Will new energy technologies power or impede global business?

THOMSON REUTERS®

Powering the Planet 2045

A Thomson Reuters perspective on the main sources of power over the next three decades and suggested business strategies.

"Today's [Paris] agreement demonstrates without question that it is possible for us to come together in common cause to address the greatest challenges we face, preventing tragedy for the many millions of people vulnerable to the effects of climate change and securing the economic prosperity of the world in the 21st century.

The result is an unequivocal signal to the business and financial communities, one that will drive real change in the real economy. The billions of dollars pledged by developed countries will be matched with the trillions of dollars that will flow to low carbon investment."

Paul Polman, CEO, Unilever

Contents

LETTER FROM THOMSON REUTERS CEO JAMES SMITH

We're on the cusp of massive electrical-energy changes that will have a lasting impact on global business and commerce. The recent volatility in oil prices has created a ripple effect in virtually every industry around the globe.

Carbon markets and emissions trading schemes are driving new energy investments. Stranded assets and carbon taxes give accountants and tax attorneys new financial considerations. Legal ramifications related to coal and hydraulic fracturing open new challenges, and opportunities, in the field of law.

Disruptive energy technologies are being funded and commercialized by innovative companies around the world, and scaled as viable solutions for how we structure, operate and succeed in the future.

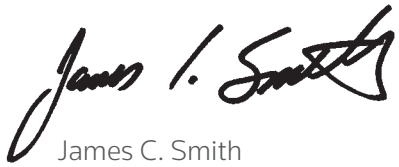
US President Barack Obama's 2011 State of the Union Address set a goal of having 80 percent of the country's electricity generated from clean-energy sources by 2035, while the conclusion of last year's historic COP21 Summit involved nearly 200 heads of state from countries that agreed to take a united stance against global-greenhouse-gas emissions and energy sources that contribute to them. It is certain that changes are afoot in the sources of power we use and how they impact us as business leaders.

Thomson Reuters is uniquely positioned to provide valuable insight on this topic. Our strategic solutions and information resources offer a one-of-a-kind perspective on a multitude of factors related to energy, from legal and tax implications to investment opportunities and emissions trading schemes.

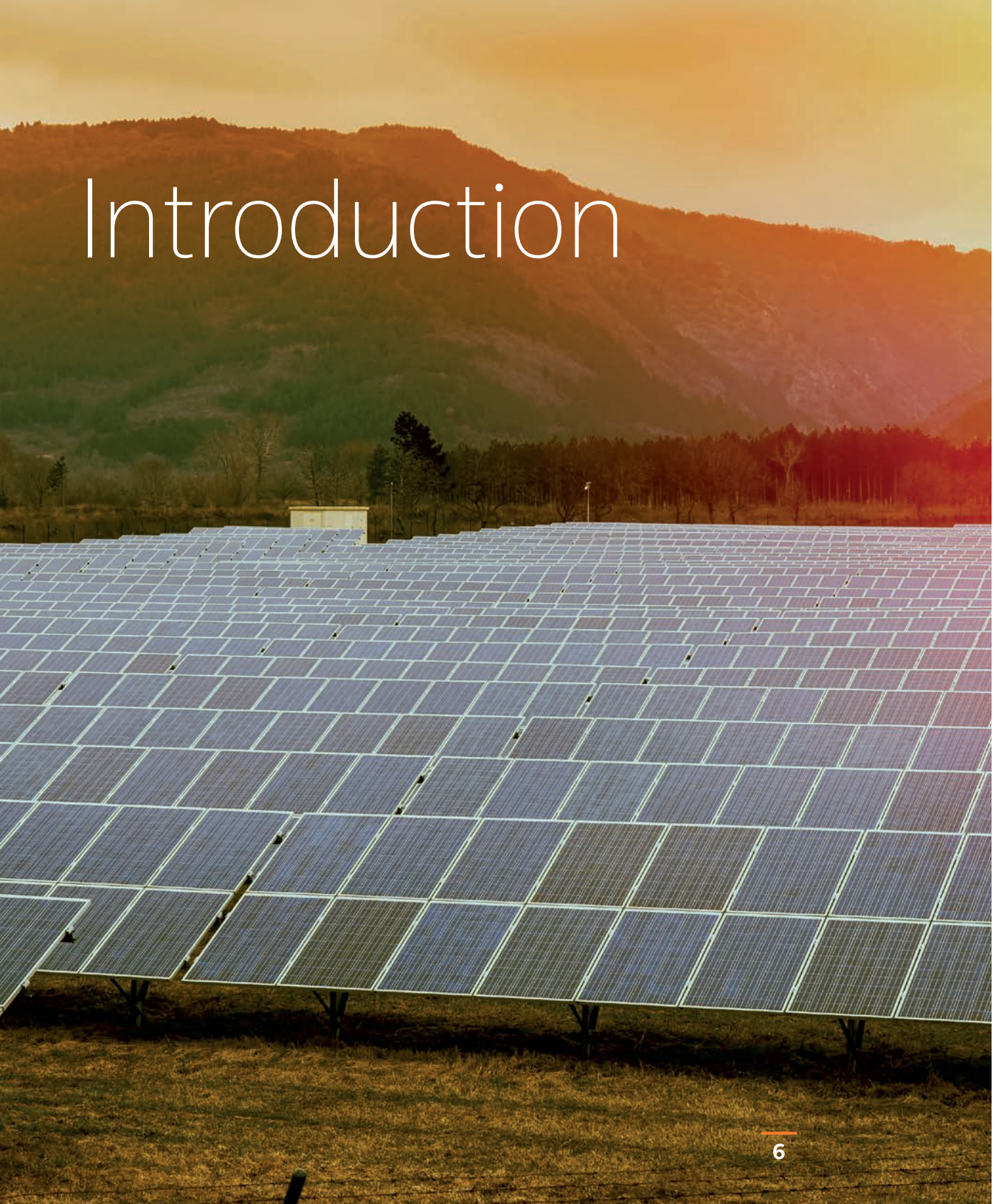
This document is the first in a series of enterprise perspectives that provides a holistic view on big issues using detailed snapshots of the underlying catalysts to change.

I invite you to take a read-through and share your thoughts and comments with us on twitter.com/#poweringtheplanet. We look forward to continuing the discussion with you.

Very truly yours,



James C. Smith
CEO
Thomson Reuters



Introduction

There's a perfect storm brewing that's destined to have a lasting impact on all of us.

The frequency and severity of catastrophic weather events have reached an all-time high while the price of oil has plummeted to a near-record low. Public sentiment is calling for the preservation of our planet for future generations. Social media and news articles tout an increase in global temperatures, decrease in fossil-fuel appetite and the difficult challenge of actualizing 2015's historic Conference of Parties (COP21) agreement. From farmers to federal agents to front-office business executives, the world's attention is focused on how to manage risk and secure a stable future.

While very few can agree on the best path forward for addressing this challenge, the one thing pretty much every constituency does agree on is that global energy production plays a central role in the debate.

There are many sources of greenhouse gas emissions including a significant percentage coming from methane production associated with fracking and well pads, as well as carbon monoxide and carbon dioxide emissions associated with the burning of fossil fuels to generate electricity. In order to reduce global warming and our carbon footprint, we need to change the sources of energy on which we rely. To preserve our planet and reduce the risk of the Digital Age's environmental waste, we need to better understand the energy mix and prepare to capitalize on technologies that will be viable (and scalable) in the next 10-30 years.

Is it even possible to achieve the outcome set forth at COP21: a 2-degree Celsius cap in the rise of global temperatures above Industrial Era levels? What impact will changes made and specific incentives have on businesses today, and tomorrow? With this as part of the backdrop as we move through 2016, Thomson Reuters analysts address the topic of energy by focusing on the future of power, methods for generating electricity over the next several decades and what it means for business around the world.

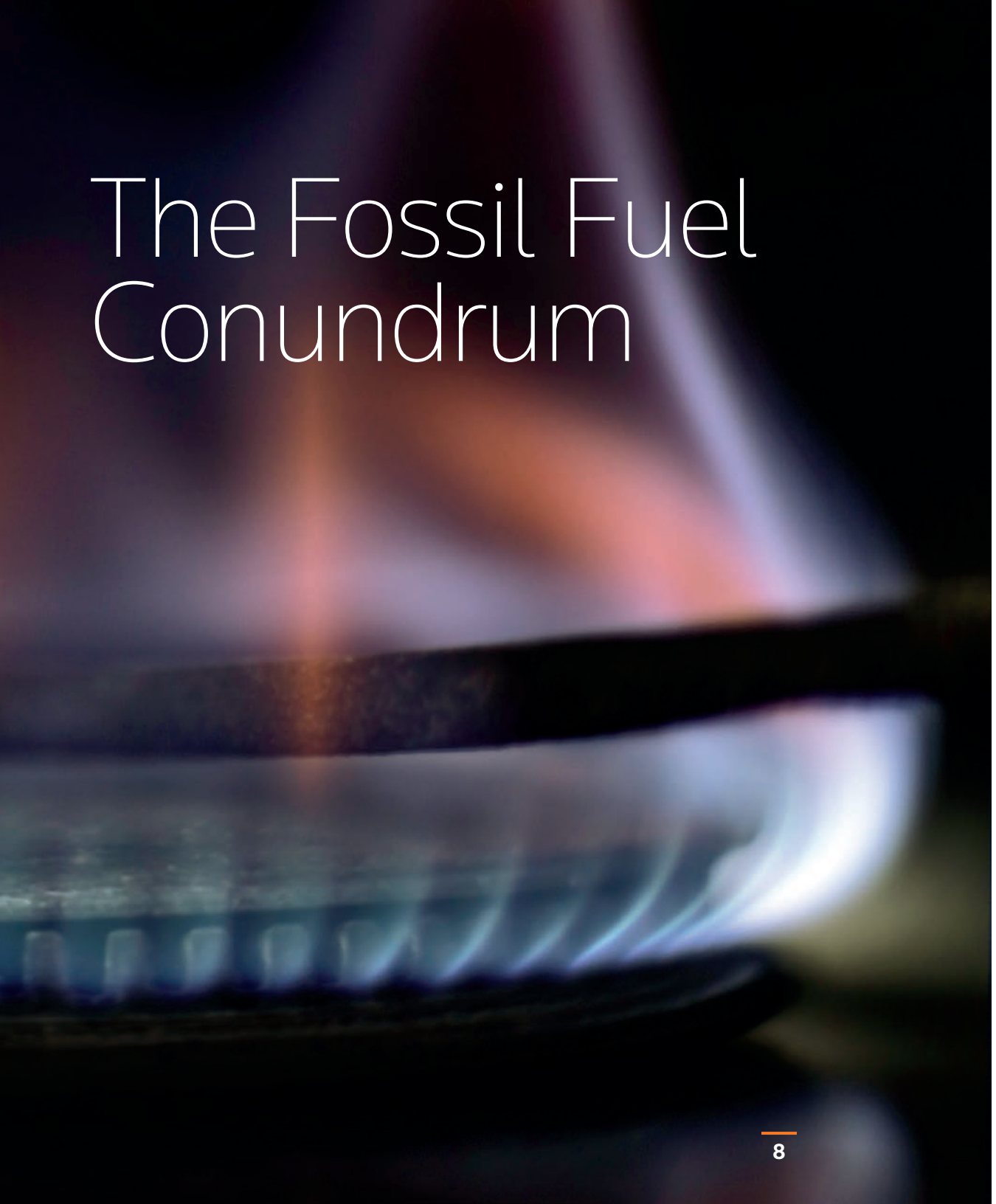
ENERGY

From the first moment of our universe's inception to the recent discovery of the Higgs boson particle, energy has been an essential component of life. Different forms of energy produce different results, providing the power necessary to fuel our bodies, vehicles, homes, communities and planet.

The journey of energy that powers the planet has been varied. In the beginning, the sun was the main source of power. However, technology to harvest its power has only recently become scalable and viable. In its early days, it was used to grow food and provide warmth. Today, it can power automobiles and cities.

With the introduction of fire came the eventual incineration of various combustible materials, including coal. Oil was next, the purported godsend for powering vehicles, heating homes and producing electricity to power the proliferation of electronic devices used daily. Today, all of these methods of power generation persist, yet even more advanced options, many of which we refer to as renewables, are also increasing in viability.

The purpose of this paper is to showcase the primary methods of generating electricity that will be used to power earth in the next 10 to 30 years, providing insight into their benefits and drawbacks based on perspectives from industry experts and using Thomson Reuters data and solutions.



The Fossil Fuel Conundrum

The perils of greenhouse gas emissions from burning fossil fuels are well-documented, and while this report is primarily associated with power generation in the form of electricity, it is important to look at emissions across all sectors to get a complete picture of the situation.

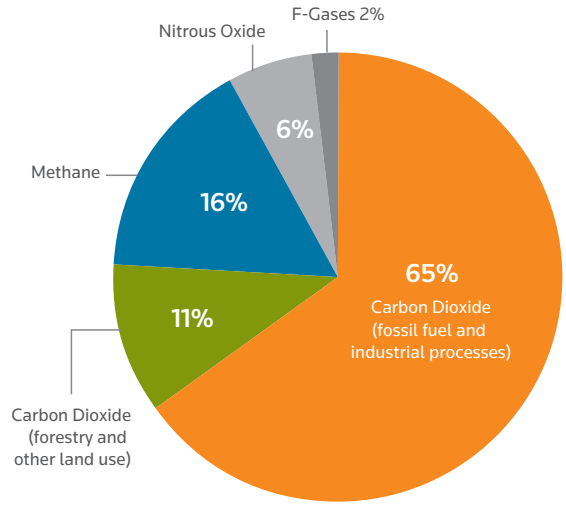
Despite the known perils, fossil fuels continue to persist as dominant power sources at present (see **Figures 1A** and **1B**). In fact, the European Commission's Joint Research Centre & Institute for Environment and Sustainability reported that global emissions from fossil-fuel combustion and industrial processes reached 35.7 billion tonnes (Gt) in 2014, the highest year on record (prior to 2015 data being available).[1]

The Thomson Reuters Global 500 Greenhouse Gas Report: The Fossil Fuel Energy Sector[2] outlines how the GHG-emissions gap is widening. For example, from 2010 to 2013, emissions increased by 1.3 percent when they should have decreased by 1.4 percent per year. This equates to a 5.5 percent gap over that period. **Figure 2** shows the projected long-term effects of this gap and sharp adjustment needed to meet goals set for 2050.

Despite their ubiquitous prevalence, fossil fuels have peaked. Thomson Reuters analysts state that it's now clear that 2005 was the year with the largest volume of oil consumption in the US and other advanced economies, as reported in *A Brief History of the Oil Crash*.

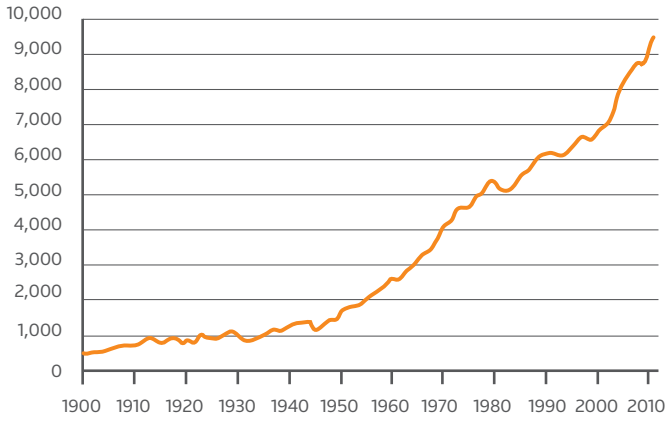
A confluence of factors has contributed to the decline of oil: the shifting landscape and production of oil in the Middle East and elsewhere, an increase in shale drilling and natural gas consumption, and expanded awareness of the ill effects of greenhouse gas emissions. These have resulted in extremely low oil prices. **Figure 3** shows hedge fund positions versus oil prices for the 12 months of 2014. Brent oil dropped over the last quarter of that year from $86/barrel to less than $47/barrel at the beginning of 2015, and the slide has continued.

Figure 1A. Global Greenhouse Gas Emissions and Their Sources (2010)



Source: Intergovernmental Panel on Climate Change (IPCC)[3]

Figure 1B. Global Trends in Carbon Emissions from Fossil Fuels (1900 – 2011)



Source: Carbon Dioxide Information Analysis Center (CDIAC)[4]

1 http://edgar.jrc.ec.europa.eu/news_docs/jrc-2015-trends-in-global-co2-emissions-2015-report-98184.pdf

2 http://thomsonreuters.com/content/dam/openweb/documents/pdf/corporate/Reports/global-500-greenhouse-gas-report-fossil-fuel-energy-sector.pdf

3 http://www3.epa.gov/climatechange/ghgemissions/global.html

4 http://www3.epa.gov/climatechange/ghgemissions/global.html

WHERE NATURAL GAS LOSES STEAM

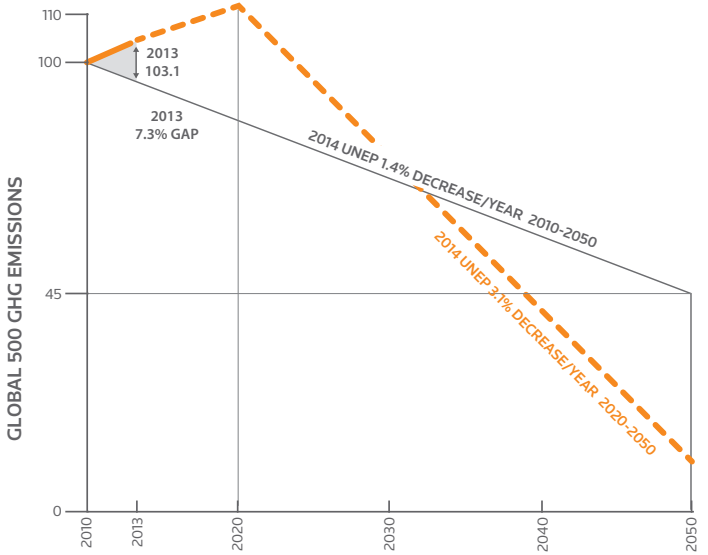
The US increased its shale drilling and natural gas production to offset oil's uncertainties. In response, the US Department of the Interior's Bureau of Land Management (BLM) developed new regulations for hydraulic fracturing ("fracking"), acknowledging that "this technology has opened large portions of the country to oil and gas development." The new federal rules took effect on June 24, 2015 (80 FR 16128-01; 43 CFR Part 3160). Prior regulations were developed 30 years earlier and hadn't anticipated the widespread use of fracking or the advanced horizontal-drilling technology now used to extract oil and natural gas.

The Fish & Wildlife Service in the US expressed its concerns about fracking in a recent document: "...hydraulic fracking and steam injection are relatively new techniques and there is limited knowledge and evidence of their potential to affect surface resources. Due to these uncertainties, data limitations prevent us from quantifying the likelihood or magnitude of ...the potential impact of hydraulic fracking."

Although natural gas and clean coal have been hailed as saviors from the hazards affiliated with traditional coal and oil, contributing less to the world's carbon footprint than their long-standing cousins, their use as a viable, long-term source of power is questionable. Professor James O'Reilly explains this in his book *The Law of Fracking* (2015, Thomson Reuters).

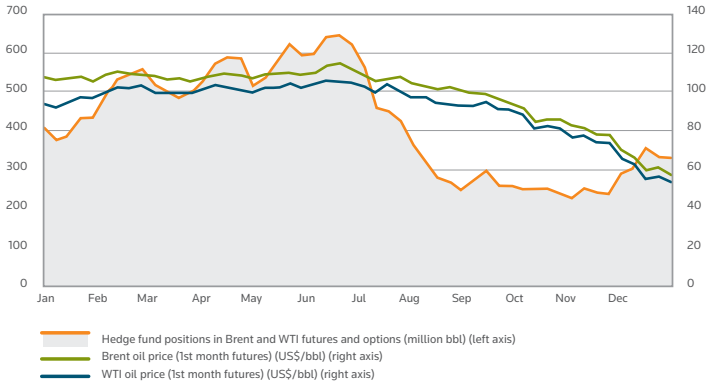
Despite improvements in techniques used to extract the gas from new and previously used oil sites, the process is disruptive and its aftereffects uncertain. Lateral drilling requires pumping massive volumes of water and chemicals into underground caverns to extract the gas. Once extracted, it is accompanied by hazardous elements such as radium-226, thorium, radium-228, brominated compounds, volatile organics, lead and other hazardous waste. These are typically left at the drilling site for the local community to handle, alongside the standing ponds with their contaminants and sludge that pose a threat to local residents and the environmental ecosystem. News reports cite an increase in earth-quakes and aftershocks in regions where shale drilling and hydraulic fracturing occur, regions that previously were immune to these environmental calamities.

Figure 2. Top 32 GHG-Producing Companies Globally and Their Emission Output



Source: Data from the Carbon Dioxide Information Analysis Center (CDIAC); analysis by Thomson Reuters

Figure 3. 2014 Hedge Fund Positions and Oil Prices



Source: Thomson Reuters Eikon™

Professor O'Reilly explains that today's natural gas fracking is virtually always done by LLCs interacting at a well site under some form of a master agreement with the extracted gas sold into export or interstate uses.

Americans have yet to work out the fiscal puzzle of gas fracking's "legacy costs," which economists call "environmental externalities," O'Reilly states. Who owns the legacy cost of the fracking boom after the boom has shrunk, and when will the repair funds for roads and bridges and culverts that suffered mega-sized convoys of supply trucks arrive? Who remains to restore the stream flow and neutralize the toxins – and more practically, who pays for the fence to keep out children or animals at risk of adverse exposures?

"Legacy costs cannot be borne by the shadows in an empty Delaware post office box, the former home of a dissolved LLC," O'Reilly professes. "'Full speed ahead for extraction' was the rallying cry of the fracking blitz. Now, the United States and its smaller communities have inherited legacy costs earlier dismissed as an irrelevant obstruction. How legislation responds is still to be determined."

"The cheap natural gas boom in the US has helped to undercut coal economics, and coupled with very cheap wind power and declining solar costs, this has actually helped renewable adoption. As an example, the US installed more solar capacity in 2015 than it did natural gas capacity, despite record low natural gas prices. This is likely a trend that will continue, and once the coal is largely displaced, natural gas will be the natural next target."

Neil Fromer, Executive Director, Resnick Institute

Hydraulic Fracturing ("fracking") – A Thomson Reuters Author's Perspective

From an interview with Professor James T. O'Reilly, author of *The Law of Fracking*

THOMSON REUTERS: *Is fracking a risk in itself?*

JAMES T. O'REILLY: No, it is a technique that maximizes recovery of gas from shale when done with safe workers and awareness of waste issues. The risk comes from the volatile "off-gassing" of methane from well pads, especially when the radioactive drilling wastes are left undealt with by the drillers. These "legacy cost" risks become significant expense items after the industry dissolves its limited liability companies at the site.

THOMSON REUTERS: *What's the outlook for fracking?*

O'REILLY: The recent years' rapid growth in shale gas extraction represents its "teenager" years. The technology is not new yet there remains lots of room for future growth. The rate-limiting step is, "Who pays for the waste effects?" If the industry operated in a manner that neutralized the radium and thorium waste and could reduce the volatility of the biocide/lubricant outflow, these technical changes would aid the reputation of the drillers who often leave local residents unable to use their land or water.

THOMSON REUTERS: *What is good about fracking?*

O'REILLY: In the US, technological advances have pleased engineers by capturing more of the long-dormant shale gas bubbles, while local production numbers have pleased economists by substituting for imports of liquefied natural gas from the Middle East.

THOMSON REUTERS: *What are some of the regulatory-related trends shaping this industry?*

O'REILLY: Most of the action is playing out at the administrative level within federal EPA and some state water quality agencies. The December 2015 US EPA announcement of its multi-office coordinating team on fracking problems heralds more central attention within the EPA. The radioactive sludge barge proposals for moving wastewater down a few major rivers will be decided by the Coast Guard this year and likely will be immediately litigated. Export terminals and the rush for additional miles of gas pipelines to the export sites will stir even more legal controversies.

THOMSON REUTERS: *How have the setbacks with the Keystone Pipeline impacted the industry?*

O'REILLY: Keystone directly impacted only Canada's tar sands liquids. The pipeline was not designed for gas that would flow from fracking. But by focusing public attention on pipeline accidents and leaks, the debate raised awareness that the rush to pump huge volumes of fracking gas into East Coast and West Coast tanker ports could have localized negative impacts.

THOMSON REUTERS: *What are some specific liability issues around transport by rail?*

O'REILLY: North Dakota's "Bakken crude" is much more volatile than conventional oil train cargoes of the past. Railroads assert that they must accept these cargoes as "common carriers" but many in the public fear aging rails and weaker infrastructure may lead to more deaths and property damage. By 2020, I believe derailment explosions will have led to tougher legislation, but near-term change is doubtful. Rail safety issues have not reached the national visibility that is likely to occur in the near future. ●

LITIGATION: OIL & GAS vs. COAL

Professor O'Reilly warns about the potential for increasing litigation and legal action related to hydraulic fracturing, greenhouse gases, oil and gas transportation, among other things. In order to monitor this, it's important to have a benchmark to understand the current litigation landscape for leading sources of power that generate electricity.

The Oil & Gas and Coal industries face differing challenges in terms of litigation. Westlaw® data on cases in US District Courts from 2012 to 2015 reveals significant differences in the makeup of lawsuits impacting each industry, reflecting a degree of their divergent fortunes.

Oil & Gas

For the Oil & Gas industry, torts/negligence cases make up the largest proportion of lawsuits. A sizable minority percentage of those cases are related to the BP/Deepwater Horizon accident in 2010 and resulting litigation.

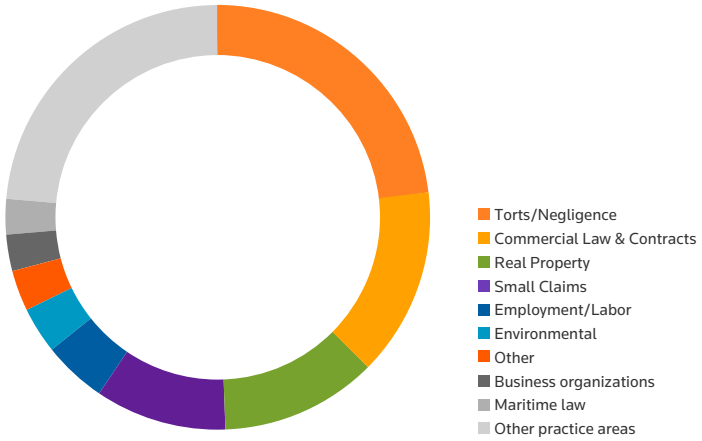
Together with commercial law & contracts and real property cases, the top three practice areas make up roughly half the lawsuits the industry faced from 2012 to 2015, as shown in Figure 4.

Coal

In contrast, the Coal industry faces increasing pressure on several fronts, including stricter, more costly environmental regulations and competition from significantly lower oil prices. This has led to higher levels of corporate debt, falling profit margins and widespread layoffs.

Analysis of lawsuits on Westlaw reflects some of these pressures. Employment and labor law cases make up the largest proportion of them, as companies, labor unions and workers deal with contentious employment issues involving layoffs, labor agreements, work actions and unemployment. These cases accounted for nearly one-quarter of all industry lawsuits from 2012-2015. In contrast, employment and labor-law cases accounted for less than five percent of lawsuits facing the Oil & Gas industry.

Figure 4. Oil & Gas Industry Lawsuits (2012 – 2015)



Source: Thomson Reuters Westlaw™

Environmental cases made up a slightly higher percentage of lawsuits for the Coal industry (5.6 percent) compared to the Oil & Gas industry (3.6 percent). Meanwhile, bankruptcy cases made up 4.1 percent of cases facing Coal, as shown in **Figure 5**, as more than half a dozen coal producers filed for bankruptcy in 2015. In comparison, bankruptcy cases made up less than one percent of cases for the Oil & Gas sector.

Patent Litigation in the Oil & Gas Industry

Many of the major Oil & Gas industry players have avoided being involved in patent litigation in US courts in recent years, the notable exception being Royal Dutch Shell PLC.

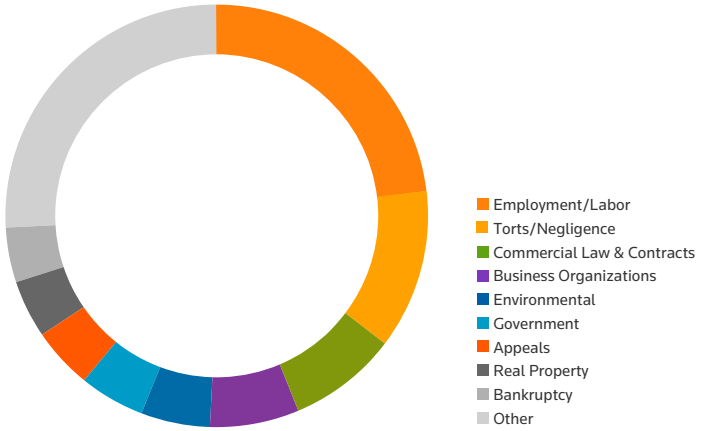
Analysis of Westlaw data from 2012 to 2015 shows that Royal Dutch Shell was named as a defendant or counter-claimant in nine cases in US Federal Courts, by far the most of any Oil & Gas company, as shown in **Figure 6**. BP Biofuels North America LLC, part of UK-based BP PLC, was named in five cases. Marathon Oil Corp. was a defendant in two. Gulf Oil LP, BP Energy Co., and Occidental Petroleum Corp. had one case each over the same period.

Notably absent are many of the other large oil and gas companies, particularly US-based ExxonMobil, Chevron and ConocoPhillips.

Nearly all the litigation was filed by smaller companies, claiming that others had illegally appropriated their technology. An example is Deep Water Slender Wells Ltd., a small US-based company, which claimed that Shell had infringed on its patent for deep-water drilling technology.

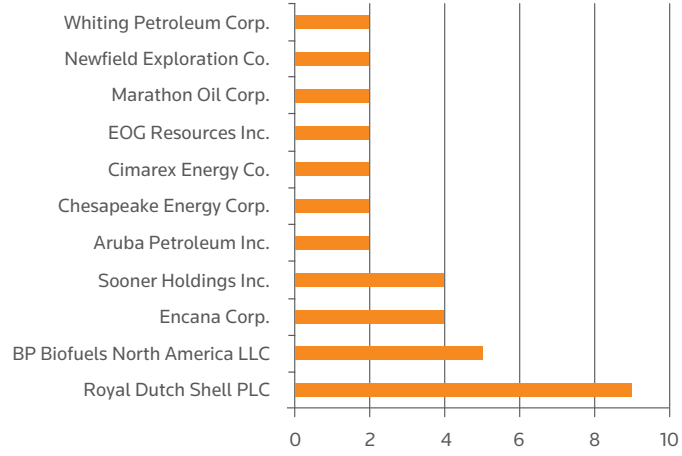
Major Oil & Gas companies were rarely involved as plaintiffs. Royal Dutch Shell PLC filed two cases between 2012 and 2015. There were no patent litigation cases involving two large Oil & Gas companies on opposing sides during that period. ●

Figure 5. Coal Industry Lawsuits (2012 – 2015)

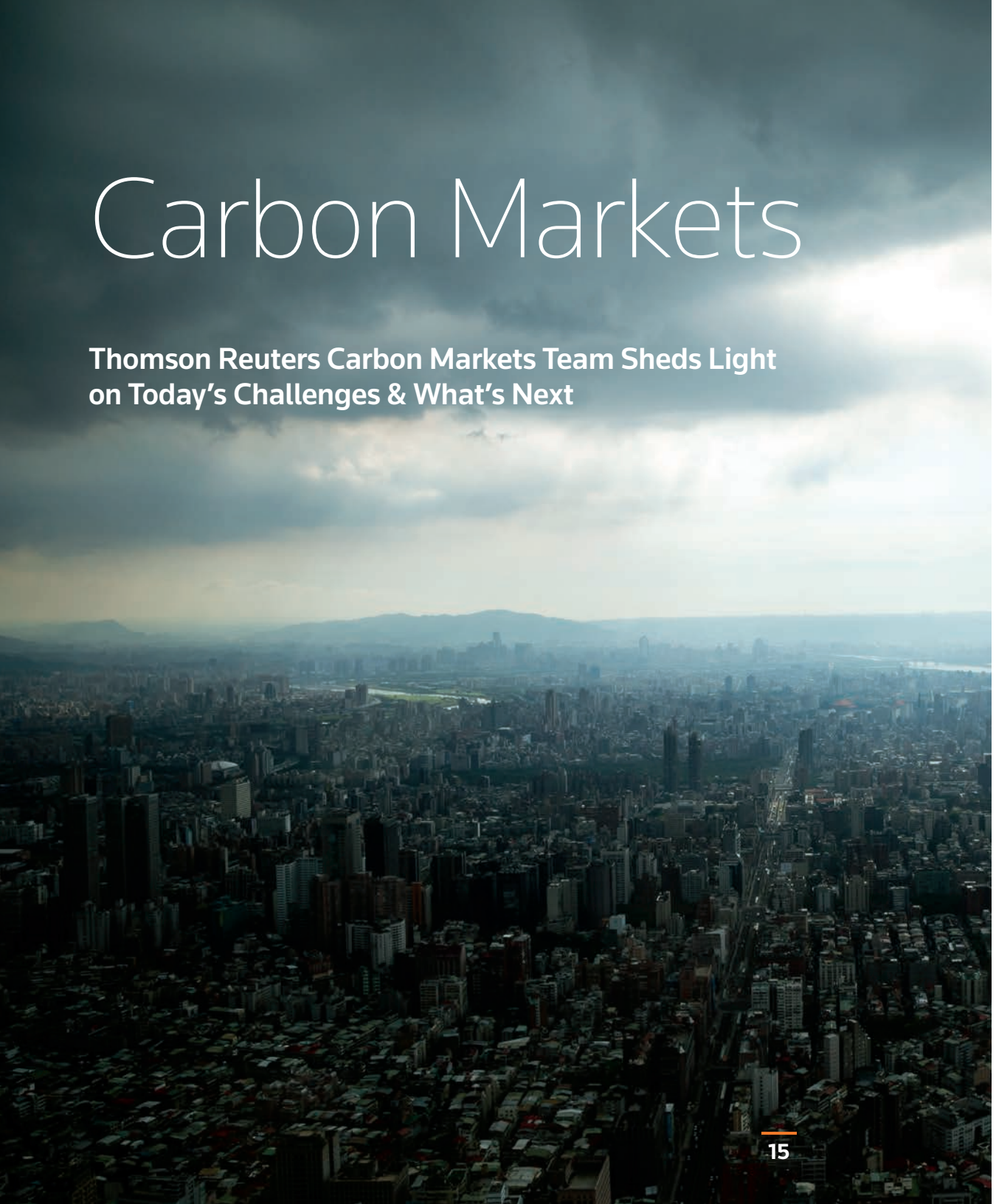


Source: Thomson Reuters Westlaw

Figure 6. Oil & Gas Industry Patent Infringement Cases (2012 – 2015)



Source: Thomson Reuters Westlaw



Carbon Markets

Thomson Reuters Carbon Markets Team Sheds Light on Today's Challenges & What's Next

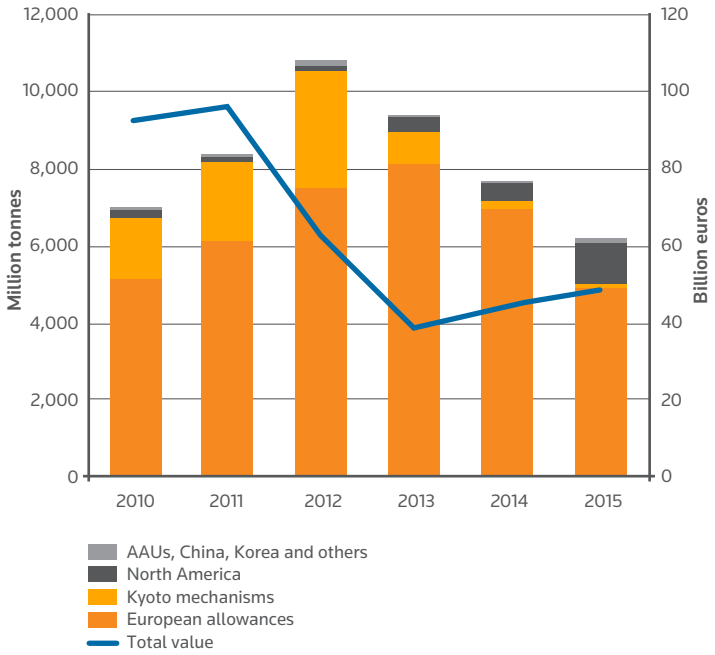
While litigation may generate financial rewards for one of the involved parties, carbon markets and emission trading schemes (ETSs) are other mechanisms important to the energy ecosystem that can also reap rewards for the involved parties.

The growth of carbon markets is a 21st century phenomenon resulting from political mandates to reduce carbon emissions and mitigate global warming. As with carbon taxes, the aim of emission trading schemes is to put a price on emissions, make it more expensive to pollute and create incentives to put abatement measures in place. Unlike taxes, however, ETSs enable private companies in domestic markets to trade carbon credits as commodities. The role of the market is to identify abatement measures with the lowest cost, thereby ensuring a cost-efficient delivery of the reduction targets put in place by policymakers.

Countries with higher carbon outputs can also purchase credits to emit more greenhouse gases from nations with lower output, although this is a much smaller portion of the global market. Emission trading schemes target carbon dioxide and in some cases other harmful greenhouse gases, as calculated in tonnes of carbon dioxide equivalent or tCO_2e.

According to the Thomson Reuters Point Carbon team, some 6.2 gigatonnes worth of emission allowances and offsets were traded globally in 2015, valued at approximately 50 billion euros, as shown in **Figure 7**. 2012 was the most recent banner year for trading. Expectations for 2016 are for volumes to rise slightly over 2015, with prices closing higher at year-end and the overall value of carbon markets growing by a quarter.[5]

Figure 7. World Carbon Markets (2010 – 2015)



Source: Thomson Reuters Eikon & Point Carbon

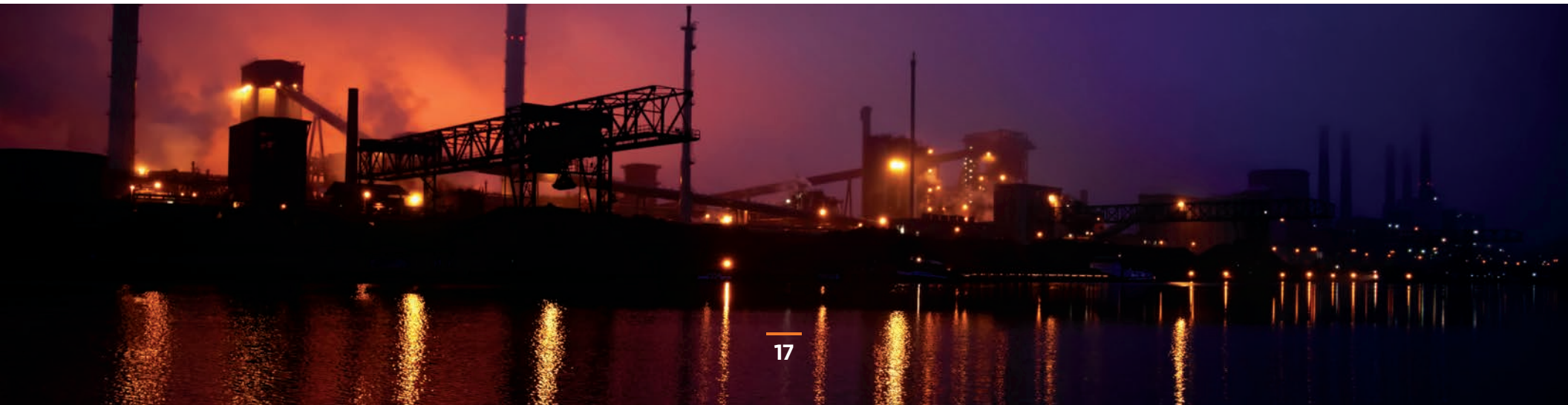
5 http://trmcs-documents.s3.amazonaws.com/3501ec8eae589bfbef9cc1729a7312f0_20160111104949_Carbon%20Market%20Review%202016_1.5.pdf

Table 1. The Size of the Global Carbon Markets, Beginning in 2013 and Projected through 2018
Projections are for incremental growth in 2016 and 2017, with a slight tapering in 2018.

	2013		2014		2015		2016		2017	2018
	FINAL FIGURES		FINAL FIGURES		FINAL FIGURES		FORECAST		FORECAST	FORECAST
	MT.	€ MILLION	MT.	€ MILLION	MT.	€ MILLION	MT.	€ MILLION	MT.	MT.
Europe (EUAs, aviation EUAs)	8,092	36,045	6,942	40,694	4,960	37,460	5,343	46,873	5,799	5,133
CERs	727	316	185	110	100	80	90	102	74	53
ERUs	112	24	18	2	0	0	0	0	0	0
North America (CCAs, RGAs, offsets)	389	2,100	472	3,320	1,042	10,633	1,216	13,047	1,412	1,514
South Korea (KAUs and offsets)	0	0	0	0	1,2	11	19	170	28	50
Chinese pilot schemes (allowances and offsets)	3,8	26	24	123	65	165	70	146	176	236
Other markets	16	82	1,3	0,8	2	4	3	6	2	2
Total	**9,340**	**38,593**	**7,642**	**44,250**	**6,170**	**48,353**	**6,741**	**60,343**	**7,491**	**6,988**

Thomson Reuters assessment of the volume and value of the major carbon markers from 2013 to 2015, and forecasts for 2016 to 2018. Volumes in millions of tonnes (Mt). Thousand megatonnes = one gigatonne (Gt). Values in millions (m) of euros. Thousand million = one billion (bn).

Source: Thomson Reuters Eikon & Point Carbon



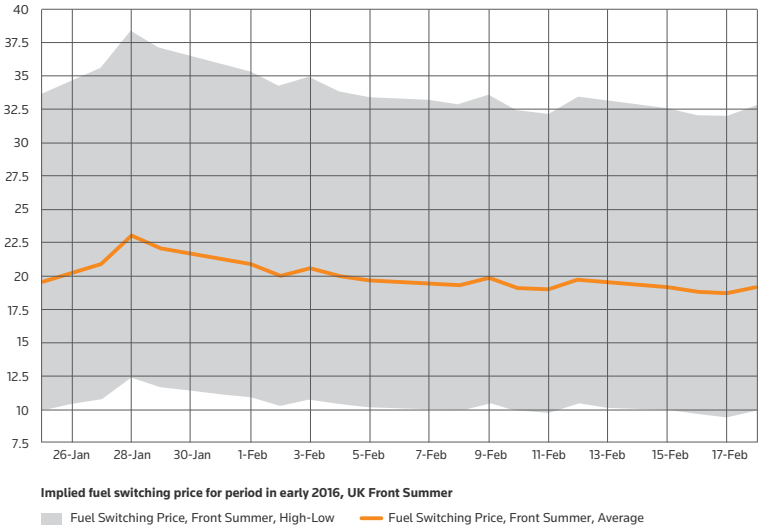
THE ROLE OF CARBON PRICING

Given the Paris Agreement and the international effort to limit global warming, there is now universal support to keep the global temperature increase well below the two degrees Celsius target and eliminate net carbon emissions in the second half of this century.

According to Stig Schjolset, head of carbon research and forecasts for Thomson Reuters Financial & Risk, the agreement will likely accelerate the ongoing transformation of the Energy sector. After Paris, all assets in fossil fuels should have a higher risk premium attached, making the case for renewable-energy investment stronger than ever before. The long-term direction toward a low-carbon future is clear.

The Paris Agreement also gives a push for increased use of carbon pricing. This will not take the form of a uniform price agreed at the UN level. Rather, it will be a bottom-up process where several countries will implement carbon taxes or emission trading schemes in order to meet the domestic reduction targets they have pledged under the agreement. Such carbon markets are already in place in Europe, Korea, New Zealand and several states in the US. And, the share of emissions included in these trading schemes will increase significantly as China

Figure 8. Fuel-Switching Price



Source: Thomson Reuters Eikon

"... renewable energy will likely be the most profitable investment when adding new capacity in power markets around the world."

Stig Schjolset, Head of Carbon Research and Forecasts, Thomson Reuters Financial & Risk

intends to roll out a national carbon market in 2017. According to the initial plans, the Chinese market would cover some 10,000 companies, including nearly all power generators as well as some industry sectors and aviation, in total accounting for around 45 percent of the nation's emissions.

Thomson Reuters Carbon Research and Forecast analysts point out that countries and jurisdictions with ETSs are already talking to each other, aiming to coordinate their efforts. It is thus possible that within the next 10-15 years, the regional carbon markets will start to link up with each other, potentially making several of the large economies in the world subject to comparable carbon prices.

"In order to meet the overall targets agreed in the Paris Agreement, the level of ambition – which in the end determines the price on carbon allowances – must be significantly increased over the next decades," said Schjolset. "If the big emitters are able to move forward in such a coordinated way, it might be possible to scale up the climate ambition significantly. Even

a moderate carbon price could have a huge impact on the global energy mix as it would make natural gas more profitable relative to coal and make it more attractive to invest in renewable energy."

The main aim of a carbon pricing scheme is to make it more expensive to emit carbon and more attractive to invest in low-carbon technologies. In the short term, fuel switching from coal to gas is a typical example of emission reductions that can be triggered by a carbon price. Taking the current energy mix in the UK as an example, an average coal plant will have a lower generation cost than an average gas plant before any carbon cost is taken into account. However, as the carbon emissions from a coal plant are twice as high as the emissions from a gas plant per unit of electricity, the average gas plant would be more profitable when carbon prices reach the level of around €20/t of emissions (see **Figure 8**), as identified in Thomson Reuters Eikon.

Schjolset proclaims that in the longer term, it is the expectation about the future carbon price that will impact investment decisions across the Power sector. With increased use of carbon markets, new power plants running on fossil fuels will have a higher risk premium attached.

And conversely, already with a carbon cost of €20-30/t, renewable energy will likely be the most profitable investment when adding new capacity in power markets around the world.

The Paris Agreement has definitely set a clear direction toward a low carbon future, and many countries will use carbon pricing to speed up the transition of their energy sectors. What remains to be seen is how fast the change will take place. While the world has signed the divorce papers with the fossil fuel industry, it will still take decades before we know whether it will be a dramatic, gradual or slow separation.

CLEAN COAL

Clean coal covers a range of technologies but usually involves removing the carbon dioxide from the exhaust of coal-fired power stations and storing it underground. This is called Carbon Capture and Storage (CCS). The value of this is to avoid the cost of emitting carbon dioxide and therefore would depend on the carbon price (in the absence of a carbon tax or a carbon market, the commercial value of clean coal is zero).

A lot of research has gone into technologies to achieve Carbon Capture and Storage but at present, commercial-stage technology solutions are only starting to emerge.[6] The biggest CCS plant in the world opened last year in Canada[7] but it is still small scale (100 MW) compared to typical coal plants (800 MW).

Estimates vary but sources suggest the cost of CO_2 emissions avoided using CCS on coal plants is currently about 50-70 $/t$CO_2$.[8] That means a carbon price of 55-80 $/t$CO_2$ is needed for the technology to be profitable. This is a far cry from being commercially viable (current CO_2 prices in Europe are 9 $/t$CO_2$). At this stage, these numbers are still rough as only a few commercial projects have been built. ●

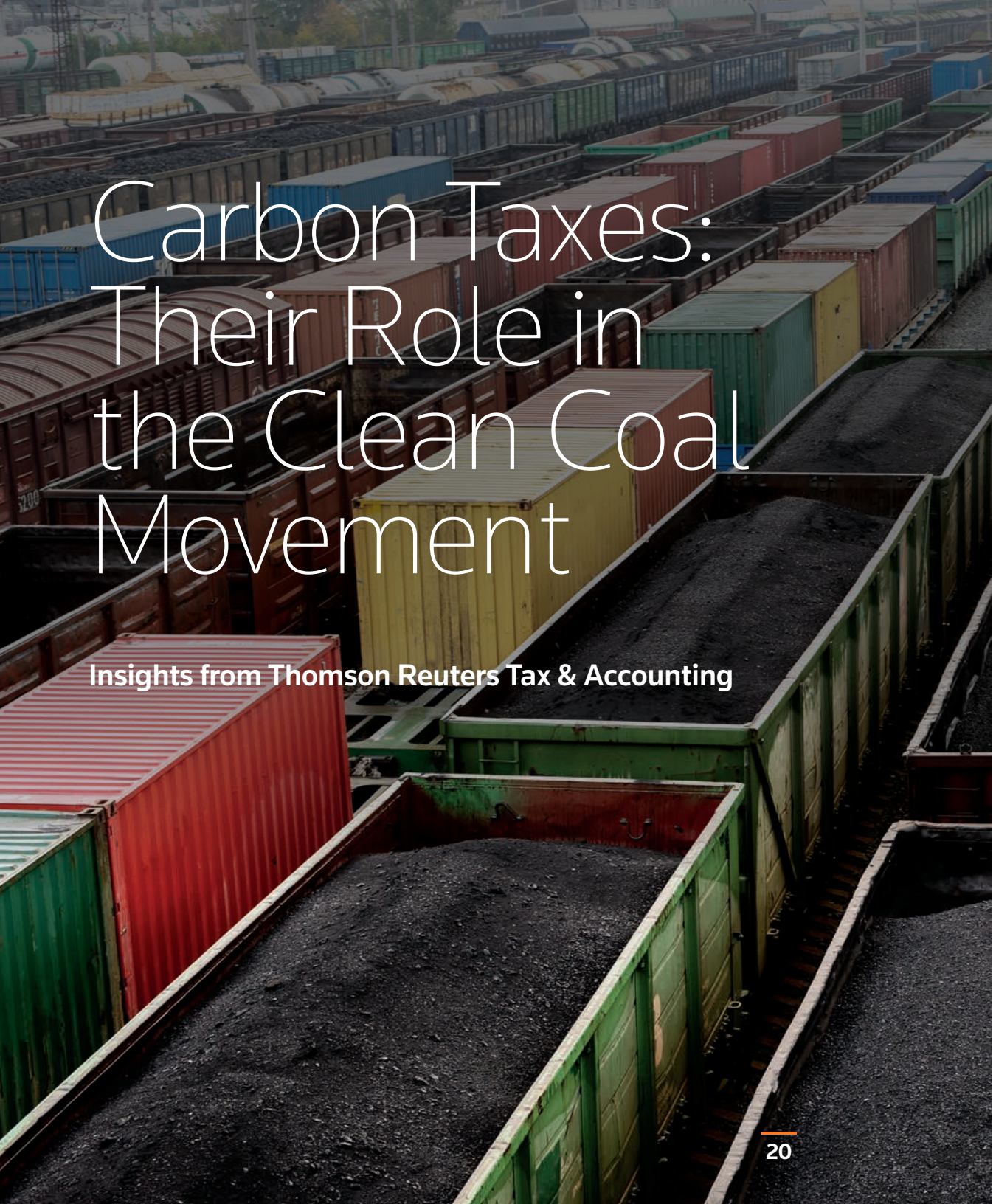
"Even a moderate carbon price could have a huge impact on the global energy mix as it would make natural gas more profitable relative to coal and make it more attractive to invest in renewable energy."

Stig Schjolset,
Head of Carbon Research and Forecasts,
Thomson Reuters Financial & Risk

6 http://www.carbonbrief.org/around-the-world-in-22-carbon-capture-projects

7 http://www.theguardian.com/environment/2014/oct/01/canada-switches-on-worlds-first-carbon-capture-power-plant

8 https://www.iea.org/publications/freepublications/publication/costperf_ccs_powergen.pdf, http://www.netl.doe.gov/energy-analyses/pubs/BitBase_FinRep_Rev2a-3_20130919_1.pdf



Carbon Taxes: Their Role in the Clean Coal Movement

Insights from Thomson Reuters Tax & Accounting

As new sources of energy that generate electricity continue to climb up the legislative agendas of global economies, tax is certain to play a role in helping to modify behavior and shift resources to alternatives. Thomson Reuters Tax & Accounting dives into the issue with an analysis of how many governments around the world are deploying carbon taxes to help drive the development of renewable energy.

The landmark climate accord in Paris thrust the idea of a carbon tax back into the global spotlight. Tesla Motors Chief Elon Musk has also taken up the cause, making the bold proclamation that a widely implemented carbon tax would cut the amount of time it would take to transition to clean, renewable energy in half. Even big oil companies have voiced support for the idea.

To understand the situation, it's important to first have some background on how carbon taxes, or Pigovian taxes, as they are sometimes called, work. In the simplest terms, these types of taxes are designed to disincentivize a particular type of behavior. Thus, in the case of burning fossil fuels, the aim is to disincentivize the emission of carbon dioxide (CO2). To do this, a carbon tax would be applied to a tax rate per-ton of CO2 produced when fossil fuels are burned.

World leaders agree that something needs to be done to promote clean energy. As Brian Peccarelli, President of the Tax & Accounting business of Thomson Reuters points out:

"With today's inconsistent implementation of carbon tax policy around the world and changing political climates, it's difficult to imagine the manifestation of a globally coordinated tax on carbon in the near-term. But with the growing urgency to reduce carbon emissions and meet global climate goals that are sure to escalate over the next few decades, governments will have good reason to unite in the development of global standards for a carbon tax."

To date, carbon taxes have been implemented in pockets around the planet. Some of the most notable programs have been rolled out in the Canadian province of British Columbia, Ireland and the UK. Carbon taxes are also currently under consideration throughout China, Brazil and in the US states of Washington and Oregon. The World Bank has broken out a full list of them, shown in **Figure 9**.

Australia also generated a great deal of attention in the summer of 2014 when its government voted to repeal the carbon tax it had implemented just two years earlier. Citing an untenable burden on household heating bills and Energy sector job losses resulting from the carbon tax, Prime Minister Tony Abbott didn't mince words in his announcement of the vote: "Today, the tax that you voted to get rid of is finally gone: a useless, destructive tax which damaged jobs, which hurt families' cost of living and which didn't actually help the environment." Australia has since started to reverse course under Liberal Party Prime Minister Malcolm Turnbull, and has signed on to support the Paris accord, but the example serves as strong evidence of just how political a tax-based environmental scheme can become.

"With today's inconsistent implementation of carbon tax policy around the world and changing political climates, it's difficult to imagine the manifestation of a globally-coordinated tax on carbon in the near-term. But with the growing urgency to reduce carbon emissions and meet global climate goals that are sure to escalate over the next few decades, governments will have good reason to unite in the development of global standards for a carbon tax."

Brian Peccarelli
President
Thomson Reuters Tax & Accounting

On the flip side of the Australian experience, the carbon tax in British Columbia has been upheld as the poster-child for sustainable energy policy. The program, which has been in place since 2008, is credited with declining use of fossil fuels in British Columbia, even as fuel consumption increased throughout the rest of Canada. The province's economy also grew faster during the time period in which the tax has been implemented than that of the rest of Canada.

CARBON TAX DIFFERENCES

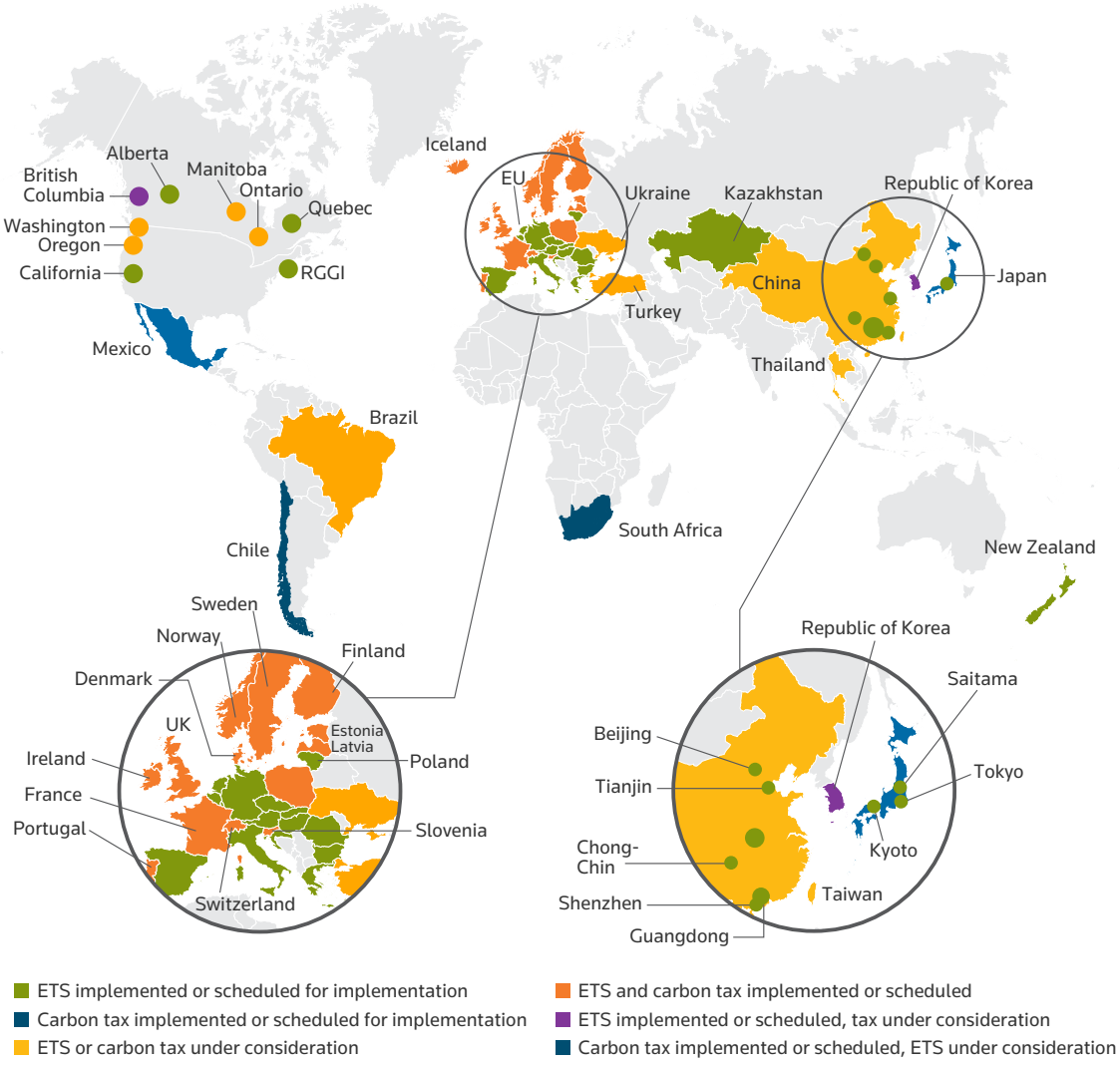
What makes the carbon tax concept work in some places and not others? Anil Kuruvilla, senior manager for tax research and content at Thomson Reuters, explains that the issue has as much to do with base politics as it does with the complexity of the tax itself and different ways of implementing it.

"Right now, although everyone is talking about them, true carbon taxes are only active in some pockets of the world and there are as many different approaches to implementing them as there are taxes themselves. In Ireland, for example, the carbon tax is applied to the use of all fossil fuels used for the generation of electricity and propulsion of automobiles. Just a few miles east, the UK has implemented a 'climate change levy' which applies to the use of all fossil-fuel-derived energy and its use to support energy efficiency initiatives."

The lack of consistency of implementation from one region to the next makes it challenging to truly evaluate the success of each program on an apples-to-apples basis. It also makes it hard to establish a set of best practices. But the real issue is politics. As Kuruvilla points out:

"The situation in Australia was a simple case of partisan politics. [Former] Prime Minister Abbott's coalition government was elected largely based on campaign promises to repeal

Figure 9. Map of Carbon Taxes



Source: The World Bank Group

the carbon tax, which every Australian taxpayer was feeling in their wallets, despite the fact that it was designed as a revenue-neutral tax for the Australian government. That kind of volatile swing in policy based on populist sentiment can play a major role in tax."

This last point is critical for the US because tax policy has become such a polarizing issue. Dr. Steven A. Cohen, Executive Director and Chief Operating Officer of Columbia University's Earth Institute, explained the issue this way:

"My particular issue with the carbon tax is not that it's bad or good. I just don't think it's feasible here in the US. I'm a political scientist; I study how issues get on the agenda and this one has made so little progress and has been met with such resistance that we're just spinning our wheels to pursue it."

Add the conflicting agendas of the various parties who've been most vocal on this issue: a billionaire CEO of a company that sells luxury electric vehicles; oil companies who stand to benefit long-term from a carbon tax by shifting more demand into their natural gas businesses; and monetary relief organizations that are concerned about the impact of regulation on the global economy, and the political risks associated with carbon tax policy shine in sharp contrast.

Though the timing of when a globally accepted and implemented carbon tax is open for debate, tax practitioners in the Corporate, Financial and Government sectors will no doubt be interested to see where the debate goes. As Brian Peccarelli observes:

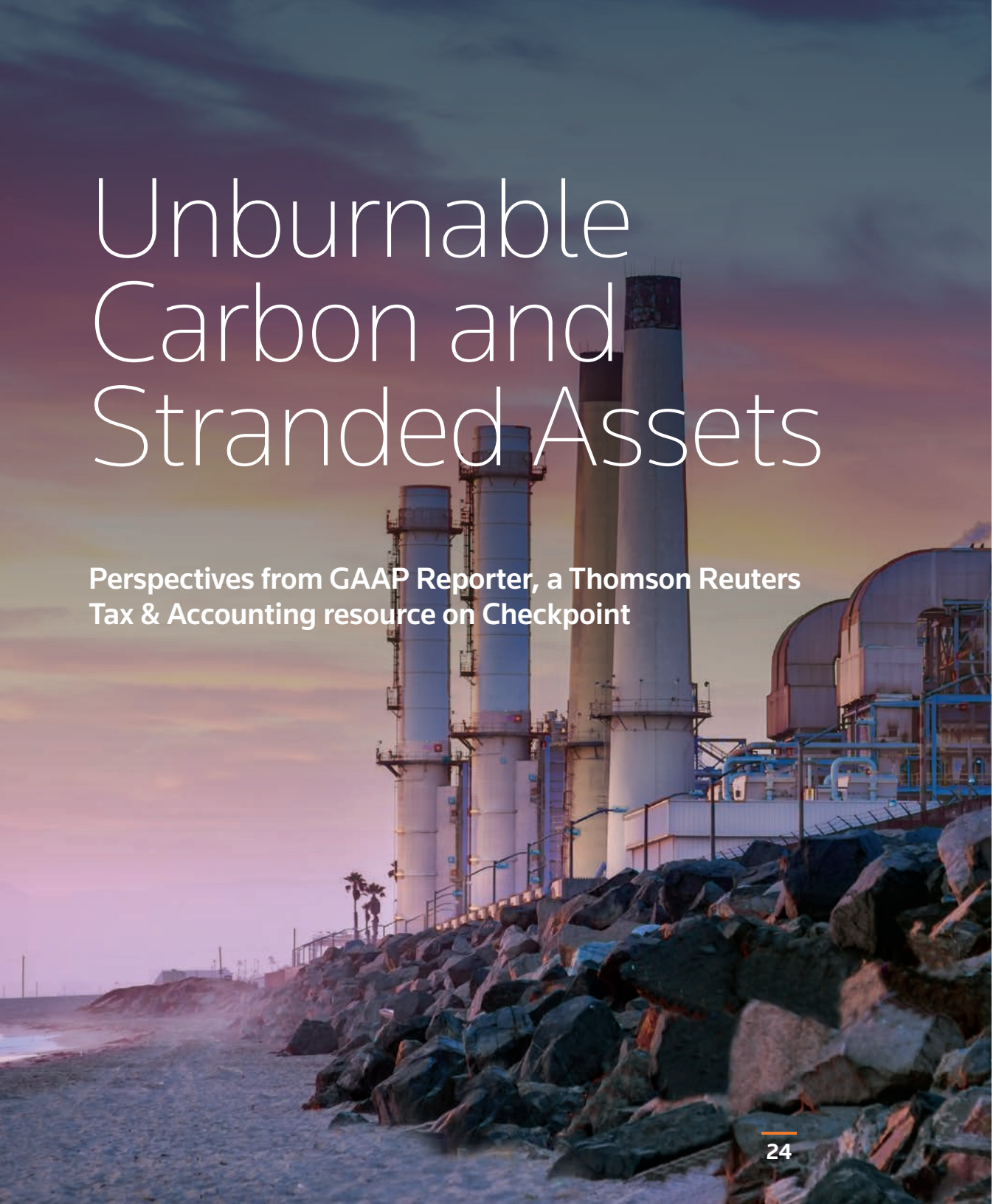
"Staying abreast of global tax policy changes and trends is a must; the ramifications of a universal carbon tax to businesses and governments would be truly significant and far-reaching. It's with a view toward preparing for future tax developments that solutions such as Thomson Reuters Checkpoint® are designed for. Providing real-time information, tools, technology and research on content that spans tax, accounting, finance and trade, Thomson Reuters Checkpoint allows business leaders to make intelligent decisions in a complex tax landscape." ●

"Right now, although everyone is talking about them, true carbon taxes are only active in some pockets of the world and there are as many different approaches to implementing them as there are taxes themselves."

Anil Kuruvilla,
Senior Manager, Tax Research and Content
Thomson Reuters Tax & Accounting

Unburnable Carbon and Stranded Assets

Perspectives from GAAP Reporter, a Thomson Reuters Tax & Accounting resource on Checkpoint



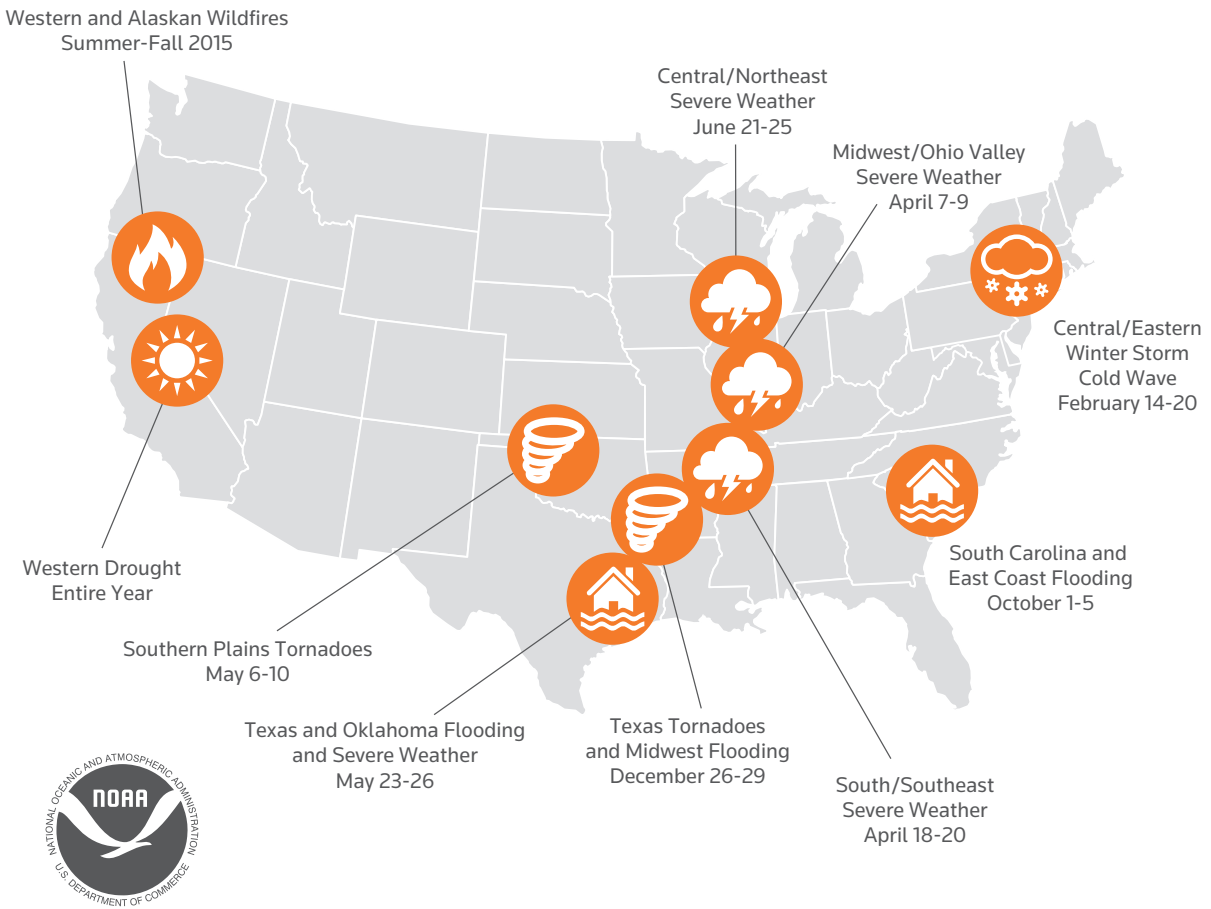
Beyond straight taxes imposed on companies for producing carbon emissions, individual company balance sheets are also susceptible to volatility at the hands of greenhouse gas emissions and related climate change events. There's a potential looming threat of "stranded assets" appearing on company balance sheets as climate change continues to reach its tentacles into more areas of business and commerce.

Generally accepted accounting and financial reporting standards have no formal definition of "stranded assets." A working definition established by the Stranded Assets Programme at the Smith School of Enterprise and the Environment at the University of Oxford identifies a stranded asset as financial value that has sustained "unanticipated or premature write-downs, devaluations or conversion to liabilities" due to environmental issues. More specifically, climate change – both the effects of weather events and the efforts to forestall future adversities — raises the risk of stranded assets.

As has been stated throughout this document, scientific consensus concludes that burning fossil fuels to power modern productivity releases greenhouse gas, primarily carbon dioxide, which is elevating atmospheric, surface and oceanic temperatures, melting polar ice caps and raising sea levels. These planetary changes are raising the frequency and intensity of weather events.

The US National Centers for Environmental Information, part of the National Oceanic and Atmospheric Administration (NOAA), reported 10 weather and climate disasters in 2015 with losses that individually exceeded $1 billion, as shown in **Figure 10**. Munich Re reported that since 1980, worldwide overall losses from climate events have increased threefold.

Figure 10. US Billion-Dollar Weather and Climate Disasters (2015)



Source: National Oceanic and Atmospheric Administration

Hurricane Katrina ($151 billion), Hurricane Sandy ($67 billion), and the California drought are among the 178 US disasters over the last 35 years with individual costs in excess of $1 billion. These organizations, experts in documenting risk, conclude that there is a strong likelihood that the effects of climate change will lead to increasing financial losses. According to a comprehensive 2014 study by the CDP (formerly, the Climate Disclosure Project), S&P 500 businesses are increasingly reporting climate-related physical disruptions and incurring costs. These companies are assessing financial exposure to physical assets with "increasing urgency."

In 2012, the Carbon Tracker Initiative (CTI) used the phrase "unburnable carbon" to describe energy producers' inability to use fossil-fuel reserves productively due to targeted emission reductions. Prior to the Paris Agreement, academic research concluded that meeting the 2 degrees Celsius target would require foregoing 33 percent of oil reserves, 49 percent of gas reserves and 82 percent of coal reserves. In 2013, the CTI along with the London School of Economics estimated that unburnable reserves (based on 2012 valuations) represented $4 trillion of market value in equity investments and $1.27 trillion in debt. Unusable reserves are at risk of becoming stranded assets, assets that will affect the near-term economic viability of the power-generation infrastructure.

Even before Paris, as Thomson Reuters 2015 *A Brief History of the Oil Crash* reported, fossil-fuel demand was already responding to "policies related to air quality, energy efficiency, renewable energy and subsidy reform," and 2005 may have been the peak year for oil consumption in the US and other advanced economies due, at least in part, to long-term demand destruction. Oil prices remain at or near historic lows, and economies around the world, including China, are reassessing their reliance on coal.

A company's climate-related exposure raises legal and accounting considerations. These losses, both incurred and expected, require assessment under financial accounting standards and securities regulations. Without public disclosure of the material effects of climate change, business entities' apparent profitability may be misleading and result in overstated market prices.

Federal securities law, enforced by the SEC, requires entities with publicly traded securities in the US to issue regular reports, including an annual report on Form 10-K, which must include risk disclosures and a management discussion and analysis (MD&A) that states "known trends, events, demands, commitments and uncertainties that are reasonably likely to have a material effect on financial condition or operating performance." An SEC interpretation, issued in 2010, concludes that its regulatory disclosure requirements cover the effects of climate change. In April 2016, the SEC issued a new comprehensive Concept Release for the modernization of regulatory disclosures, including climate change and other sustainability information.

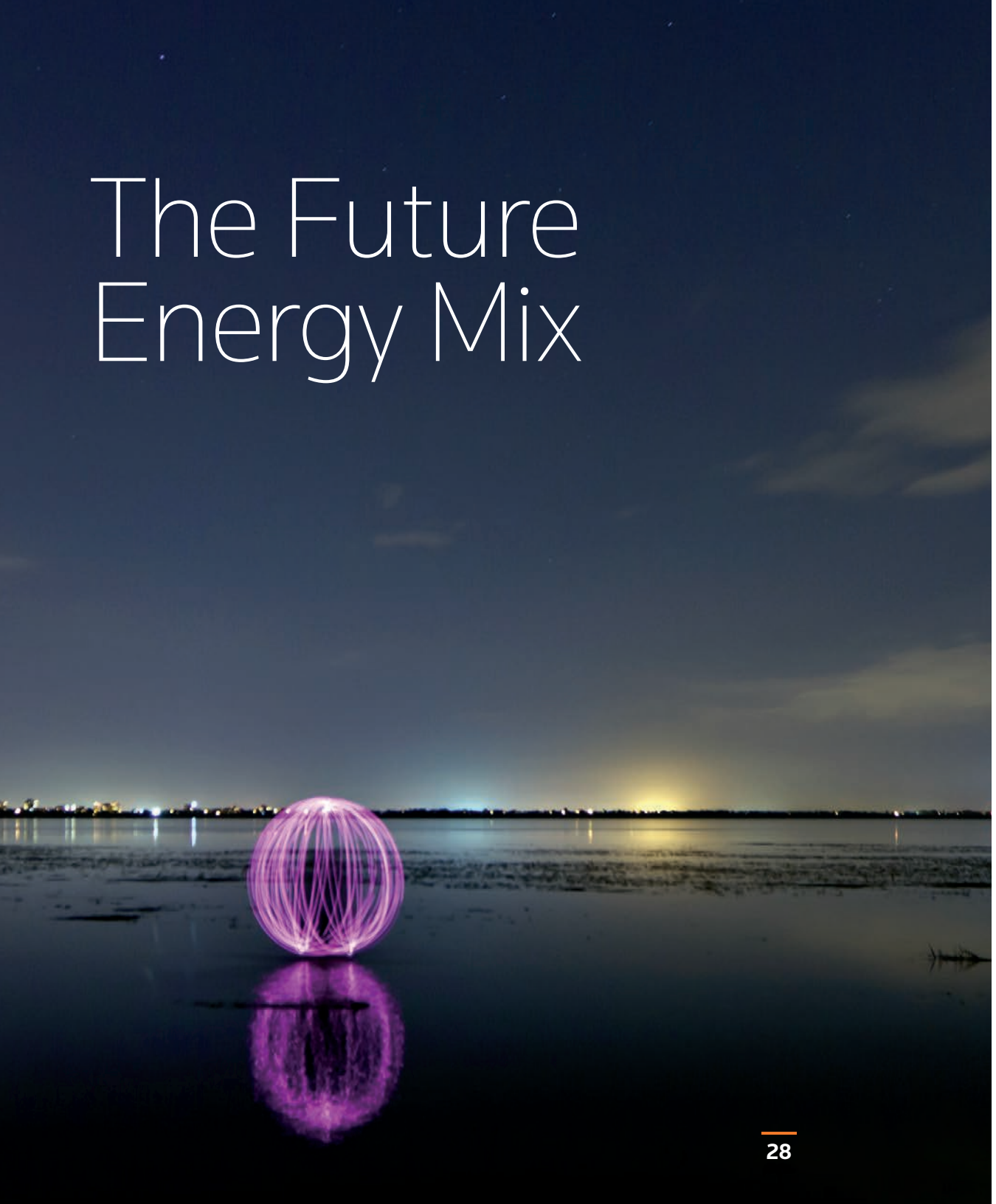
In addition to the regulatory disclosures, Form 10-K must present audited financial statements in accordance with US GAAP. Compliance with US GAAP requires an assessment of whether long-lived assets such as mineral reserves and equipment are impaired. If the estimated cash flows from using an asset in operations cannot justify an entity's investment, the entity must recognize an impairment loss (commonly, a "write-off").

Similar EU regulations require a company with securities that trade on EU markets to issue an annual report that contains audited financial statements prepared in accordance with International Financial Reporting Standards (IFRS). Like US GAAP, IFRS requires the write-off of assets that become unproductive. In addition, in 2014, the European Parliament adopted Directive 2014/95/EU that mandates nonfinancial disclosures concerning sustainability, including environmental risks, by large publicly held entities (based on the number of employees). Within two years of its effective date, the Directive will require EU Member States to transpose the directive into national law.

As assets become increasingly at risk of becoming stranded due to climate change both from weather-related events and the loss of fossil-fuel productivity, more attention to accounting and disclosure is required. These risks are carried not only by a reporting company, but also by its lenders and investors. Given the magnitude of financial investments at risk, business leaders are raising red flags. For example, Nick Robins, former Head of HSBC Climate Change Centre of Excellence, now Co-Director of United Nations Environment Programme (UNEP) Inquiry into the Design of a Sustainable Financial System, has advocated for financial market participants to make informed assessments of climate change risks to encourage a "soft landing" rather than a crisis initiated by an event.

Henry Paulson Jr., former US Treasury Secretary under President George W. Bush, has similarly warned that the financial markets must recognize and respond to climate risk. Mark Carney, Governor of the Bank of England, is leading investigations into the effects of stranded assets on financial stability, particularly in the insurance industry.

A company and its investors can ensure robust assessment and appropriate disclosure to help avoid wasteful losses and direct capital to safer and more sustainable alternatives before a catastrophic event triggers accountability.



The Future Energy Mix

The generation of electricity in the future will look much different from how it does today. By the end of this century, fossil-fuel-based sources will be all but dried up, figuratively and possibly literally. In their place will be the next generation of renewables, some of which have an established footprint today and some of which are still to be discovered.

The transition to tomorrow's sources will be consistent and persistent. The goals set forth in Paris, December 2015, caught the world's attention and there's no question that the attainment of them will require change. The challenge is to find balance. Things will evolve gradually and steadily. There are certain to be pain points along the way. Entire industries have been built around fossil-fuel consumption. Markets are tied to the companies that drive them. As the tide turns, new sectors will emerge while others cease. Opportunities, as well as challenges, will arise. A new yin and yang of energy will emerge.

From a business standpoint, it is imperative that the leaders of today, and tomorrow, be ready for what is to come. In short, they need to begin preparing for a future where renewables play a larger part in the mixture of methods used to generate electricity. But, how, exactly, will we get there?

Anecdotal evidence on the suburban streets of America and sub-Saharan Africa suggests that solar is on its way to going mainstream as homeowners with big tax incentives strap reflective panels to their roofs and expansive areas install solar-panel parks, respectively. Look to the northeast coast of Yorkshire in the UK, however, where the world's largest offshore wind farm is currently being developed, and you might be inclined to think that wind power will redefine the way we generate energy in the coming decades.

In order to put some hard data behind the speculation of whether these examples add up to an electrical power strategy for the future, we've dug into our financial, tax and legal resources, as well as accessed global patent data, to identify which energy-production technologies are receiving the greatest R&D investment and some pros/cons associated with those sources of power.

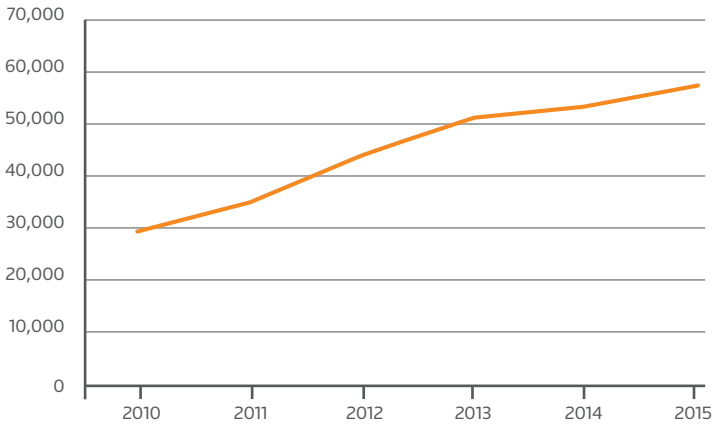
We identified three dominant methods for generating electricity that are most likely to emerge from the realm of "alternative" energy and become much more mainstream in the next three decades. These include:

- Hydro-Wave
- Nuclear Fusion
- Solar Photovoltaics

Coal, natural gas and other fossil-fuel-based electricity-generation methods will remain in the near-term mix. However, while there are currently efforts underway to mitigate the impact these sources have on the environment, the burning of fossil fuels is ultimately not sustainable and will diminish in significance over the next 30 years.

Analysis of energy-related inventions and where they are being protected with patent rights provides a unique view into which technologies have the greatest potential for future commercialization. **Figure 11** shows the evolution of electrical-power-related innovation over the last six years, which has increased by 94 percent from approximately 29,500 inventions in 2010 to 57,229 at the end of 2015.

Figure 11. Electrical-Power-Related Innovation (2010 – 2015)



Source: Derwent World Patents Index®
Based on 270,157 electrical-power-related inventions from publication year beginning January 1, 2010 through December 31, 2015 based on one document per INPADOC family.

There are nine main areas of electrical-power innovation within which activity has been happening:

- Clean Coal
- Coal
- Hydro-Wave
- Natural Gas
- Nuclear
- Petroleum
- Solar Photovoltaics
- Solar Thermal
- Wind

Figures 12A and 12B show the comparison in innovation activity across each area over a six-year period (notice the change in the y-axis between the two charts). Solar Photovoltaics continues to hold the lead position, representing over 7,500 inventions more than Petroleum, the second-most-active category in terms of overall volume.

Solar Photovoltaics grew by 160 percent over the six years and has the largest overall activity with 17,569 unique inventions at the end of 2015. This is the second-most-significant increase of electrical-power sources studied. Clean coal had the largest overall growth rate at 181 percent, as shown in Table 2, although it occupies the lowest point across the group.

Solar thermal saw just 10 percent growth over the same timeframe, the smallest of all sectors, and closed out last year with a decline from its peak point in 2013. For this reason, solar thermal has been eliminated from the remainder of analysis, and the report focuses on areas showing the sharpest growth and promise.

Figure 12A. Top Electrical-Power-Related Innovation Areas, #1-#4 (2010 – 2015)

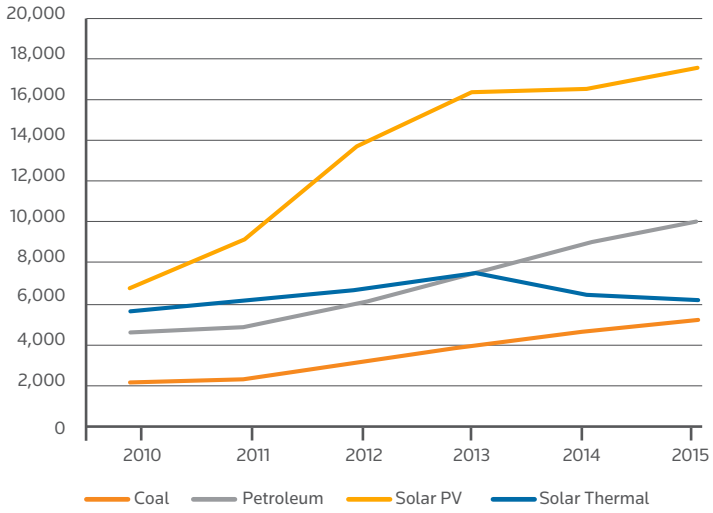
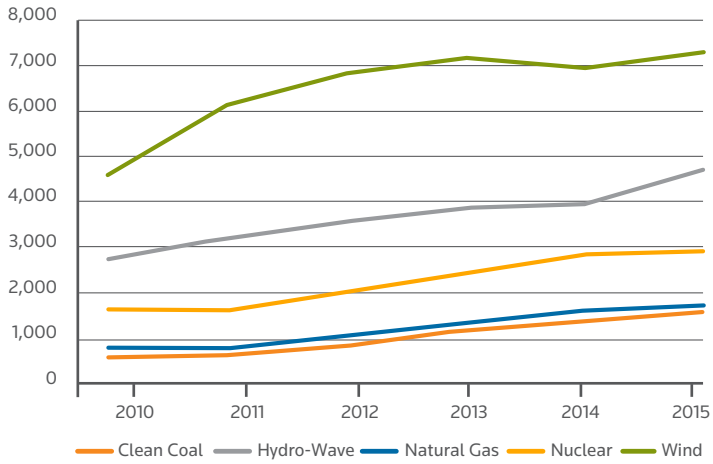


Figure 12B. Top Electrical-Power-Related Innovation Areas, #5-#9 (2010 – 2015)



Source: Derwent World Patents Index

Table 2. Percent Change in Electrical Power-Related Innovation Activity (2010 – 2015)

CATEOGRY	UNIQUE INVENTIONS 2010	UNIQUE INVENTIONS 2015	% CHANGE
Clean Coal	567	1,595	181
Solar Photovoltaics	6,759	17,569	160
Coal	2,180	5,251	141
Natural Gas	773	1,725	123
Petroleum	4,643	10,002	115
Nuclear	1,606	2,909	81
Hydro-Wave	2,733	4,712	72
Wind	4,582	7,261	59
Solar Thermal	5,665	6,205	10

Source: Derwent World Patents Index

TOP ENERGY INNOVATORS

The top energy innovators span the gamut from the likely to unlikely, as seen in **Figures 13A, 13B** and **13C**. Likely innovators have titles such as Hitachi-GE Nuclear Energy, PetroChina and Vestas Wind Systems, while unlikely players include companies like Mitsubishi, the most active innovator across all the areas, Siemens and Hyundai. The charts in Figure 13 highlight the composition of innovation activity across the nine areas, including Solar Thermal, in order to show just where these companies are investing in the energy innovation mix.

Figure 13A. Leading Organizations in Energy-Related Innovation (2010 – 2015)

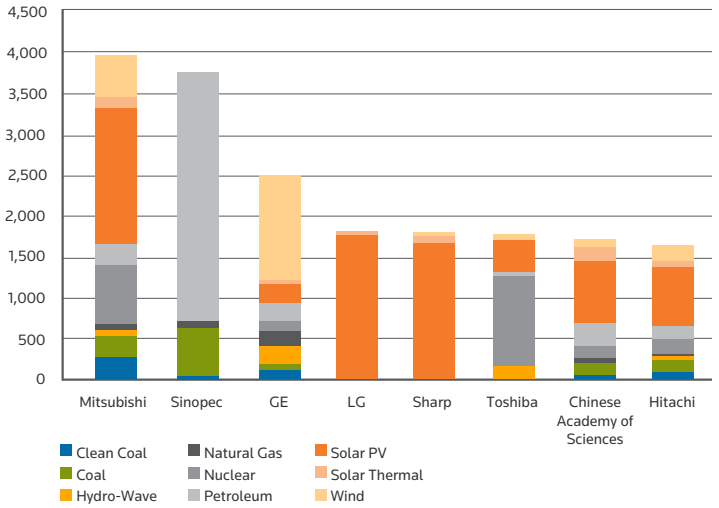
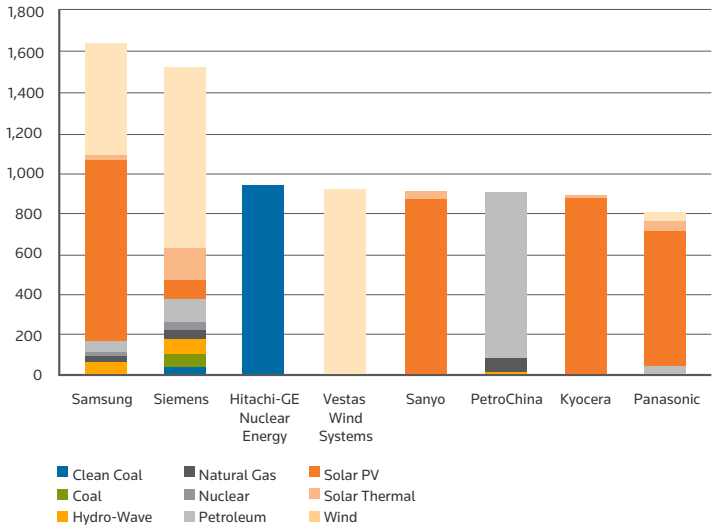


Figure 13B. Organizations (#9 - #16) in Energy-Related Innovation (2010 – 2015)



Source: Derwent World Patents Index

GREENHOUSE GAS MITIGATION

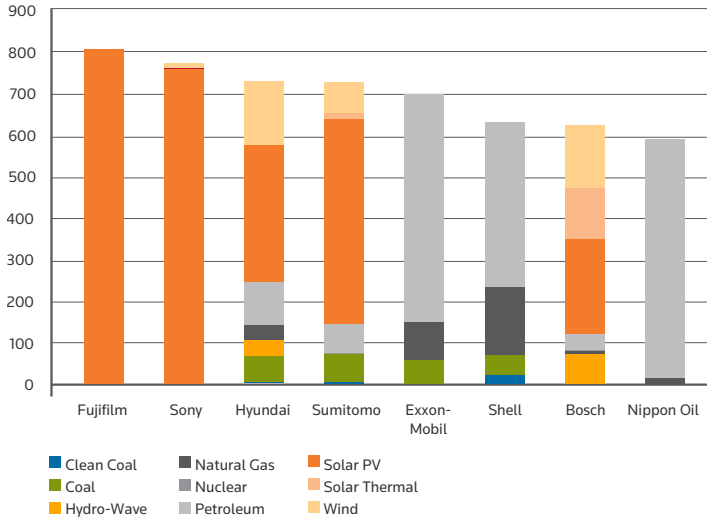
Fossil-fuel-related innovation increased by 122 percent from 2010 to year-end 2015, with the sharpest incline coming after 2011. The majority of the invention investment has been associated with combustion methods that generate greenhouse gases. Greenhouse gas (GHG) mitigation-related inventions, also associated with fossil fuels, experienced a jump of 197 percent during that same period, albeit starting from a much lower base, as shown in Figure 14.

There are different ways to mitigate greenhouse gases resulting from fossil-fuel electrical power generation. Some of these include purifying carbon monoxide, withdrawing gas, treating the smoke and fumes, and removing it altogether. All areas associated with electrical power generation have seen an increase in activity over the last six years except CO_2 mitigation, as shown in Figure 15; the modification or purification of carbon monoxide as it is produced is the most active area.

Efforts to reduce or eliminate greenhouse gases from by-products associated with electricity generation are international in scope, but Asian companies including Mitsubishi, Hitachi, Xinli Energy, CAS, Sinopec and Nippon Steel are among the top organizations in this area. European and US companies are also present, but to a lesser extent, as seen in Figures 16A and 16B.

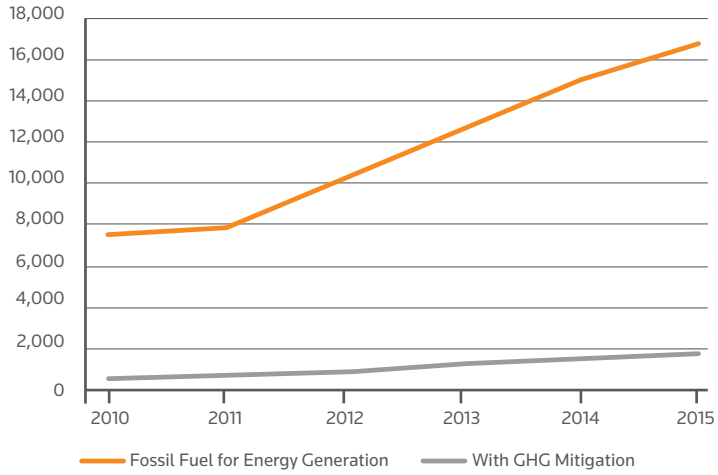
The second figure, 16B, shows the top five innovators in the area. They are all fairly diversified in their mitigation techniques; however, it is really only Hitachi that is concerned with mitigating the emission of carbon dioxide entirely, versus somehow purifying, withdrawing or treating it. Alstom and GE recently announced a merger. Their approaches to clean coal are complementary to one another, which gives credibility to their decision.

Figure 13C. Organizations (#17 - #24) in Energy-Related Innovation (2010 – 2015)



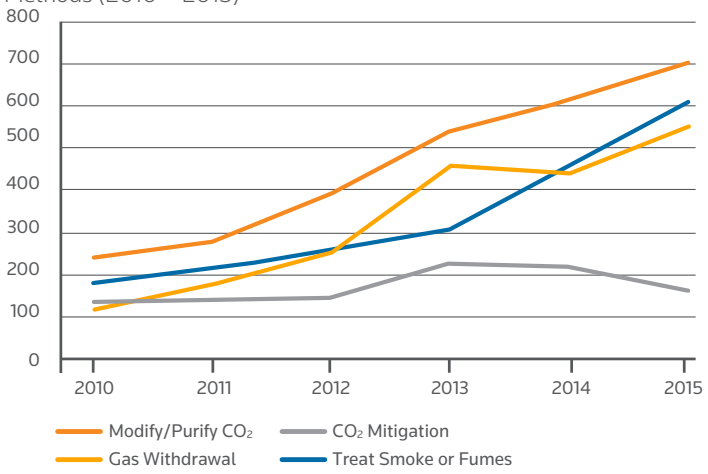
Source: Derwent World Patents Index

Figure 14. Fossil-Fuel-Based Electrical-Power Innovation, with and without GHG Mitigation (2010 – 2015)



Source: Derwent World Patents Index

Figure 15. GHG-Mediation Innovation from Fossil-Fuel Energy Methods (2010 – 2015)



Source: Derwent World Patents Index

Figure 16A. Top Innovators Using Electricity Generation from Fossil Fuels and Also Seeking to Mitigate Greenhouse Gases (2010 – 2015)

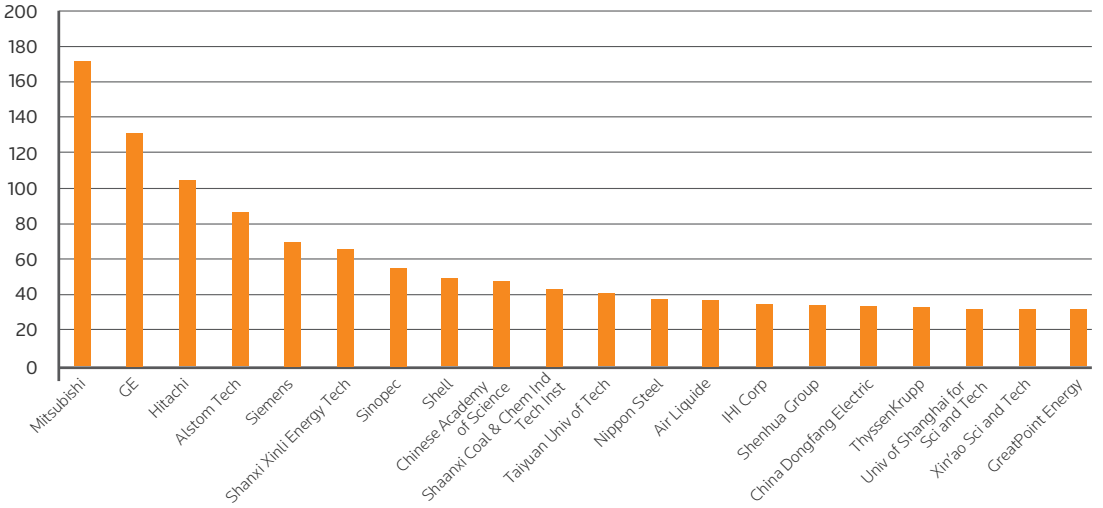
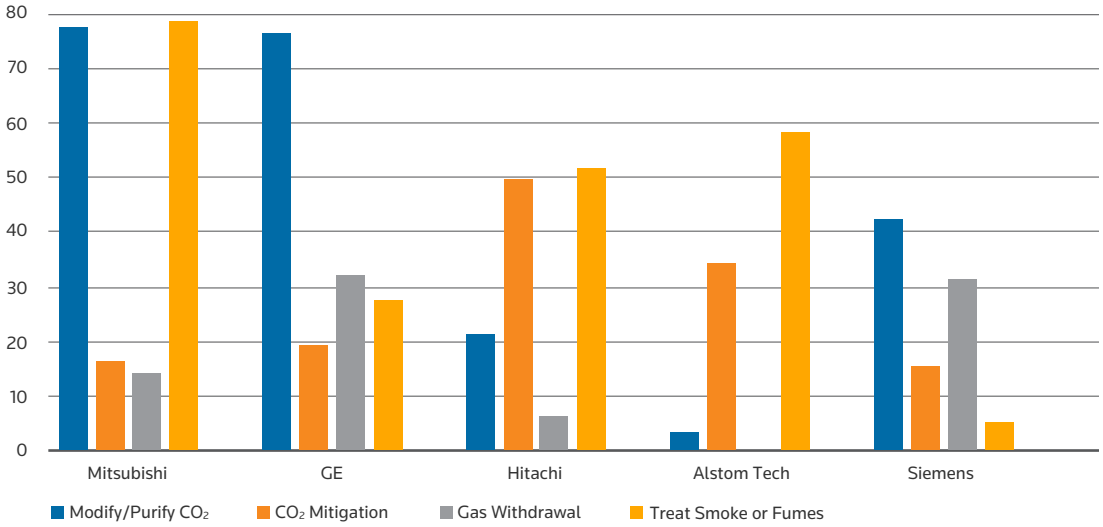


Figure 16B. Top 5 GHG Mitigation Companies by Method (2010 – 2015)



Source: Derwent World Patents Index

Unquestionably, China is the world leader in innovations related to mitigating greenhouse gas effects. Of the top 20 companies working in this area, 45 percent (nine of them) hail from China, as shown in **Table 3**. Add to that four from Japan, and Asia dominates in terms of its innovation efforts to improve fossil-fuel emissions with 65 percent of the companies coming from that region. Europe is the next most prolific area, with 25 percent (five) of the leading innovators, while North America, represented by the US, has 10 percent or two companies in the top 20.

For clean coal and natural gas to persist as long-term electrical-power sources, it's imperative that methods and measures to reduce their carbon footprints be increased dramatically. The players in Table 3 will partially contribute to this; however, it is increasingly likely that true renewables, without harmful emissions, will begin to overtake sources that include the burning of fossil fuels.

Nevertheless, it's still not likely that US President Obama's goal of having 80 percent of electricity from renewables will be achieved by 2035. Rather, the Energy Information Administration suggests that number will be closer to 65 percent by 2040 (five years later), according to its Annual Energy Outlook (2015).[9] And this is despite the fact that large cities like San Diego, California, are committing to only use renewable sources of energy in 20 years,[10] as well as corporate America investing in renewable-energy sources and renewable power-purchase agreements (Practice Note, Types of Power Purchase Agreements: Commercial or Industrial PPAs).

Message: There's a lot of work to still be done. ●

Table 3. Top 20 GHG-Mitigating Innovators and Headquarter Country

COMPANY	COUNTRY
Mitsubishi	Japan
GE	US
Hitachi	Japan
Alstom Tech	France
Siemens	Germany
Shanxi Xinli Energy Technology	China
Sinopec (China Petroleum & Chemical Corporation)	China
Royal Dutch Shell	Netherlands
Chinese Academy of Sciences	China
Shaanxi Coal and Chemical Industry Institute of Technology	China
Taiyuan University of Technology	China
Nippon Steel	Japan
Air Liquide	France
IHI Corp	Japan
Shenhua Group	China
China Dongfang Electric	China
ThyssenKrupp	Germany
University of Shanghai for Science & Tech	China
Xin'ao Science and Technology Development Co.	China
GreatPoint Energy	US

Source: Derwent World Patents Index

9 http://www.eia.gov/forecasts/aeo/pdf/0383(2015).pdf

10 http://www.npr.org/2016/01/26/464323475/san-diego-mulls-whether-to-let-city-not-utility-buy-alternative-energy

Industry Interview

Bjørn Otto Sverdrup
Senior Vice President of Sustainability
Statoil

THOMSON REUTERS: *How do you see the level of oil dependence evolving over this century?*

BJØRN OTTO SVERDRUP: Through our Energy Perspectives report each year, Statoil presents several scenarios for the energy mix and demand leading up to 2040. Our Renewal scenario, which envisages a world that stays below 2 degrees Celsius (3.6 degrees Fahrenheit) of global warming, as the Paris agreement sets out, includes substantial amounts of oil and gas, but oil demand starts to taper off after 2020.

Despite expected reduced demand in the future, our industry still needs to find a large amount of oil and gas to supply the growing energy demand and fill the production decline from older fields. We are talking about a transition to a future with less carbon, but both oil and gas will be needed through the transition.

THOMSON REUTERS: *How is Statoil innovating to account for this evolution?*

SVERDRUP: Statoil aims to be competitive at all times. That means being robust enough to handle low oil prices and changes in the market. To do that in a world that needs to transition to low carbon, we have a massive effort on our hands.

In Norway, we produce oil and gas with half of the CO_2 emissions per unit of output compared to the industry average. However, our first priority is to reduce the energy intensity in our production of oil and gas even further. This means implementing measures that will reduce emissions from the production of our products. Efforts include carbon capture and storage, improved energy efficiency in our operations and implementing technology that will reduce emissions.

Just recently Statoil announced that four years ahead of schedule, we are already close to achieving our aim of reducing CO_2 emissions on the Norwegian continental shelf (NCS) by up to 800,000 tonnes by 2020. We are therefore increasing our target by 50 percent to 1.2 million tonnes. This is the equivalent of the emissions of several hundred thousand cars.

The measures we have implemented, and plan to implement, will not only lead to reduced emissions but also value creation. If we can combine what is good for the environment and what is good for business, we are on a very good path.

But innovation is not just about technology. It is also about how we conduct our business. In my role as the head of Statoil's Sustainability unit, my team and I work with the entire company to implement sustainability thinking in our entire business and all of our projects. As a large energy provider, we have the possibility to play an important role in providing energy to the world, also within new frameworks.

THOMSON REUTERS: *Are you getting involved in R&D efforts related to renewables or alternative energy sources?*

SVERDRUP: Statoil is the proud developer and operator of the Hywind offshore floating wind turbine. This pilot project has been producing electricity since 2009. Statoil took the idea through the concept/development phase and into piloting. We have now made an investment decision for Hywind Scotland, the world's first floating wind park offshore in Scotland. There we aim to take the experiences from our first pilot and implement them in a larger-scale environment. We are also involved in two of the UK's largest offshore wind projects: Sheringham Shoal and Dudgeon. Together these will provide electricity for over 600,000 homes. Our investments in renewables are made with a commercial mind-set and we are growing this business as well as looking into other new energy sources and business models.

THOMSON REUTERS: *How are government regulations impacting your business? And what are you doing to address them?*

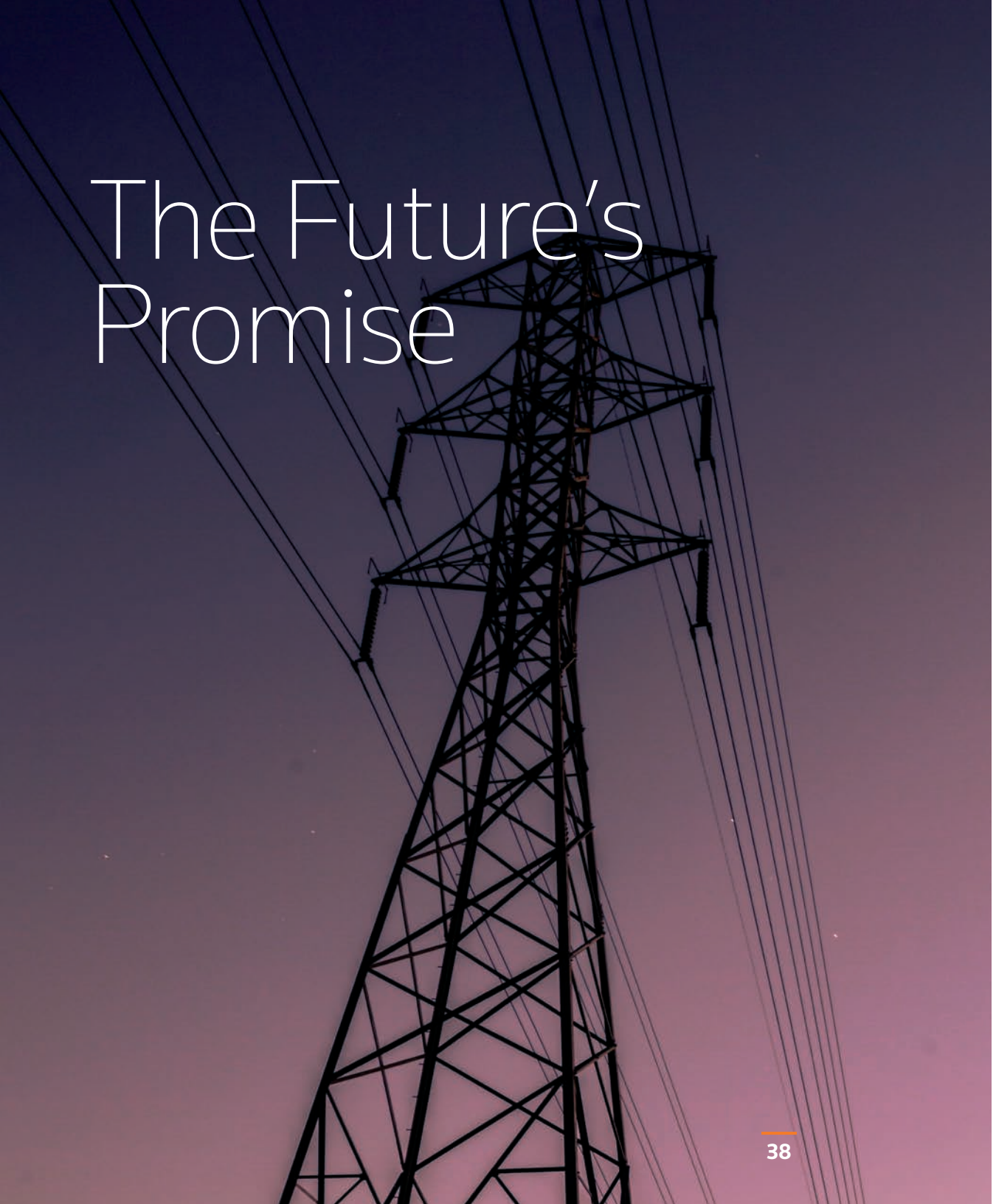
SVERDRUP: Our industry has always been impacted by government regulations and we welcome that. It's important that an industry like ours has predictable frameworks so we can plan for the long term. There are different types of regulations though. Some regulate how we do our operations, focusing on health, safety and environment, technical integrity and standards and so on. We work together with regulators to develop these to be as fit-for-purpose as possible. The other type of regulations includes items like CO_2 taxes. We welcome a high CO_2 tax, to level the playing field between various energy sources. A high CO_2 tax can contribute to the substitution of gas for coal in the energy mix, making a solid contribution to reducing CO_2 emissions.

THOMSON REUTERS: *How do you envision the planet being powered in the next 20, 30, 50 years?*

SVERDRUP: It's nigh on impossible to predict the future. Nevertheless, we create scenarios that assist in our planning, giving us possible outcomes related to a certain set of circumstances. One thing we know is that the world will have to transition from a dependence on fossil fuels to increasingly get energy from renewable sources. This transition is already starting, but it will take time to change the world's energy systems. I truly believe that a key decision that needs to be made is to switch from coal to gas. Since coal has much higher CO_2 emissions, this will have a direct and immediate effect on emissions. This is also why, within our scenarios that I referred to, I see a global growth for gas over the next decades. ●

"One thing we know is that the world will have to transition from a dependence on fossil fuels to increasingly get energy from renewable sources. This transition is already starting, but it will take time to change the world's energy systems."

Bjørn Otto Sverdrup
Senior Vice President of Sustainability
Statoil



The Future's Promise

The combination of the aforementioned research, analysis and insight enables Thomson Reuters to predict that the methods used to generate electricity will noticeably shift such that alternative sources will overtake fossil-fuel-based methods as the main sources of electrical power for the planet in the next two to three decades.

Specifically, these methods will include hydro-wave, solar and nuclear technologies. They will reduce our collective carbon footprint, contribute to capping the rise in global temperatures and be healthier for the environment.

Each area is explained in more detail and calls out the companies that will be at the forefront of ushering in the next generation of electrical power generation.

HYDRO-WAVE

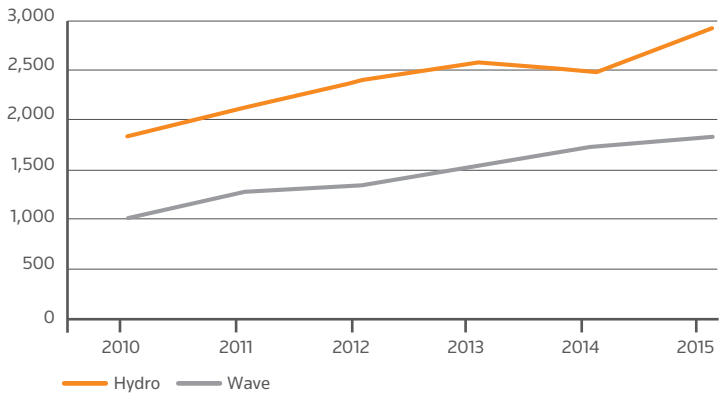
Water-related innovation for generating power has been on a steady climb over the last several years, including both power secured from the movement of fluids by gravity (hydro) and oceanic/sea tidal movement (wave). The former jumped by 60 percent and the latter by 82 percent from 2010 through 2015, as shown in **Figure 17**. Although hydro has had more activity, wave-related power is growing more quickly. While there are still logistic hurdles to be addressed regarding generating electricity using these methods, the amount of interest as captured in the number of patents being filed suggests that innovators believe this will be a viable method in the future.

In the area related to energy from waves, innovation can be broken into two types: oceanic wave movement and tidal current movement. The differences in their activity levels are shown in **Figure 18**. Oceanic wave innovation is growing faster than the tidal type, as it nearly doubled (99 percent increase) in the period from 2010 through 2015. Tidal innovation jumped by 65 percent over that same timeframe.

Within the hydro portion of water-gravity-energy innovation, there are four areas of activity: water plants; water wheels; blades, turbines and rotors; and hydrostatic thrust or liquid flow, as shown in **Figure 19**. While blades, turbines and rotors is the most voluminous category, with 73 percent growth from 2010 through 2015, it is the water plants category that experienced the largest increase, 152 percent, during that same period. Water wheels is the segment with the second highest growth, checking in at 88 percent, while hydrostatic thrust grew by just 12 percent.

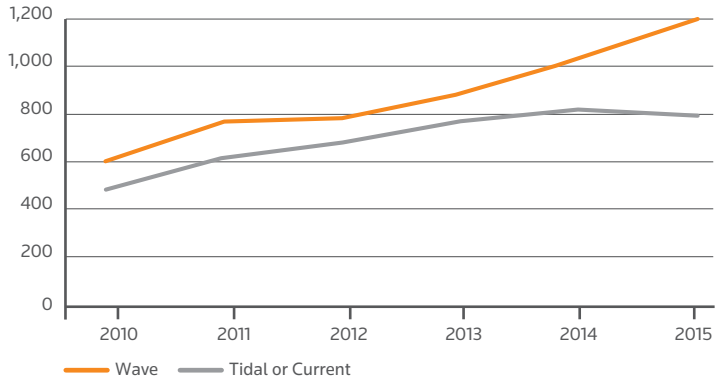
Guangdong Meiyan Jixiang, GE, Toshiba, Zhejiang Ocean University and Voith are the top five organizations innovating in this space. **Figure 20** shows the breakout between their innovation related to hydro or wave activity from 2010 – 2015. Of them all, Guangdong Meiyan Jixiang has had the most recent, fastest uptick in activity, with a massive spike in publications in 2015, as shown in **Figure 21**. The others have remained fairly consistent in their innovation activity and ended 2015 in the 20-40 published inventions that year. Guangdong eclipsed them all with nearly 150 for the same period.

Figure 17. Water-Related Energy Innovation (2010 – 2015)



Source: Derwent World Patents Index

Figure 18. Wave-Related Water Innovation (2010 – 2015)



Source: Derwent World Patents Index

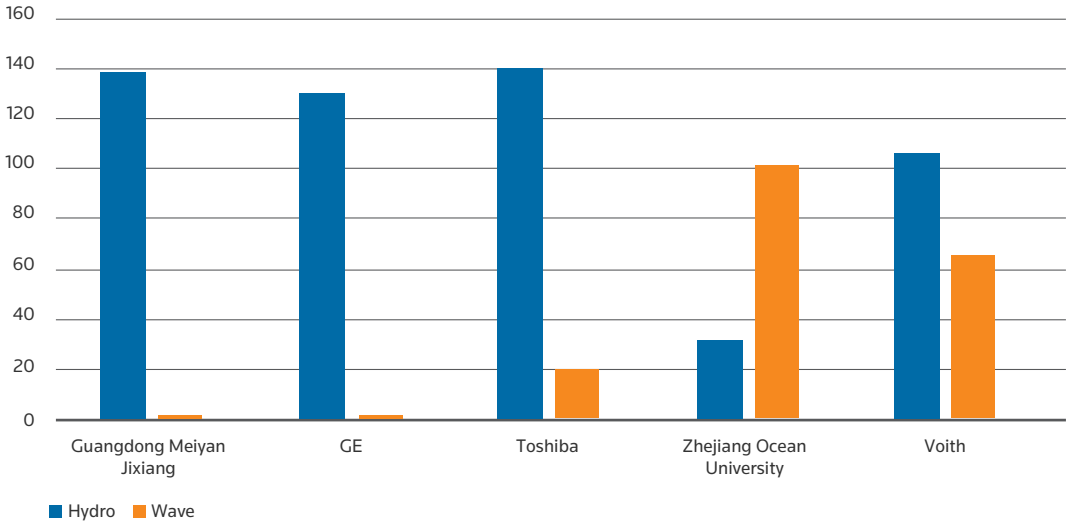
SOLAR

Sunlight is an abundant source of energy for our planet. Many regions are drenched in it frequently, if not daily. That said, the technology to make it into a viable, scalable power source is just starting to be a reality for the masses.

The components that comprise technology that harnesses energy from the sun fall into two categories: solar cell materials and other solar PV (photovoltaic) components. The former is represented by the blue line and the latter by the orange in **Figure 22**. While there is much more activity in the realm of solar PV components, it is the solar cell material that is essential for converting sunlight into electrons for energy.

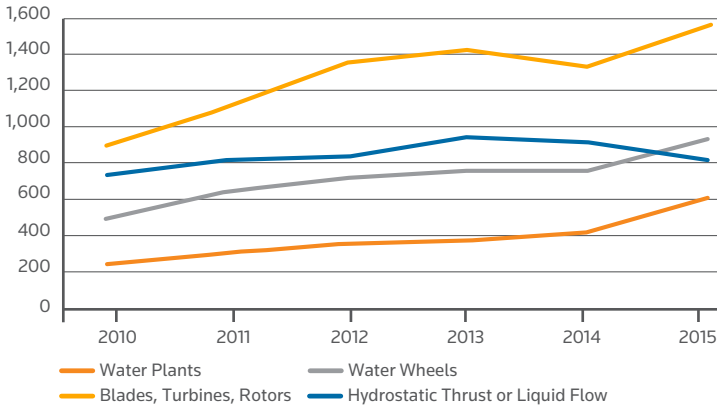
The photovoltaic process happens when photons from sunlight are absorbed by semiconducting materials, freeing electrons so they flow through it to produce electricity (voltage). Photovoltaic cells use solar energy to power everything from small devices, like clocks or calculators, to homes, offices and communities. Concentrated solar is exclusively for large-capacity systems.

Figure 20. Top 5 Water-Based Power Innovators by Type (2010 – 2015)



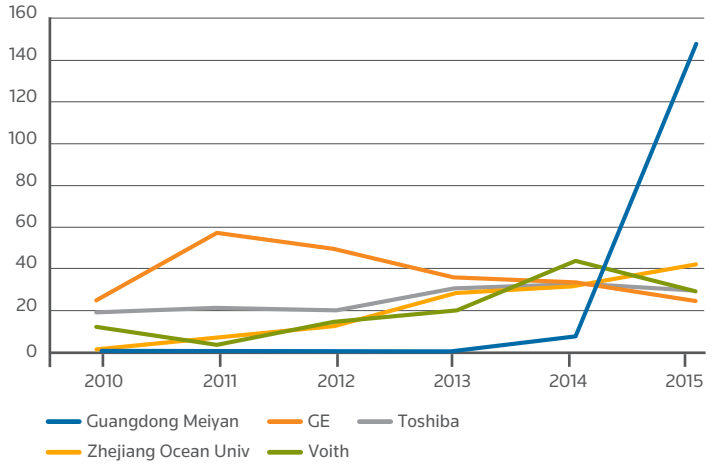
Source: Derwent World Patents Index

Figure 19. Hydro-Related Water Innovation (2010 – 2015)



Source: Derwent World Patents Index

Figure 21. Top 5 Water-Based Power Innovators by Yearly Activity (2010 – 2015)

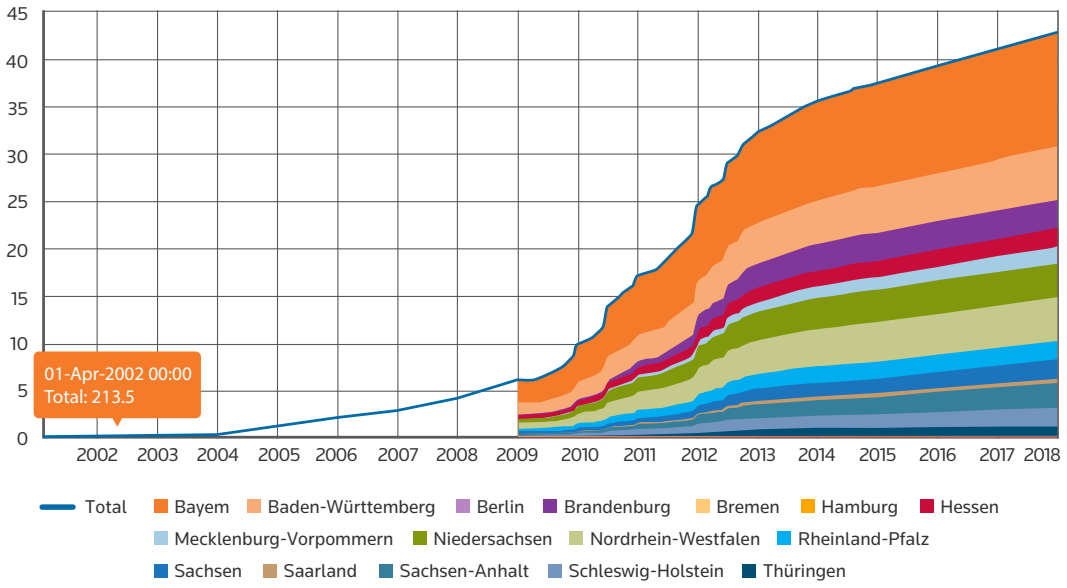


Source: Derwent World Patents Index

According to Thomson Reuters solar analysts, roughly a third of the world's installed solar capacity is in Germany, as the government has offered significant subsidies to incent its use, as shown in **Figure 23**. With the turn of the millennia came Germany's growing commitment to solar. Projections through 2018 show it continuing to increase.

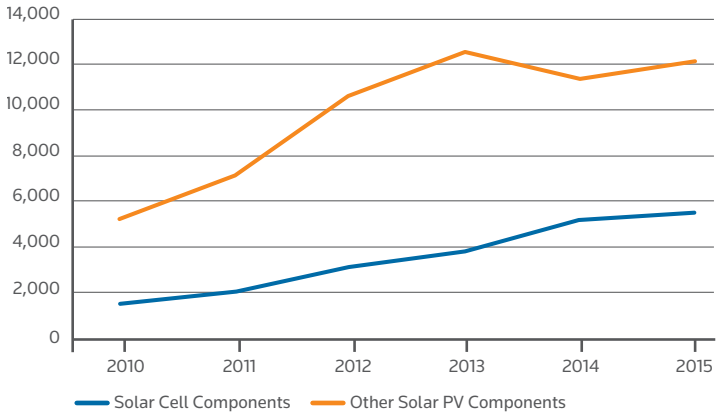
The chart in **Figure 24** shows how solar power generation has completely displaced gas generation on a sunny autumn day. The deployment of renewable energy sources in Germany, such as solar and wind, has resulted in lower power prices and a loss of value for thermal generators as illustrated by the recent write-offs seen by utilities in Europe.[11]

Figure 23. Solar Installed Capacity in Germany (Projected Through 2018)



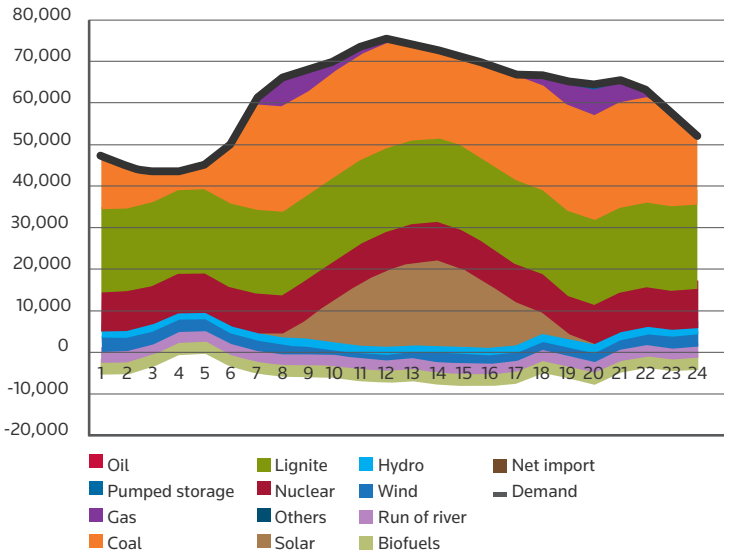
Source: Thomson Reuters Eikon

Figure 22. Solar-Related Energy Innovation (2010 – 2015)



Source: Derwent World Patents Index

Figure 24. Solar Power Generation Displacing Gas (October 1, 2015 - Germany)



Source: Thomson Reuters Eikon

11 http://www.wsj.com/articles/SB10001424052702304255604579408362026916346
http://www.wsj.com/articles/e-on-driven-to-loss-by-write-downs-1426056446
http://www.wsj.com/articles/rwe-plans-further-cost-cuts-1425968788

Table 4. Top Solar PV Innovators

COMPANY	COUNTRY	RANK SOLAR CELL MATERIALS	RANK OTHER SOLAR PV COMPONENTS
Sharp	Japan	1	2
Mitsubishi	Japan	2	3
Kyocera	Japan	3	6
Fujifilm	Japan	4	7
LG	South Korea	5	1
Samsung	South Korea	6	4
Konica Minolta	Japan	7	13
Chinese Academy of Sciences	China	8	8
Merck Patent GmbH	Germany	9	19
Ocean's King Lighting Science & Tech	China	10	
Sumitomo	Japan	11	15
Sanyo	Japan	12	5
Sony	Japan	13	9
Hitachi	Japan	14	10
Panasonic	Japan	15	11
Dainippon Printing	Japan	16	18
IBM	US	17	
BASF	Germany	18	
Haiyangwang Lighting Tech	China	19	
DuPont	US	20	12
Canon	Japan		14
Changzhou Trina Solar Energy	China		16
Toshiba	Japan		17
Hyundai	South Korea		20

Source: Derwent World Patents Index

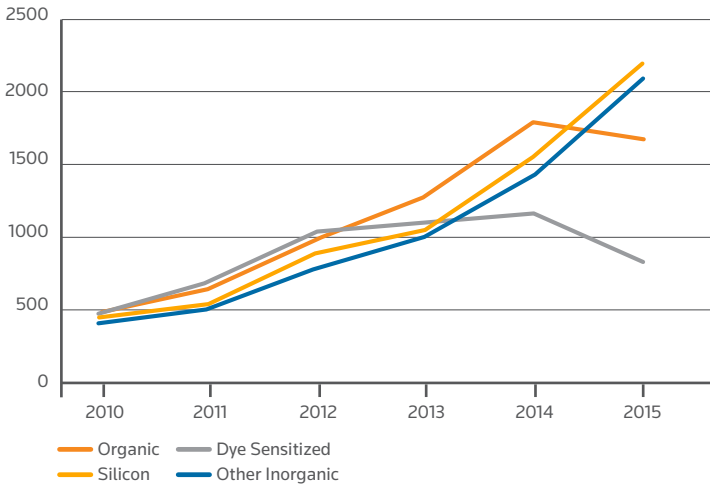
The Top Solar Innovators

There's a lot of overlap between the companies innovating in solar cell materials versus photovoltaic components. Table 4 shows the top companies across both segments and their respective placements. Sharp is the top innovator for solar cell materials and ranks second for other solar PV components. LG leads in terms of other solar PV components, but places fifth in solar cell materials.

Within the realm of solar cell materials, there are different approaches for capturing sunlight from solar and harnessing its energy. These include organic methods, dye sensitization, the use of silicon, and other inorganics, the recent activity of which is featured in Figure 25. Silicon and other inorganics lead in terms of 2015 output, whereas dye-sensitized and organic methods both declined over the last year.

Companies leading in solar cell material innovation and the diversification of their portfolios across the four methods are showcased in Figure 26. Sharp, Mitsubishi and LG top the charts in terms of silicon-related work, whereas Kyocera, Fujifilm and Sharp are the most active with other inorganics.

Figure 25. Solar Cell Material Innovation (2010 – 2015)

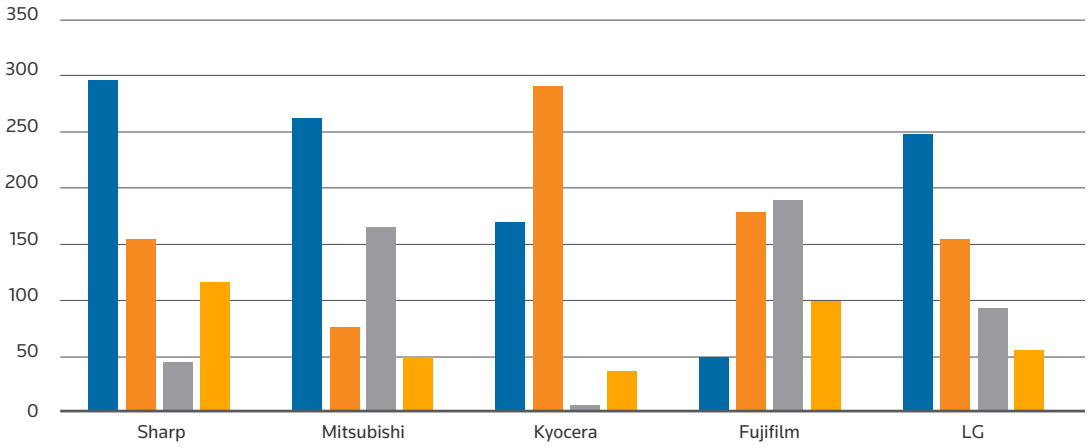


Source: Derwent World Patents Index

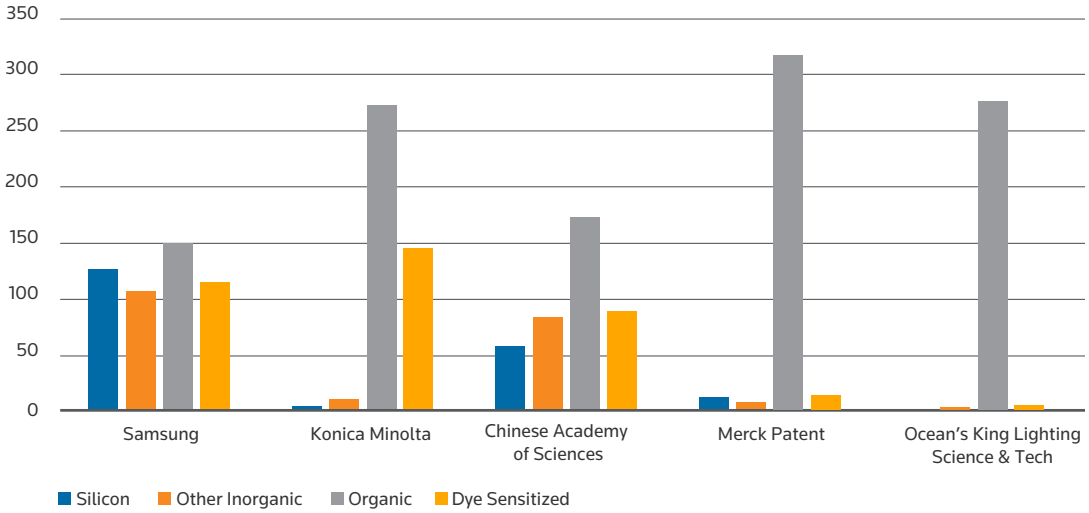
"Our investments in renewables are made with a commercial mind-set and we are growing this business as well as looking into other new energy sources and business models."

Bjørn Otto Sverdrup
Senior Vice President of Sustainability
Statoil

Figure 26. Top Solar Cell Material-Related Energy Innovators (2010 – 2015)



Solar Cell Assignees 6-10 by Material (2010 – 2015)



Source: Derwent World Patents Index

NUCLEAR

The effectiveness of nuclear energy as a long-term source of power is often debated, especially given mass tragedies such as Chernobyl in 1986 and the Fukushima Daiichi nuclear breakdown in 2011, as well as other perceived environmental and human threats related to this power source. Nevertheless, the field continues to advance due to an increase in recent innovation activity and is becoming a more viable contender as a major source of future power.

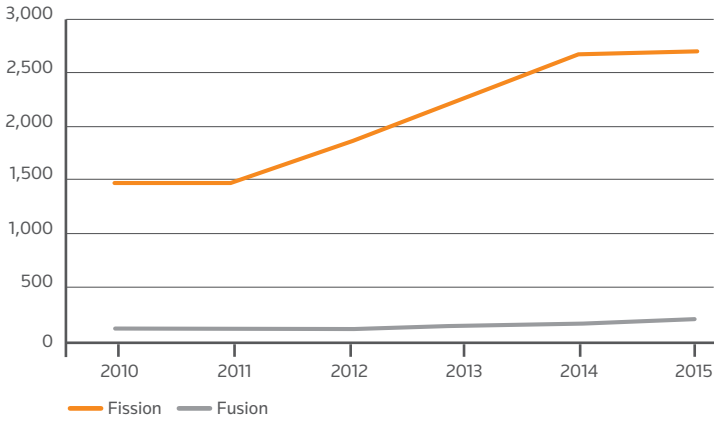
There are two main types of nuclear innovation related to energy: nuclear fission and nuclear fusion. The former has much more activity than the latter, as shown in Figure 27, and has been in existence and use longer.

Fission involves the process by which uranium atoms are split, releasing energy that in turn produces steam, which powers a turbine and generates electricity. Nuclear power plants can generate a lot of electricity with minimal pollution but the fission process produces radioactive waste that must be properly dealt with or it can be harmful to life and the planet.

Nuclear power is, and will continue to be, a source of electricity to large geographic regions and populations, especially if public sentiment is swayed via new inventions and technology. The more noteworthy promise, however, is with nuclear fusion, which generates electricity without the production of dangerous radioactive waste, even though it is still in the research phase and not in commercial use. Nonetheless, patenting in this area is increasing and certain subcategories related to nuclear fusion are emerging and can be identified by looking at patent filings.

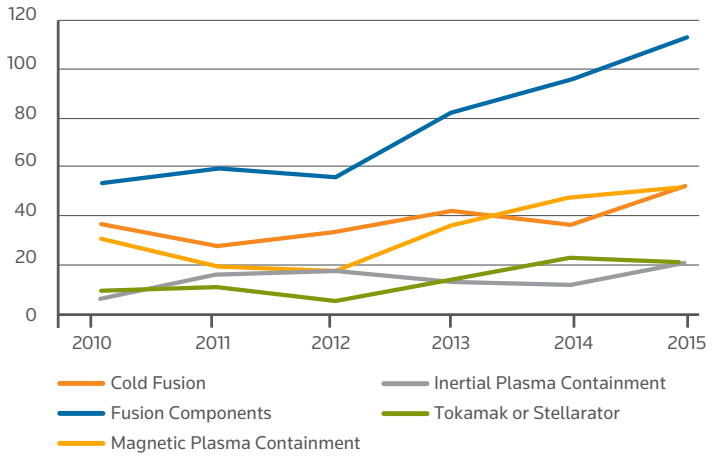
Within the realm of nuclear fusion innovation, there are several different areas of activity: cold fusion, inertial plasma containment, magnetic plasma containment, fusion components and tokamak or stellarator, as shown in Figure 28. By far the most active area is that of the fusion components, followed by magnetic plasma containment and cold fusion, which have traded top spots with one another over the past few years.

Figure 27. Nuclear-Power Innovation Activity by Reactor Type (2010 – 2015)



Source: Derwent World Patents Index

Figure 28. Nuclear Fusion Innovation (2010 – 2015)



Source: Derwent World Patents Index

The organizations leading the nuclear fission/fusion race hail predominantly from Asia, with 75 percent (15 of the 20) either entirely or partially from that continent, as shown in **Table 5**. China is by far the most active, with 35 percent of the top 20, followed by Japan, with 25 percent. Two of the Japanese innovators are joint partnerships, of which at least one of the partners is US-based GE.

Figure 29 shows the innovation investment activity of the top 22 nuclear companies in fission versus fusion work. By far the largest nuclear fusion contributor is the Chinese Academy of Sciences, which is not surprising as China is slated to have the most near-term plants being built – 24 in total are under construction.[12] Nuclear fusion, as mentioned, is a newer process for generating energy from nuclear activity and has potential to be more environmentally sound and still cost-effective.

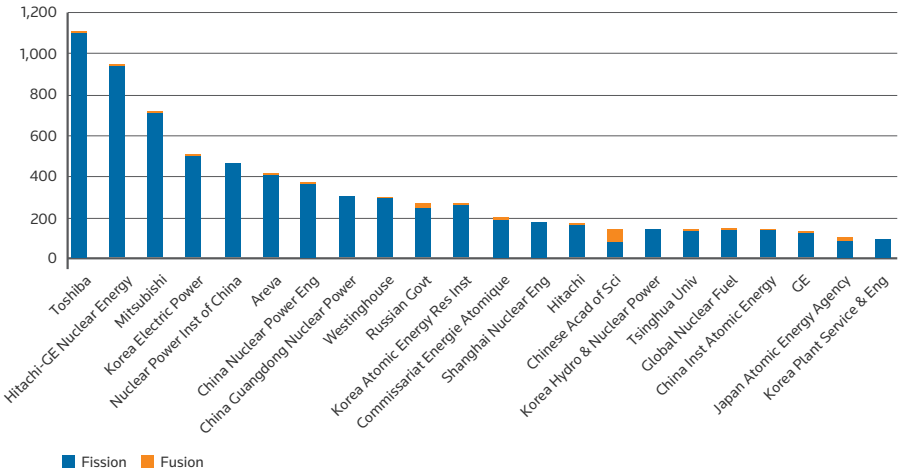
Table 5. Top 20 Organizations Innovating in Nuclear Energy

COMPANY	COUNTRY
Toshiba	Japan
Hitachi-GE Nuclear Energy	Japan/US
Mitsubishi	Japan
Korea Electric Power	South Korea
Nuclear Power Institute of China	China
Areva	France
China Nuclear Power Engineering	China
China Guangdong Nuclear Power	China
Westinghouse	US
Russian Government	Russia
Korea Atomic Energy Res Institute	South Korea
Commissariat Energie Atomique	France
Shanghai Nuclear Engineering	China
Hitachi	Japan
Chinese Academy of Sciences	China
Korea Hydro & Nuclear Power	South Korea
Tsinghua University	China
Global Nuclear Fuel	US/Japan
China Institute of Atomic Energy	China
GE	US

Source: Derwent World Patents Index

12 Helm, Dieter, *The Carbon Crunch* (2012), Yale University Press, page 136.

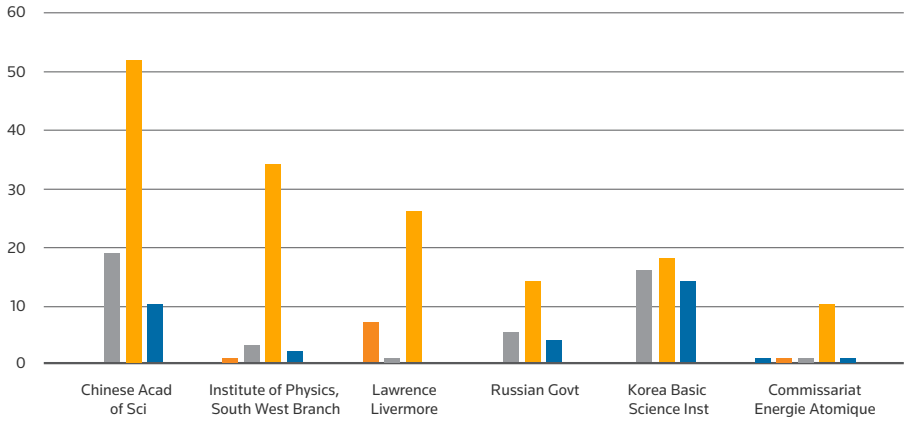
Figure 29. Top Nuclear Innovators (2010 - 2015)



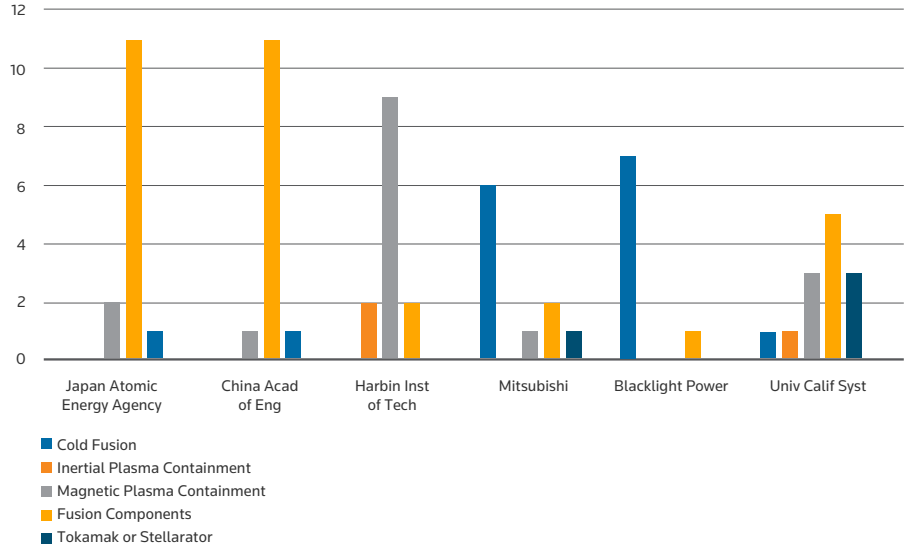
Source: Derwent World Patents Index

The ITER (International Thermonuclear Experimental Reactor) is an international project focused on nuclear fusion research and engineering located in the south of France. It is the world's largest experimental tokamak nuclear fusion reactor.

Figure 30. Top Six Nuclear Fusion Innovators & Activity by Reactor Type (2010 – 2015)



Fusion Assignees 7-12 by Reactor Type or Component (2010 – 2015)



Source: Derwent World Patents Index

The top nuclear fusion innovators are shown in **Figure 30**, with the apportionment of their portfolio across the five categories. As noted, the Chinese Academy of Sciences is the lead innovator in the fusion realm, with most of its activity dedicated to fusion components, followed by the Institute of Physics, South West Branch and Lawrence Livermore.

The leading fusion innovators and their innovation activity over the past six years are shown in **Figure 31**. These are the same organizations as in Figure 30, however their contributions are plotted on an annual basis. From this view it is clear to see that overall the Russian Government closed out 2015 in third place, beating Lawrence Livermore in volume for that year.

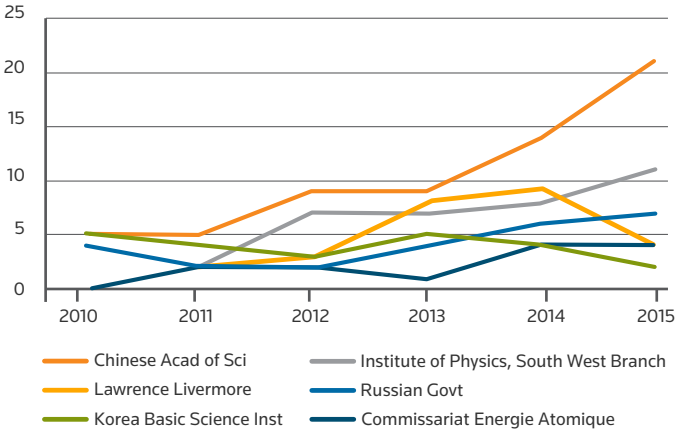
Reactions to Nuclear Reactors: Legal Battles Heat Up

While the future of nuclear power shows definite promise, its outcome will depend on whether the industry can win over public sentiment. New inventions in development could potentially ease the minds of citizens and constituents wary of building reactors in their area. However, there's presently a major legal battle facing the US nuclear power industry regarding rules for storage of spent nuclear fuel and licensing of existing and proposed plants.

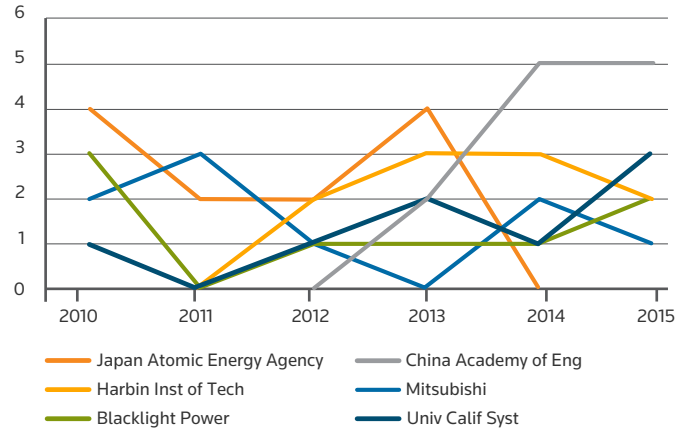
In September 2014, the Nuclear Regulatory Commission (NRC) issued revisions to its final rule on the continued storage of spent nuclear fuel at power-generating reactor sites beyond the licensed life of the reactor (79 FR 56263-01). Spent nuclear fuel is currently being stored at 22 decommissioned plants around the US.

Attorney Generals from New York, Connecticut and New Hampshire are challenging the NRC and have asked the D.C. Circuit of the Federal Court of Appeals to vacate the revised rule (Westlaw: *State of New York, et al. v. NRC, et al.*). The Commonwealth of Massachusetts and several environmental groups, including the Nuclear Resources Defense Council and Beyond Nuclear Inc., recently joined the case.

Figure 31. Top Six Nuclear Fusion Innovators (2010 – 2015)



Fusion Assignees 7-12 by Publication Year (2010 – 2015)



Source: Derwent World Patents Index

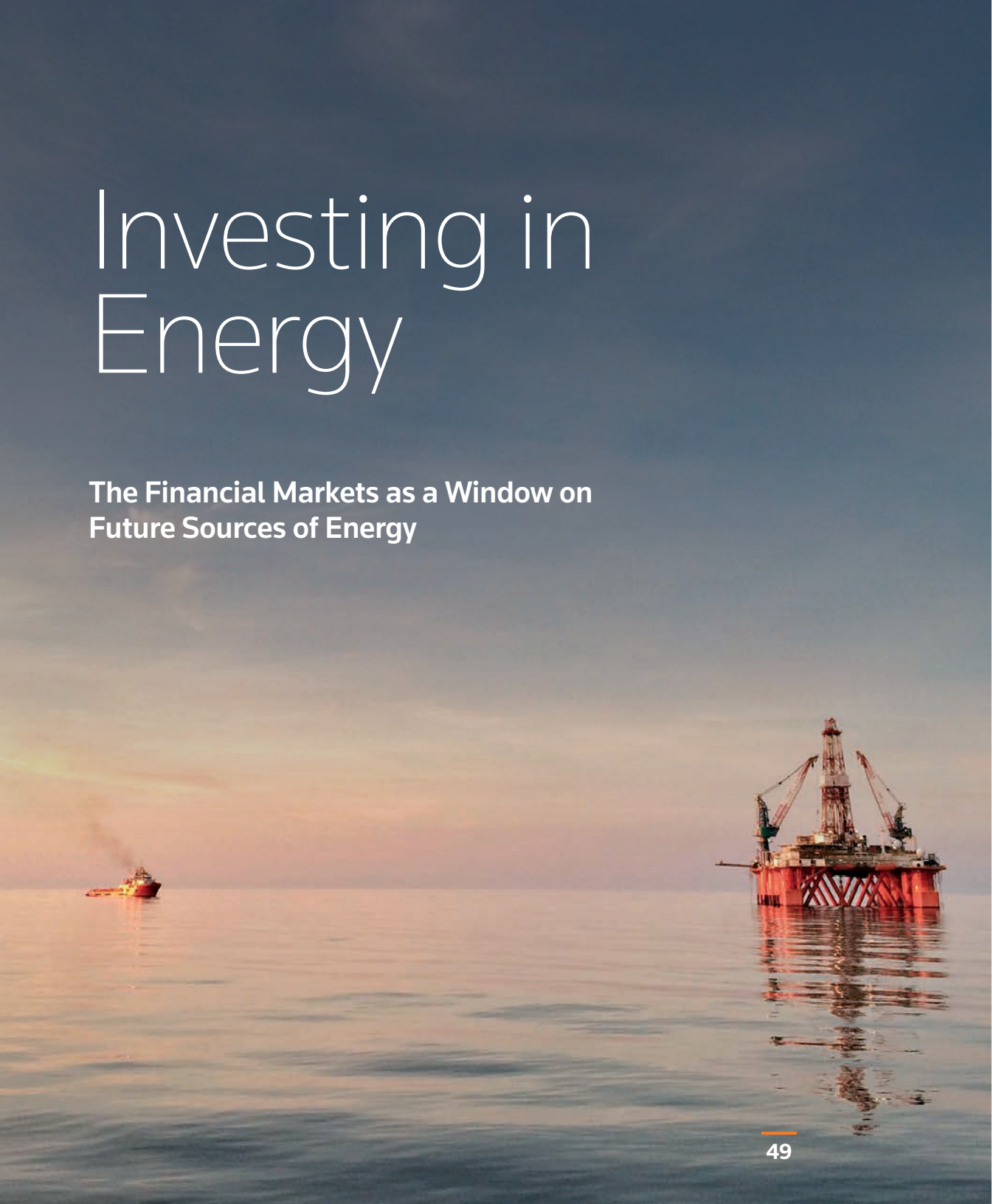
The suit claims the agency's generic environmental review of the law failed to consider the cumulative impacts of storing spent nuclear fuel over an extended period. It asserts that the NRC violated the National Environmental Policy Act by proposing to implement the rule and issuing licenses for reactors without properly considering alternatives that could help avoid or mitigate the adverse environmental impacts.

The Nuclear Energy Institute supports the new NRC rule, saying it will facilitate the re-licensing of existing reactors as well as the issuance of site permits for proposed new reactors. The NRC had suspended all licensing decisions for two years while it finalized its rule on nuclear fuel storage.

Protracted litigation could potentially inhibit the ability of the agency to issue licenses, impacting the industry's ability to build new reactors and continue operating existing sites. Such issues and legal battles need to be prevented for real traction to occur.

Investing in Energy

The Financial Markets as a Window on Future Sources of Energy



The oil industry has been hard-hit recently due to the confluence of factors discussed in this paper: the outcome of COP21, environmental concerns over global warming, regional turbulence in the Middle East and others. These have had a tangible impact on company performance across many sectors of energy.

Table 6. Oil Stocks and Analyst Reactions

TICKER	COMPANY	MARKET CAP (US MILLIONS)	ANALYST REVISION SCORE	TOTAL BUY RECOS	TOTAL SELL RECOS
APC	Anadarko Petroleum	18923.24532	9	29	1
APA	Apache Corp	13449.73812	1	10	4
BHI	Baker Hughes	18206.63225	4	23	1
COG	Cabot Oil & Gas	8107.81125	14	18	0
CAM	Cameron International	11902.12988	30	13	0
CHK	Chesapeake Energy	1296.88845	1	2	11
CVX	Chevron	156058.508	21	14	1
XEC	Cimarex Energy	7749.192	19	20	1
CPGX	Columbia Pipeline Group	6198.61788	26	4	0
COP	ConocoPhillips	41459.27836	2	12	1
CNX	Consol Energy	1724.77662	7	8	1
DVN	Devon Energy	9313.26	5	24	1
DO	Diamond Offshore Drilling	2382.45183	96	2	12
ESV	Ensco	1994.47325	15	5	9
EOG	EOG Resources	36055.28213	9	26	0
EQT	Eqt Corp	8690.2038	7	17	0
XOM	ExxonMobil	333368.1551	5	9	6
FTI	FMC Technologies	5238.9804	13	16	0
HAL	Halliburton	25398.33978	12	28	1
HP	Helmerich & Payne	5186.68822	11	11	5
HES	Hess	12035.8935	4	13	0
KMI	Kinder Morgan	32602.43415	37	12	0
MRO	Marathon Oil	4937.2254	1	9	2
MPC	Marathon Petroleum	16735.3836	8	14	0
MUR	Murphy Oil	3072.3665	11	0	5
NOV	National Oilwell Varco	10356.0834	5	6	6
NFX	Newfield Exploration	3889.2056	10	24	0

Continued ...

When looking specifically at the Oil sector, Table 6 shows a glimpse of its recent state, highlighting the companies that have analyst buy recommendations versus those that are a bit bearish.

Benchmark Comparisons

Recent information pulled from Thomson Reuters Eikon compares the Portfolio Cumulative Return (blue) with the Benchmark Cumulative Return (green) for the Lipper Global Natural Resources vs. PowerShares Global Clean Energy Portfolio, as shown in Figure 32. This shows how these particular energy funds have performed related to one another during January 2016.

The Analyst Revisions Model (ARM) is a percentile (1-100) ranking of stocks based on changes in analyst sentiment, with 100 representing the highest rank. A higher score indicates that the model expects analysts to revise estimates higher going forward. A lower score indicates that analysts are likely to lower estimates, or possibly downgrade the stock. More than half of the exploration and production companies in Table 6 have Analyst Revision Scores below 20, or in the bottom quintile of all companies in the region. This is an indicator that analysts are likely to continue to revise estimates lower and that more downgrades may be coming.

Table 6. Oil Stocks and Analyst Reactions *(continued)*

TICKER	COMPANY	MARKET CAP (US MILLIONS)	ANALYST REVISION SCORE	TOTAL BUY RECOS	TOTAL SELL RECOS
NBL	Noble Energy	11939.51444	5	21	1
OXY	Occidental Petroleum	49810.86192	3	16	2
OKE	Oneck	4317.40514	97	6	3
PSX	Phillips 66	40242.7136	6	9	1
PXD	Pioneer Natural Resource	17974.22532	30	35	0
RRC	Range Resources	4749.1348	29	24	0
SLB	Schlumberger	85181.7504	17	30	1
SWN	Southwestern Energy	3218.08923	1	7	2
SE	Spectra Energy	19571.63065	11	5	0
TSO	Tesoro	8863.1118	33	6	0
RIG	Transocean	3268.68874	50	3	21
VLO	Valero Energy	26395.99446	79	16	1
WMB	Williams Companies	8892.1847		5	0

Source: Thomson Reuters StarMine® & Asset 4

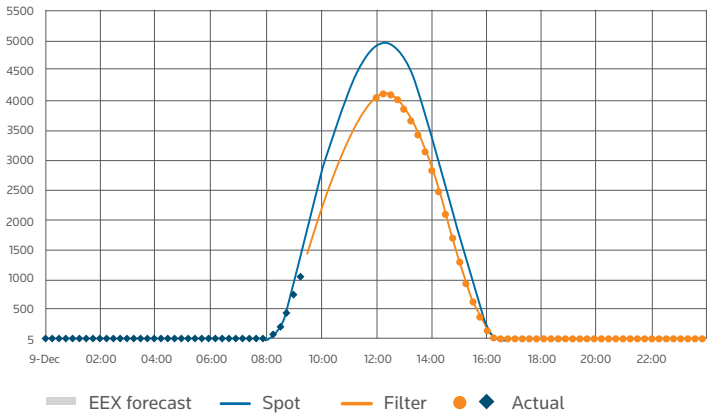
Table 7 shows a portion of the companies comprising the PowerShares Global Clean Energy Portfolio and their performance during January 2016. It is one of many tools that give analysts additional insight regarding investment opportunities, which help inform buy versus sell decisions.

Traders can also access forecasts that are updated in real time for different energy sectors, such as the one for wind and solar generation shown in Figure 33. This information allows them to maximize the value of their thermal generation. The initial forecast is in blue, while the new, updated forecast taking into account observed actuals is in orange. ●

Figure 32. Comparison of Two Energy Portfolios (January 2016)

Source: Thomson Reuters Eikon

Figure 33. Intraday Solar Forecast (December 9, 2015)

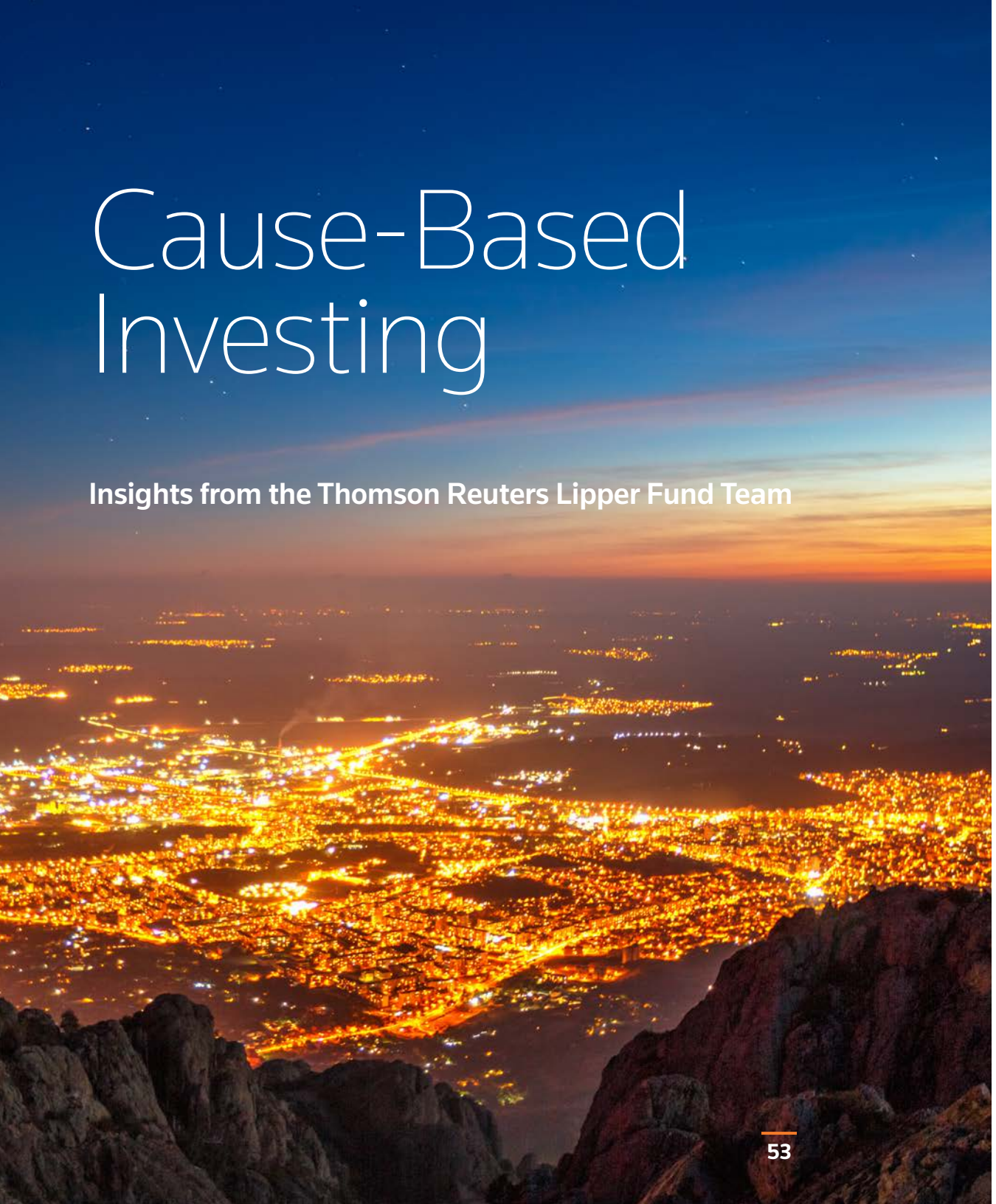


Source: Thomson Reuters Eikon

Table 7. Composition of PowerShares Global Clean Energy Portfolio
PowerShares Global Clean Energy Portfolio vs. Lipper Global Natural Resources 12/31/2015 – 1/31/2016; Base Currency: US Dollar

SECTOR NAME	ISSUE NAME	ID	AVG PORT WT	PORT RETURN	PORT CONTRIB	AVG BMRK WT	BMRK RETURN	BMRK CONTRIB	ALLOC EFFECT	SELECT EFFECT	TOTAL EFFECT
Total Portfolio		3011301	100.00	-11.04	-11.04	100.00	-6.09	-6.09	-1.24	-3.72	-4.96
Consumer Staples		30	1.61	2.75	0.05	2.07	-3.37	-0.07	-0.02	0.09	0.07
SÃO MARTINHO SA	São Martinho Ord Shs	B1P3R4	1.61	2.75	0.05	0.00	0.00	0.00	0.00	0.09	0.09
TYSON FOODS INC	Tyson Foods Ord Shs Class A	TSN	0.00	0.00	0.00	0.20	0.06	0.00	0.00	0.00	0.00
PILGRIM'S PRIDE CORP	Pilgrim's Pride Ord Shs	PPC	0.00	0.00	0.00	0.08	0.41	0.00	0.00	0.00	0.00
BUNGE LTD	Bunge Ord Shs	BG	0.00	0.00	0.00	0.29	-9.18	-0.03	0.00	0.01	0.01
ADECOAGRO SA	Adecoagro Ord Shs	AGRO	0.00	0.00	0.00	0.14	-3.01	0.00	0.00	0.00	0.00
CASEY'S GENERAL STORES INC	Casey's General Stores Ord Shs	CASY	0.00	0.00	0.00	0.13	0.43	0.00	0.00	0.00	0.00
FIRST RESOURCES LTD	First Resources Ord Shs	B2927P	0.00	0.00	0.00	0.06	-9.41	-0.01	0.00	0.00	0.00
ARCHER DANIELS MIDLAND CO	Archer Daniels Midland Ord Shs	ADM	0.00	0.00	0.00	0.70	-3.63	-0.02	0.00	0.00	0.00
BRITANNIA INDUSTRIES LTD	Britannia Industries Ord Shs	612477	0.00	0.00	0.00	0.15	-11.66	-0.02	0.00	0.01	0.01
CHAROEN POKPHAND INDONESIA TBK PT	Charoen Pokphand Indonesia Ord Shs	631534	0.00	0.00	0.00	0.05	28.75	0.01	0.00	-0.01	-0.01
ALIMENTATION COUCHE-TARD INC	Alimentation Couche Tard Sub Voting Ord Shs Class 6	+ATD.B	0.00	0.00	0.00			0.00	0.00	0.00	0.00
Financials		40	0.30	-3.06	-0.01	1.08	-5.14	-0.05	-0.01	0.01	0.00
METRO PACIFIC INVESTMENTS COR	Metro Pacific Inv Ord Shs	B1L883	0.00	0.00	0.00	0.04	4.45	0.00	0.00	0.00	0.00
PICO HOLDINGS INC	PICO Holdings Ord Shs	PICO	0.00	0.00	0.00	0.20	-14.92	-0.03	0.00	0.01	0.01
CAPITAL STAGE AG	Capital Stage Ord Shs	549196	0.30	-3.06	-0.01	0.84	-3.06	-0.02	0.00	0.00	0.00
N/A		N/A	1.06	-7.85	-0.08	0.00	0.00	0.00	-0.03	0.00	-0.03
GCP INFRASTRUCTURE INVESTMENTS L TO GCP	GCP Infrastructure Investments Ord Shs	861733	1.06	-7.85	-0.08	0.00	0.00	0.00	0.00	0.00	0.00

Source: Thomson Reuters Eikon



Cause-Based Investing

Insights from the Thomson Reuters Lipper Fund Team

The concept of socially responsible investing (SRI) can be traced back to the colonial era in the United States, when some religious groups – particularly the Methodist Church and later the Religious Society of Friends (the Quakers) – refused to invest their funds in the slave trade. However it wasn't until the 1920s that SRI took a specific form: an ecclesiastical group created the first publicly available investment fund (Pioneer Fund) to screen out tobacco, alcohol and gambling investments.

Today, SRI is often referred to as socially conscious, ethical, green, mission, religious or sustainable investing having strategies that screen out weapons manufacturers, gambling establishments, tobacco companies, abortion-related securities, pornography, etc., or that screen in best-in-class, shareholder-friendly companies. Whatever their cause, SRI investors seek two things: reasonable returns and targeting special social causes.

In recent literature on social investing, there are two fairly new terms related to responsible investing. The first is environmental, social and governance (ESG) investing, which aims to improve investment performance by searching for the best-in-class organizations. There is a growing understanding that certain ESG issues that are not captured in traditional, fundamental analysis can prove to be germane to investment performance; for example, when Coca-Cola cut its emissions it saved millions of dollars in the process.

The second new term is impact investing, which involves investing in securities, projects or firms with the stated goal of impacting the portfolio's mission-related social or environmental change. On the mutual fund side, **Access Capital Community Investment Fund** is a prime example of an impact investment offering that might not have shown up on SRI screens a few years back because of its one-topic focus: The fund invests primarily in debt securities and other debt instruments supporting the affordable housing industry.

Interest in SRI mutual funds has grown over the last two decades. In 1994 there were only 56 unique funds (ignoring share classes), with combined total net assets (TNA) of just $4.0 billion. By March 31, 2015, those numbers jumped to 186 unique funds with a combined value of $89.9 billion. While assets under management remained relatively subdued, the "stickiness" of the assets and the conviction of SRI fund investors through the market tribulations of the bursting of the tech bubble from 2000 – 2003 and the 2008 financial crisis were quite amazing. While conventional equity mutual funds witnessed net redemptions for 2002 and 2008, SRI funds witnessed net inflows for both periods. While TNA did decline for SRI funds because of the market losses (-12.88 percent and -30.59 percent on average for 2002 and 2008), investors appeared to use those opportunities to buy on the dip. After hitting a low in 2008, the TNA of the group jumped 121 percent from $40.7 billion to nearly $90 billion now.

Perhaps as noteworthy is the number of diversified investment options available to investors. In 1994 there were approximately 28 different Lipper classifications from which to choose socially aware funds. By March 2015, socially aware funds were offered in 57 classifications. For the one-year period ended March 31, 2015, 49 percent (26 of the classifications) of the average returns for SRI/ESG/impact-investing funds beat their non-SRI classification averages. For example, the average one-year return for all Global Equity Income Funds was 1.68 percent, while the average return for SRI Global Equity Income Funds was 6.39 percent, a 4.71-percentage-point difference.

The SRI average consisted of the two share classes of the same fund: **Steward Global Equity Income Fund**. Nonetheless, and in contradiction to what many pundits have hypothesized, SRI funds don't always underperform their category averages or their underlying benchmarks. In fact, all five top-performing SRI funds shown in **Table 8** handsomely beat their broad-based classification averages for most of the periods.

Despite the relative increase in the number of SRI-fund offerings, clients are still finding it difficult to find advisors who are knowledgeable of SRI/ESG/Impact investing. BlackRock, Merrill Lynch and other key money managers are increasing their efforts to add value-based strategies and develop new products. With some additional research, advisors can find funds that fit their clients' needs with excellent track records.

Table 8. Top 5 Performing SRI Funds for the One-Year Period Ended March 31, 2015

			THROUGH THE PERIOD ENDED MARCH 31, 2015					
NAME	US MUTUAL FUND CLASSIFICATION	NASDAQ TICKER	1-YR TOTAL RETURN	1-YR TOTAL CLASSIFICATION AVERAGE*	3-YRS TOTAL RETURN	3-YRS TOTAL CLASSIFICATION AVERAGE*	5-YRS TOTAL RETURN	5-YRS TOTAL CLASSIFICATION AVERAGE*
Ariel Fund, Investor	Mid-Cap Core Funds	ARGFX	19.54	9.64	21.60	15.63	16.11	13.72
Parnassus Endeavor Fund	Multi-Cap Core Funds	PARWX	18.69	10.01	19.20	15.37	13.01	13.06
GuideStone Real Estate Securities Fund; Inv	Global Real Estate Funds	GREZX	16.76	14.84	9.23	11.67	13.01	10.75
Eventide Gilead Fund; N	Mid-Cap Growth Funds	ETGLX	16.30	11.63	24.85	15.22	20.40	14.92
Praxis Growth Index Fund; I	Large-Cap Growth Funds	MMD EX	16.04	14.53	16.36	15.06	15.16	13.99

Source: Lipper, a Thomson Reuters company

* Classification averages are for all mutual funds; periods longer than one year are annualized; primary share class used for evaluation

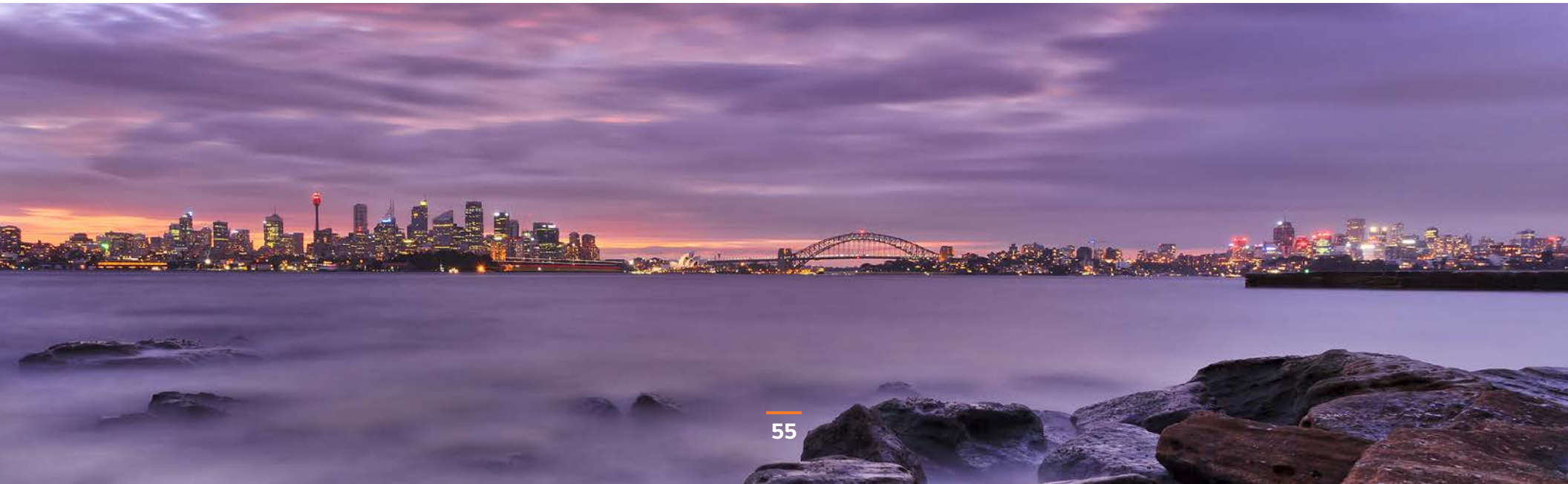


Table 9. Top Funds Dedicated to Renewables

NAME	ONE-YEAR RETURN	THREE-YEAR ANNUALIZED RETURN	FIVE-YEAR ANNUALIZED RETURN
Guggenheim Invest S&P Global Water Index ETF	-3.03752245	6.2497484	7.34139745
AllianzGI Global Water Fund; Institutional	0.50305027	5.09362859	6.93895989
AllianzGI Global Water Fund; P	0.50468843	5.04119532	6.84507432
AllianzGI Global Water Fund; A	0.22131853	4.79232766	6.61787021
AllianzGI Global Water Fund; C	-0.57457823	3.98027006	5.80617194
Calvert Global Water Fund; Y	-12.28939182	-0.11738993	3.52732607
Calvert Global Water Fund; A	-12.51412581	-0.44761637	3.21596343
Calvert Global Water Fund; C	-13.2038835	-1.18029469	2.34157714
First Trust ISE Global Wind Energy Index Fund	6.38982972	15.13679037	2.17564631
PowerShares Global Water Portfolio	-11.05500382	2.87843174	1.50176788
Market Vectors Global Alternative Energy ETF	-5.69162105	11.8170368	-2.94195037
PowerShares Global Clean Energy Portfolio	-9.7 4954902	7.47129655	-5.20927112
iShares Global Energy ETF	-20.22977022	-9.73167713	-5.4828036
Vanguard Energy Fund; Admiral	-19.46982045	-9.49687516	-5.76697723
Calvert Global Energy Solutions Fund; I	-7.37169445	-0.09802408	-5.81019237
Vanguard Energy Fund; Investor	-19.50572108	-9.54510374	-5.82156891
Market Vectors Uranium+Nuclear Energy ETF	-8.88336336	4.15471765	-5.83434903
Calvert Global Energy Solutions Fund; A	-7.66385973	-0.49483917	-6.26170985

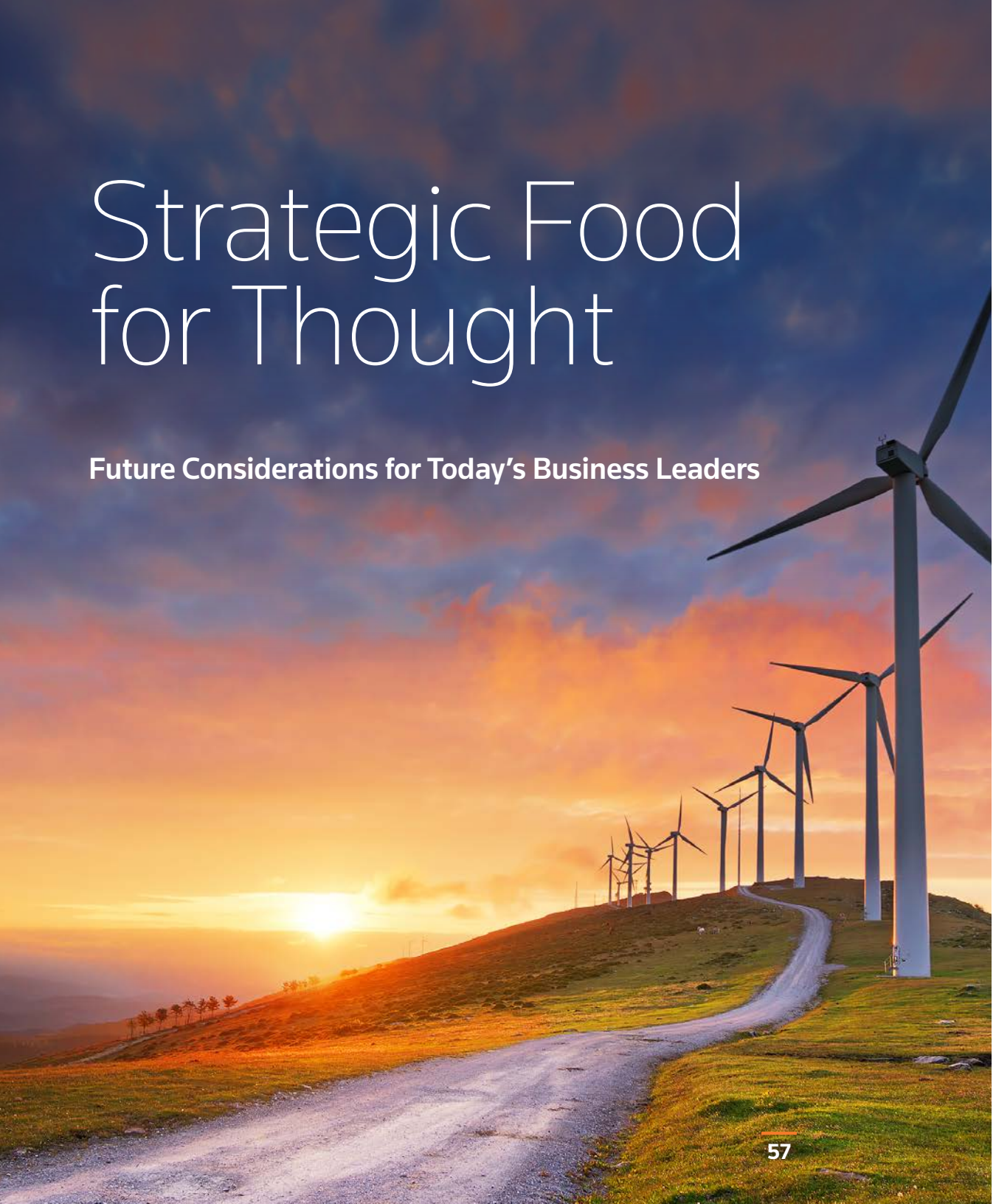
Source: Thomson Reuters Lipper Fund Performance Report 2015

Specific to energy-related funds, Table 9 shows the performance of the top funds with a dedication to renewables, including their one-, three- and five-year performance.

While conventional wisdom might suggest investors are best served by separating their ethical and religious beliefs from their investments, with the new focus on impact and ESG investing, investors may be able to do both. In fact, chasing the performance of companies whose managers think only of short-term profits might be more detrimental to one's long-term financial well-being. In the interim, SRI mutual funds offer investors a simple way to both earn a return on their investments and support their specific social beliefs.

Strategic Food for Thought

Future Considerations for Today's Business Leaders



As business leaders grapple with the challenges and opportunities ahead in the 21st century, the following are recommendations to consider related to energy strategies and how to ensure long-term success.

FINANCE

Allocate budget for renewable energy sources and consider investing in impact or ESG funds as part of your organization's investment portfolio.

Changing weather patterns and the growth of renewables will have an impact on global markets. It is imperative that business leaders have a clear understanding of these changes, and what is projected, by partnering with an experienced, trusted team to understand the ramifications of their investments on their industry and business.

Markets will liberalize in order to attract the level of investment needed to power the planet in the future. This means more open markets and a definite need for corporate financial teams to partner with organizations with an expert view on energy and its impact.

INFRASTRUCTURE

Over the next several decades, it will be imperative for corporations to continue to reduce their carbon footprint and transition to alternative sources of power. A great place to start is with their data centers, which consume enormous amounts of energy, by sourcing more power from sustainable resources.

Business leaders should partner with organizations that provide reliable electrical energy without the GHG emissions. A task force should be created to address this need.

LEGAL

There will undoubtedly be an increase in regulation as we move through the next several decades. The legal landscape is growing more complex by the day, so there is an opportunity for large firms to expand their roles and advise corporate clients on compliance and risk.

There is also a need to have an attorney within the corporate legal department dedicated to staying current on the regulations and their implications, as environmental legal matters increase in the future.

Corporations need to ensure they are in compliance with new legal mandates related to energy use and generation but also that they are being protected from environmental-related litigation.

TAX & COMPLIANCE

The regulatory environment will change alongside global markets in energy and elsewhere. Tax executives should employ tools to stay abreast of the latest global tax developments and trends, which give their teams access to integrated research, editorial insight, productivity tools and news updates.

Compliance will continue to be essential in the rapidly evolving global tax landscape. Tax department leaders need to ensure their technology infrastructure contains platforms to help them remain compliant, avoid penalties and audits, and ensure efficiency, accuracy and timeliness of their tax reporting obligations.

Insightful Solutions

Thomson Reuters Checkpoint®

Provides integrated research, editorial insight, productivity tools, online learning and news updates along with intelligent links to related content and software for tax and accounting professionals globally.

Thomson Reuters Eikon™

Provides easy access to trusted news, data, and analytics, all filtered by relevance to your exact needs, and displayed in a highly visual way that's easy to grasp and act on.

Thomson Innovation®

The global IP intelligence and collaboration platform across the Lifecycle of Innovation, from discovery to protection and commercialization.

Thomson Reuters OneSource®

Drives global tax compliance and accounting decision making across 180 countries, helping companies remain compliant, avoid penalties and audits, save time and increase efficiency across the tax lifecycle.

Thomson Reuters Point Carbon

Specialist energy market content and analysis from the Point Carbon team, available on Thomson Reuters Eikon.

Thomson Reuters Westlaw™

Build the strongest argument relying on superior legal materials, including: authoritative primary law, exclusive analytical materials, practice area insights, the largest online collection of litigation resources, public records and more.

Contributors

David Chantelou
Head of Power Modeling,
Financial Commodities
Thomson Reuters
Financial & Risk

Neil Fromer
Executive Director for the
Resnick Institute, Caltech
(The California Institute of
Technology)

Shari Helaine Littan,
CPA-JD
Editor/Author for
GAAP Reporter
Thomson Reuters
Tax & Accounting

Anil Kuruvilla
Senior Manager for Tax
Research and Content
Thomson Reuters
Tax & Accounting

Timothy Nixon
Director, Sustainability
Thomson Reuters

Brian Peccarelli
President
Thomson Reuters
Tax & Accounting

Sridharan Raman
Senior Research Analyst
Thomson Reuters
Financial & Risk

Tom Roseen
Head of Research Services,
Financial Advisory &
Investment Management
Thomson Reuters
Financial & Risk

Stig Schjolset
Head of Carbon Research
and Forecasts
Thomson Reuters
Financial & Risk

Bjørn Otto Sverdrup
Senior Vice President
of Sustainability
Statoil

tr.com/power

THOMSON REUTERS®