EV subsidies similar to the Chinese model. That's an important bellwether for emerging markets targeting cleaner transportation without sacrificing rapid economic growth.

Due to these factors, the regulatory environment of leading countries, particularly China, will profoundly affect increased EV adoption, decreased ICEV use, and ultimately, a plateau of oil demand.

> SOURCES

Adelina Colace
NEO Network Operation Program Manager

James Lewis
Sr. Director, Strategic Renewables Int'l Markets

Daniel Waters
Commodity Analyst

4. Regulation, Deregulation & New Technologies:
Impact on Renewable Energy Purchasing

Regulatory considerations and grid integration challenges notwithstanding, renewable energy growth continues unabated. The International Energy Agency (IEA) reports there is now more than 303 gigawatts (GW) of solar PV installed globally following a record-breaking 2016 (and 2017 is expected to smash that record, as well). Wind installations have similarly surged, reaching a total installed global capacity of 487 GW by the end of 2016, with 54 GW installed in 2016 alone.

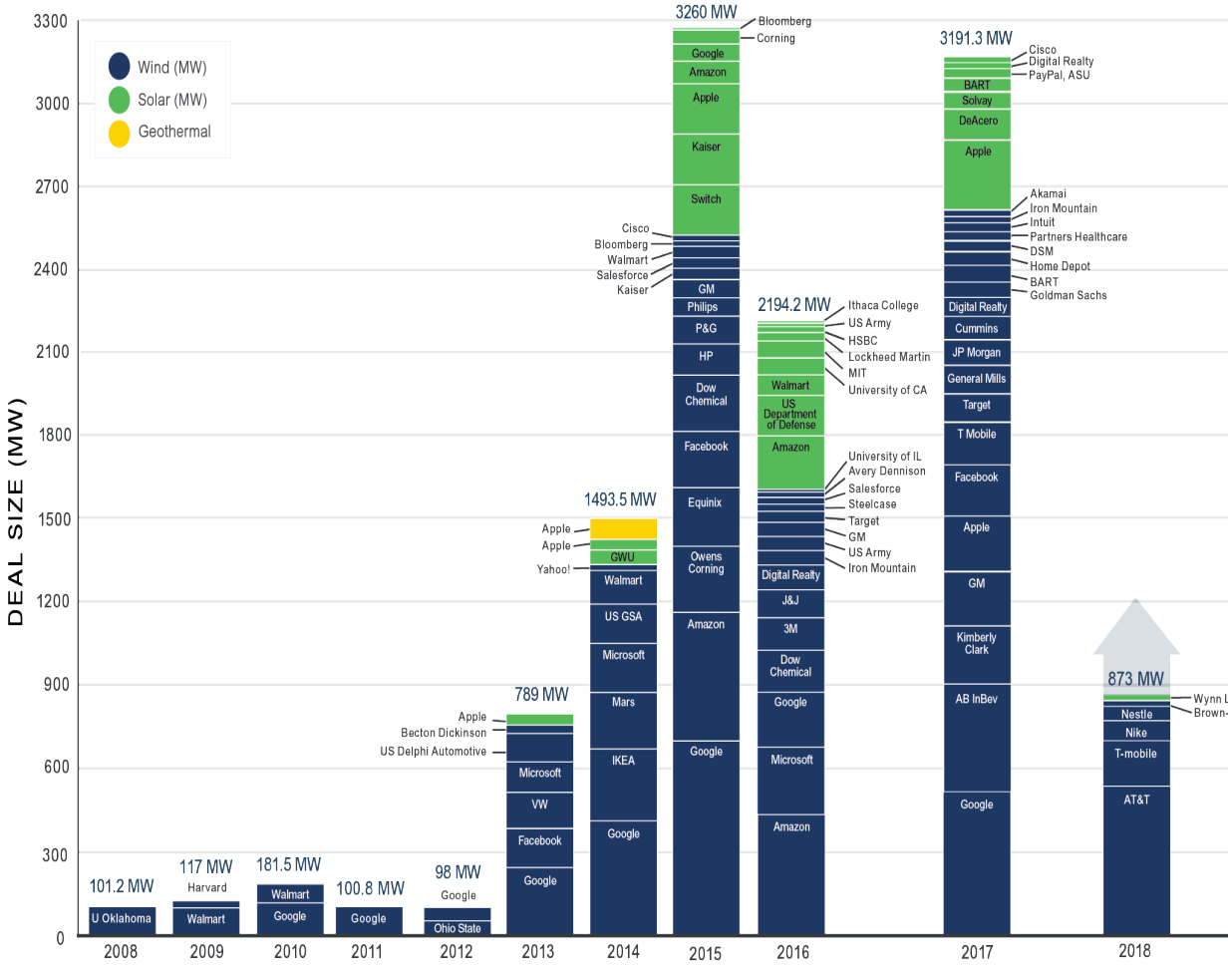
Corporate purchases are in large part responsible for this growth. Commercial, industrial and institutional (C&I) buyers seek to fulfill commitments made under the Paris Agreement, the RE100, the Science-Based Targets Initiative, or for Carbon Disclosure Project (CDP), Global Reporting Initiative (GRI) or financial reporting. In some markets, C&I buyers are finding price parity between conventional brown and green power, as cheaper technology drives down the cost of renewable energy. To date, C&I buyers have contracted for more than 16 GW of new build global solar and wind through offsite power purchase agreements (PPAs) since 2013, including a record global 5.4 GW in 2017.

The entrance of this new class of buyers to traditional supply markets, combined with market developments and disruptive technologies, is increasing the complexity of renewable energy production and utilization. Global markets have begun to respond to consumer demand for greener supply and have either:

- Liberalized (e.g., Mexico)
- Set renewable energy targets for themselves (e.g., India)
- Created commodity structures to underpin valid renewable energy trading systems (e.g., China and Singapore)

Where C&I buyers once purchased North American or European energy attribute certificates (EACs) to meet the entirety of their global goals, buying green power today is more nuanced.

Aggregate Offsite North American Renewable Energy Deals in the C&I Sector



(Source: *Based on publicly announced C&I off-site renewable energy deals (financial, virtual, green tariff, tax equity, etc. in the US and Mexico. Excludes on-site PPAs. Last updated 2/13/18.*

Market Regulation & Deregulation Creates Opportunities, Challenges

Global renewable energy markets are increasingly dynamic. In 2017, the Mexican market continued to liberalize. Reforms passed in 2014 allow for the disaggregation of market ownership by the state-owned utility and open it up to new entrants.

In Australia, a confluence of factors increased energy prices to "crisis" levels. In response, appetite for corporate PPAs increased sharply to mitigate this significant increase. Last year also saw the Chinese government issue its first EACs, which often set the foundation for future market disaggregation and development.

Elsewhere, countries fought to adapt to changing regulation. Beneficial regulations – tax credits or feed-in tariffs – typically support market development, but these policies can easily be reduced or reversed. European markets moving from feed-in tariffs to auctions, or the U.S., which faces headwinds under the conservative Trump administration, may experience uneven growth in 2018. In many global regions, only the utilities or government can own and distribute electricity. Regulation can impact onsite generation, offsite generation, and the creation and procurement of EACs – further complicating buyers' ability to meet green power needs across a global footprint. While these changes can introduce complexity into a company's renewable energy procurement strategy, it is heartening to see new options develop.

Grid Viability and Natural Resources Availability

Market penetration and renewables' availability varies depending on grid viability and natural resources. The intermittency of wind and solar power has led to concerns over the grid's ability to handle significant renewable penetration. However, as major markets reach new milestones, market structuring has helped to mitigate penetration challenges. In February 2017, 52% of load in the US's SPP region was wind-generated. In October 2017, the Texas ISO, ERCOT, met 54% of the region's demand with renewables. Meanwhile, Denmark meets its domestic load with 100% renewables.

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Renewable energy viability often comes down to nature itself: how much does the wind blow, how long does the sun shine, and how rapidly do countries adopt renewable energy solutions as a result. Concerns over the intermittency of these natural resources will continue to challenge market expansion in 2018.

Increased corporate and investor expectations have led to innovations in technology and grid structures, helping to address both intermittency and curtailment. For example, an electricity connection between Germany and Poland will re-open this year with new phase-shifting transformers. These transformers are a direct solution to the substantial wind capacity in northern Germany that regularly (but unpredictably) flows across the Polish border. Greater grid stability in Poland is welcome news as it emerges as an attractive European market for C&I direct purchasing.

China, the nation with the highest curtailment challenge, also has the most wind resources. In resource-rich northern provinces, a rapid build-out of wind technology resulted in a 17% wind energy curtailment ratio in 2016. A three-fold plan to address this constraint may serve as a model for other regions:

- New investments in Chinese wind directed at regions outside the bottlenecked supply markets through 2020;
- Investment in long-distance transmission infrastructure to better direct generation to demand centers; and
- Improved price discovery for transmission capacity, leading to more efficient performance of existing infrastructure.

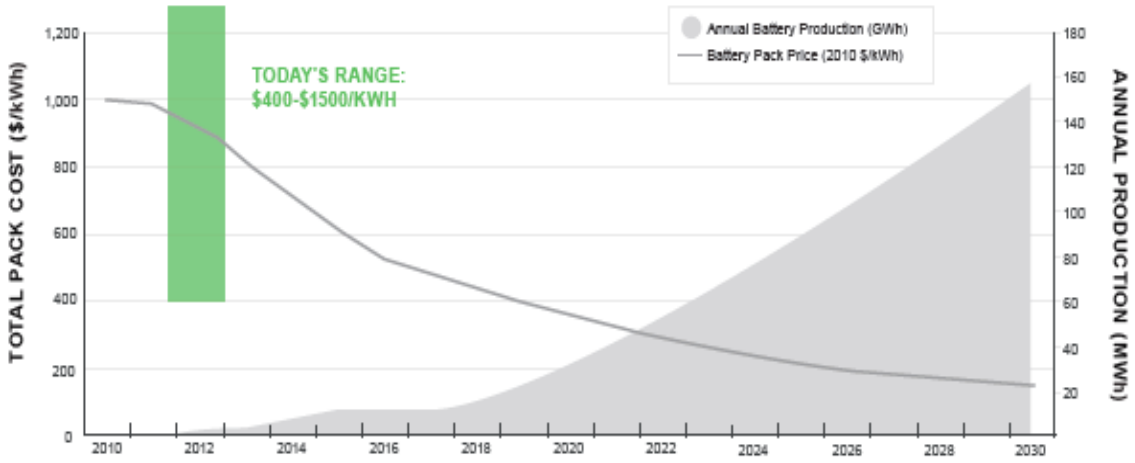
Resolving these concerns will ultimately be good news for C&I buyers looking to address their load in China as the market continues to open.

Technology Enables Growth and Innovation but Introduces Complexity

Wind and solar aren't the only cleantech opportunities becoming cost competitive. Energy storage and battery solutions are rapidly developing, as well. Amazon, Walmart, and Apple are among the C&I companies that rely on battery storage to manage intermittency and allow greater application of renewable electricity.

Innovative buyers are also looking at fuel cells as a viable, cost-feasible technology that provides an alternative to conventional baseload power. In 2017, global data center and colocation services provider Equinix announced the largest fuel cell deployment in the ICT sector to date.

Li-Ion Battery Pack Cost & Production 2010-30



(Source: *Bloomberg)*

Blockchain among the most disruptive innovations in 2017. This distributed, digital ledger tracks transactions using sophisticated algorithms that validate, encrypt, and instantaneously record exchanges securely. Blockchain underpins Bitcoin virtual currency – which has captured the attention of global financial markets – but has even greater potential due to its high degree of transactional efficiency.

As energy markets continue to deregulate and decentralize, barriers to direct market participation decrease and more distributed energy resources (DERs) — such as rooftop solar — develop. However, DERs struggle to emerge in a large centralized system that was not devised for them. Blockchain and other distributed ledgers allows DERs to instantaneously generate and track EACs without the need to work through the grid system, which facilitates improved and more flexible trading of renewable energy.

> SOURCES

How much, or how quickly, distributed ledgers will shift global grids is yet to be seen.

Matt Sanders
Sourcing Director

5. Decarbonizing Heat:

What Hydrogen, Arnold & Denmark have in Common

In early January, temperatures across Europe ranged from a comfortable 22 degrees centigrade in Palermo, Italy to a chilly -15 degrees in Kemi, Finland. The regional average was a coolish 8 degrees. Consequently, practical thoughts turned to how to effectively and affordably heat homes and work places, not necessarily the sustainability and environmental impacts of these decisions. (Statistics from the EU suggest 84% of heating and cooling is still generated from fossil fuels.)

The decarbonization of heat production doesn't garner as much interest as other related topics. Undoubtedly, images of heat pumps and district heating infrastructure are not as photogenic as wind turbines, solar arrays or the latest model Tesla. But, if the 80% CO_2 reductions target by 2050 is to be achieved in the UK, heat-related emissions must reduce significantly.

Across Europe, the majority of heat for homes and businesses is underpinned by the combustion of fossil fuels, notably natural gas or its variants. To a lesser extent, oil and coal are in play, as is nuclear-generated electricity in France. Gas usage reflects its convenience, reliability and safety for domestic and commercial heating purposes. This is coupled with its generally wide availability within Europe (from both indigenous supplies and imports from Russia, the Middle East and increasingly the US).

The global supply of gas creates, in addition to its environmental impacts, serious political tensions. These have manifested themselves in supply security issues, most notably in 2009 with supply disruptions caused by Russia and Ukraine disagreements over gas payments.

Of the c. 600 billion cubic meters (bcm) of gas used across Europe, some 250 bcm comes from within Europe (mainly Norway, UK and Netherlands) and c. 250 bcm comes from Gazprom (the Russian gas giant whose majority stakeholder is the Russian state). The remainder comes mainly from the Middle East. This dependency on Russia – and the resentment of the leverage this affords them over many central European states – is no doubt why President Trump's promise to export more US shale gas to Europe in July '17 was warmly welcomed in many quarters. This momentum only increases with new Russian sanctions on its gas and oil assets by both the US and EU.

There are history lessons in how to address both emission reductions and security of supply. During the oil crisis of 1973, Denmark's reliance on imported oil was highly problematic as both homes and businesses went without heat during the winter. Consequently, Denmark reduced its dependency on oil to improve its security of supply. Central to these plans was an emphasis on 'district heating' (alongside other energy efficiency projects and growth in renewable generation). In essence, district heating schemes created a system that generates heat and hot water (and electricity in some cases) locally and distributes it to surrounding homes and businesses.

The system's scale benefits from greater operating efficiencies (vs., say, boilers in each property). In most cases, it also captures 'left over' or wasted heat from industrial processes locally, which creates further efficiencies. This has proved successful in Denmark where nearly two-thirds of homes get their heat this way. Similarly, 50% of Swedish heating demand is supplied by district heating schemes.

In Denmark, almost **two-thirds of homes** get their heat from such schemes.

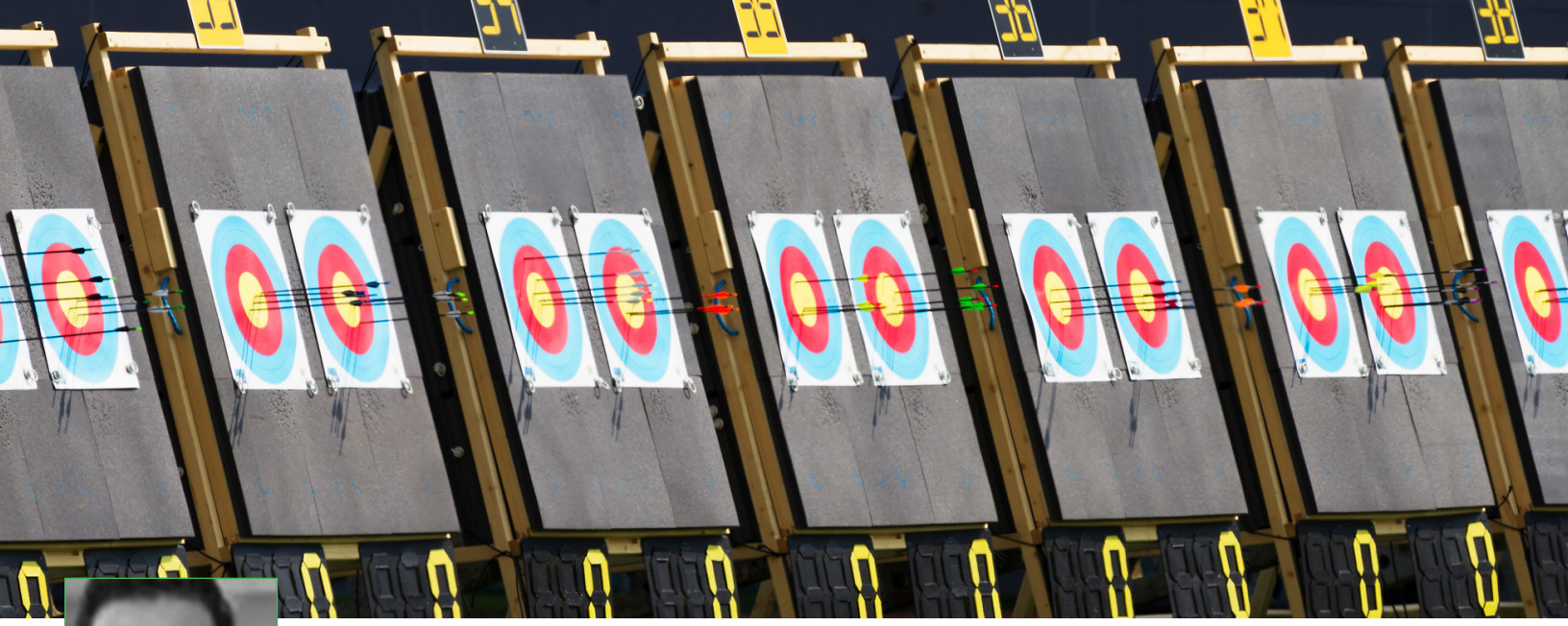
Similarly, **50% of heating demand** in Sweden is supplied by district heating schemes.

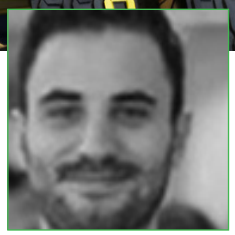
In the UK, as North Sea gas reserves dwindle, there is increasing focus on the benefits and potential of district heating schemes. Studies show waste heat in certain cities could be sufficient enough to cover a significant amount of its heating demand. District heating is also being encouraged across Europe as it forms a central part of the EU's heating and cooling strategy.

This strategy is multi-faceted, but a common theme is utilizing technology to drive energy efficiency – ranging from 'intelligent,' cloud-based systems to control district heating schemes to solutions to recover more waste heat from industrial processes through 'heat batteries'. The latter example is part of a focus on improving buildings themselves since space heating is a significant component of heating demand overall. The ability to find solutions to decarbonize the current "heating setups" across homes and businesses is no small task and will take many forms.

Hydrogen is one of these. Its part in sustainability initiatives is probably most closely associated with the 'Governator' himself, Arnold Schwarzenegger, and his plans back in 2004 to develop a "hydrogen highway" in California. Hydrogen's resurgence is led by some innovative work by the HyDeploy project. This group is exploring the potential to blend hydrogen with natural gas at the University of Keele in the UK. This would significantly reduce emissions since hydrogen, when combusted, just makes water. And, project leaders are hopeful this approach would allow the use of the existing network infrastructure and appliances without any modifications. If viable, this would be a significant step forward in decarbonizing heat whilst minimizing disruption and combating emissions.

> SOURCES





Tom Bardwell
Sustainability Consultant

6. Increased Momentum on Science-Based Targets

For many years, environmentally conscious companies have set targets to contribute to their organization's specific sustainability efforts. What's beginning to change is the thinking behind how those goals are developed. More specifically, there's increasing momentum for company's to align their corporate environmental objectives with climate science.

Enter Science-Based Targets (SBTs).

This collaboration between CDP, WWF, World Resources Institute and United Nations Global Compact provides companies with a pathway to set goals that will help limit global warming to below 2^{O} Celsius. And the practice is gaining traction: **more than 300 companies** have committed to SBTs. During 2017 alone, several large multi-national corporations committed to new SBTs and adopted them into their business strategy, including Coca-Cola, Hewlett Packard and Walmart.

Unlike general carbon reduction targets internally set by individual organizations, SBTs follow an internationally-agreed upon methodology and, in fact, require even deeper carbon consumption cuts. Setting any carbon reduction target – whether a SBT or internal – can be a daunting task, especially when an organization's operations are environmentally and geographically far-reaching.

So, why are SBTs gaining popularity among businesses? Three primary reasons:

Standardization

The SBT initiative establishes standards and methods to assess and quantify an organization's environmental impact on greenhouse gas emissions, water use and deforestation. This ensures the company sets a robust target that is proportional to its sector, economic performance or impact on global carbon emissions.

Scalability

Similar to GRI guidelines for non-financial performance reporting, committing to a SBT vs. an internally-agreed goal adds weight and relevance to an organization's environmental strategy. This improves investor and stakeholder confidence in any claims made regarding environmental achievements, and ensures organizations take proportionate responsibility for their contributions to global emissions based on their size and sector – all while accounting for growth.

Accountability

Organizations are held to publicly-announced commitments since the SBT process requires an organization to submit a commitment letter, develop a target, have it validated and then make it public. CDP only permits a 24-month window to turn that statement into an achievable and realistic target for validation. Failure to meet this deadline would invalidate the statement of commitment and potentially create some reputational damage. This structured approach seems to help businesses maintain momentum as they move from their environmental vision to reality.

Organizations with Scope 3 emissions that account for more than 40% of their overall footprint are required to include them in any SBT. For many organizations already working to reduce emissions, identifying *even more opportunity* to improve may be difficult. As mentioned previously, energy efficiency measures alone will not be enough to meet SBTs.

Companies that choose to pursue ambitious GHG reductions will need to pursue more aggressive energy management strategies. This may mean implementing energy efficiency programs in conjunction with purchasing electricity from renewable sources, engaging partners in the organization's supply chain and managing energy more actively across internal departments.

Clearly, addressing scope 3 emissions is no small task, but the momentum behind adoption of SBTs largely can be attributed to measurable business value. Companies report better data visibility and quality, reduced operational costs and improved efficiency. As more businesses incorporate SBTs, there will undoubtedly be further progress and investor demand for this approach in 2018.

> SOURCES

Conclusion

Global energy markets will continue to respond – sometimes with dizzying, even frightening speed – to geopolitical changes, regional dynamics, emerging technology, and traditional supply and demand influences. The complexity of this convergence will only grow. That's why there's real value in understanding how these trends and others that emerge will impact your enterprise in 2018.

Watch these market dynamics closely as the landscape is sure to evolve. This focus could change the way you secure energy supply, improve your efficiency and operate more sustainably in 2018.

To stay close to developments across energy and sustainability, visit us at **hub.resourceadvisor.com** and subscribe.

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