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Energy and Climate Report

Afternoon Briefing - Your Preview of Today's News

The following news provides a snapshot of what Bloomberg BNA is working on today. Read the full version of all the stories in the final issue, published each night.

Profitable Pickup Trucks, SUVs May Get Break in Trump Review

Posted August 15, 2017, 9:48 A.M. ET

By Ryan Beene and John Lippert

A move under consideration by the Trump administration could ease tough fuel-efficiency standards set to take effect in 2021 on pickups, SUVs and other light trucks, the bulwark of U.S. auto industry sales and profits.

For the 2021 model year, light trucks must average roughly 33 miles per gallon to comply with the current standards, a gain of more than 6 percent from model year 2020, according to estimates from the National Highway Traffic Safety Administration. That's triple the pace of any annual gain for trucks starting in model year 2017, the first year of the current standards, which were finalized in 2012.

President Donald Trump hasn't proposed any changes to the standards yet. But in recent weeks, both NHTSA and the U.S. Environmental Protection Agency signaled a new willingness to alter the rules earlier than originally planned. The EPA formally asked for public comment on whether its 2021 standards are appropriate and NHTSA said it may review the year in an upcoming rulemaking.

"The domestic Big Three are the big winners, and Fiat Chrysler is arguably the most advantaged" if Trump freezes the standards, said Gopal Duleep, president of H-D Systems, a Washington, D.C.-based research company.

General Motors Co., Ford Motor Co. and Fiat Chrysler Automobiles NV derive more than three-quarters of their U.S. sales from light trucks. Even Toyota Motor Corp., which has car and truck sales more closely balanced, would catch a break. For the 2016 model year, Toyota forecasts that its light truck fleet may fall nearly 9 percent below the government's fuel economy target, according to figures released by NHTSA.

Any short-term regulatory relief could handcuff automakers if it allows them to fall behind in a global race to cut emissions with electric motors that either supplement or replace gasoline engines, said Duleep. But in the short run, automakers are likely to welcome any easing of the regulations, he said.

Automakers have been preparing for the rules since they were announced in 2011, and analysts

say they're unlikely to make significant changes even if Trump moved to weaken the rules. Instead, carmakers would see a huge increase in efficiency credits they could use to help them meet stiffer targets in later years, said Dave Cooke, senior vehicles analyst with the Union of Concerned Scientists, an environmental group.

"If their plans are in place and they receive additional credits, it just makes the later years' standards that much easier to meet," Cooke said.

Fiat Chrysler Chief Executive Officer Sergio Marchionne may be bringing out new Ram Pickup and Jeep SUV models, but he's not ignoring electrification. He told investors in July that after 2022, half of his Maserati models will be battery powered.

According to the agreement the Obama administration reached with automakers and announced in 2011, much of the efficiency increase—particularly for trucks—was to come after 2020 to give automakers time to comply. The delay was seen as a crucial factor in the decision by most automakers to endorse the plan. Ford's F-Series pickup trucks alone account for the majority of the company's North American profits.

NHTSA also has said it will study freezing the standards after model year 2020 as a baseline scenario in an environmental review of pending fuel economy requirements for 2022-2025. The deliberations come as part of a so-called mid-term review included in the Obama administration's plan to boost fuel economy to a fleet average of more than 50 miles per gallon by 2025.

A freeze or cut after 2020 would make good on Trump's pledge to the chief executives of Detroit's automakers to slash environmental regulations that he made during his first days in office. It would come as GM is cutting shifts at its passenger-car assembly plants to avoid excessive inventories, Ford is reviving dormant truck nameplates like the Bronco and the Ranger and as Fiat Chrysler has already killed its slow-selling Chrysler 200 sedan.

But for now, automakers say they're simply welcoming Trump's reopening of the review after Obama sought to end parts of it during his last days in office, and are not backing a specific set of revisions.

"Global Automakers has only asked that the mid-term review be conducted in a transparent and deliberate process, based on the facts," said Lauren Boland, communications manager for the trade group, which includes Toyota and Honda Motor Co.

The trade group has not asked to put the already-final 2021 rules under review. Nor has the Alliance of Automobile Manufacturers, which represents GM, Ford, Fiat Chrysler and others, according to spokeswoman Gloria Bergquist.

"Let the facts come in and let the evidence dictate a decision next spring that optimizes our nation's environmental and economic objectives, consistent with affordability," she said in an email.

The EPA plans to determine whether the tailpipe standards for 2021 need to change by next April. That ruling could carry another risk for automakers: driving a wedge between California and Washington regulators, who've been coordinating their rules since 2011 to allow the companies to sell the same vehicles in all 50 states.

The state of California has already said it has no plans to change its 2025 emissions targets, which are followed by several other states that combined account for around 30 percent of U.S. auto sales.

"It was very difficult to get a national standard in the first place," said Stephanie Brinley, senior automotive analyst at IHS Markit. "It's best for the country to have a common standard."

Exxon Mobil's $2.6M Fine for Ruptured Pipeline Tossed

Posted August 15, 2017, 04:09 P.M. ET

By Andrew M. Ballard

Exxon Mobil will get a break on a $2.6 million fine levied against it for a 2013 pipeline spill in Arkansas.

The U.S. Court of Appeals for the Fifth Circuit ordered the Pipeline and Hazardous Materials Safety Administration to reconsider the fine in an Aug. 14 ruling because the company properly complied with certain safety regulations at issue (ExxonMobil Pipeline Co. v. DOT, 5th Cir. App., No. 16-60448, 8/14/17).

Exxon Mobil's Pegasus Pipeline ruptured near Mayflower, Ark., spilling several thousand barrels of crude oil about 22 miles north of the state's capital, Little Rock.

Seam Defect

A PHMSA investigation into the accident identified the cause as a manufacturing defect in the seam of the pipe maintained by Exxon Mobil Pipeline Co., and the agency assessed the $2.6 million fine in October 2015, based on nine alleged regulatory violations. The citations arose from risk factor and pipeline integrity assessments.

Exxon Mobil challenged six of the violations cited by regulators, and the Fifth Circuit found five of those decisions to be "arbitrary and capricious," because it said the company reasonably complied with applicable guidance.

The appeals court did affirm the agency's decision regarding one of the challenged violations, which requires pipeline operators to develop and follow a written integrity management program. But the court said the $783,300 elevated penalty for that cited violation also needed to be lowered as there was no indication the company's failure to use a proper assessment tool was a cause of the spill.

Requirements Followed

"According to the unambiguous text of the pipeline integrity regulations, pipeline operators are required to 'consider' various risk factors when they prioritize pipelines for assessment," according to Judge Jennifer Walker Elrod. "This is a process-based requirement that does not mandate a particular outcome, but rather prescribes a careful, informed decision-making process that pipeline operators must undergo in good faith," Elrod said in her Aug. 14 opinion.

As Exxon Mobil complied with that requirement when it determined the Pegasus Pipeline was not susceptible to seam failure by applying the appropriate methodology, the bulk of the violations were incorrectly cited and the fine required revision, Elrod wrote.

Suann Guthrie, a spokesperson for Exxon Mobil, told Bloomberg BNA Aug. 15 that company officials were "still reviewing the decision" and declined to comment further.

Agency representatives didn't immediately respond to requests for comment.

Southern Wins Early Review of Nuclear Reactor Cost Overruns

Posted August 15, 2017, 02:05 P.M. ET

By Mark Chediak and Margaret Newkirk

U.S. utility owner Southern Co. may have a better idea of how much of an estimated $25 billion nuclear power project it will be allowed to charge Georgia customers before a reactor is even online.

Georgia utility regulators voted 4 to 1 on Tuesday to review a new cost estimate for two delayed reactors under construction in the next few months. The move could offer Southern, which supported the measure, clarity sooner on how much of the billions it's investing in the project are recoverable through customer rates. The state Public Service Commission and Southern had previously agreed to assess expenses once a reactor was finished.

"This would send a message to the company, company's partners, Wall Street and ratepayers that the commission continues to be supportive of this project," Georgia Public Service Commission Chairman Stan Wise said at the meeting.

Although the measure included an amendment that would allow the commission to rescind Tuesday's vote or any others if Southern decides to abandon the project, it signals support among regulators for the project to continue, according to analysts at Guggenheim Securities LLC. Georgia regulators would need to sign off in order for it to go forward given the cost increases and delays.

"While Chairman Wise's motion could be viewed as punitive to the extent it leaves the door open for the commission to re-visit prior approvals, we view it as a push toward proceeding with construction," Shahriar Pourreza, a New York-based analyst for Guggenheim Securities, said in a note.

Costs Spiral

Earlier this month, Southern released new estimates indicating that the costs of the Vogtle reactors may total more than $25 billion, almost double original estimates. In March, the project's lead contractor, Westinghouse Electric Co., filed for bankruptcy, and the first reactor may not be finished until 2022.

The reactors, already years behind schedule, are the only ones actively under construction in the U.S. They've come to represent the last and best hope for a nuclear renaissance that has failed to materialize in the U.S. following Japan's Fukushima accident. Scana Corp. pulled the plug in July on a similar plant in South Carolina after the costs of that project jumped to more than $20 billion.

Southern is slated to decide by the end of this month whether it even wants to move forward with the Vogtle plant. The company's chief executive officer, Tom Fanning, stressed in an Aug. 2 interview that dropping the work altogether would leave the company with "nothing to show" for its investment.

Backers of the troubled nuclear project have meanwhile asked the Trump administration to help get it finished, people familiar with the talks said earlier this month. That could include increasing or speeding up disbursements of $8.3 billion in federal loan guarantees to the companies behind the plant, the people said, asking not to be identified because the negotiations are ongoing.

Georgia Power, the Southern unit building the reactors, said it's required by law to seek approval of new cost and schedule forecasts. "We expect to file our comprehensive schedule, cost-to-complete and cancellation assessments by the end of August and make a recommendation to the Georgia PSC based on that assessment," Jacob Hawkins, a company spokesman, said in an emailed statement on Tuesday.

Authorization for Freeport LNG Export Facility Upheld by Court

Posted August 15, 2017, 11:19 A.M. ET

By Rebecca Kern

A federal appeals court upheld the Energy Department's authorization of a Freeport LNG Development L.P., liquefied natural gas export facility in Texas, rejecting the Sierra Club's assertion that the department didn't go far enough to assess the indirect environmental impacts of the project.

The U.S. Court of Appeals for the District of Columbia Circuit held that "the department offered a reasoned explanation as to why it believed the indirect effects pertaining to increased gas production were not reasonably foreseeable."

The Sierra Club claimed in its lawsuit that the Energy Department didn't assess the indirect effects of LNG exports, including the impacts of a likely increase in natural gas production and usage that will result from the export authorization. However, the D.C. Circuit said the department was not required to "foresee the unforeseeable."

"We cannot say that the department failed to fulfill its obligations under [the National Environmental Policy Act] by declining to make specific projections about environmental impacts stemming from specific levels of export-induced gas production," D.C. Circuit Judge Robert Wilkins wrote in an Aug. 15 opinion.

Last year, the D.C. Circuit denied a Sierra Club lawsuit over the Federal Energy Regulatory Commission's approval of the Freeport LNG terminal, saying the indirect environmental impacts of LNG exports would be better addressed by the Energy Department. It was one of four Sierra Club LNG petitions against FERC that the D.C. Circuit denied.

The Sierra Club has received funding from Bloomberg Philanthropies, the charitable organization founded by Michael Bloomberg, founder of Bloomberg L.P. Bloomberg BNA is an affiliate of Bloomberg L.P.

The export facility, located on Quintana Island about 70 miles south of Houston, is expected to be completed in 2019 and will produce and export 15 metric tons per annum (MTPA) of LNG, according to the company's website.

How Elon Musk and Cheap Oil Doomed Push for Another Car Fuel

Posted August 15, 2017, 01:31 P.M. ET

By Patrick Martin

The idea was nothing short of revolutionary: convert the nation's millions of trucks, buses and other commercial vehicles to run on natural gas instead of gasoline and diesel.

Back in 2008, the proposal by energy magnate T. Boone Pickens had some appeal. U.S. oil production was plunging, and the world's biggest fuel-consuming country was becoming ever more dependent on foreign crude. Oil jumped to a record near $150 a barrel, while natural gas was comparatively cheap. Pickens co-founded Clean Energy Fuels Corp. to profit from the switch. The maker of natural gas filling stations was once valued at about $1.8 billion.

But there was a different kind of revolution. New drilling techniques led to a boom in oil supplies from the U.S., and electric cars took off. Tesla Inc., which had yet to deliver its first electric car a decade ago, now has 455,000 reservations for its Model 3—almost 20 times the number of natural-gas vehicles on U.S. roads as of 2015. Shares of Clean Energy Fuels are down 90 percent from a 2012 peak, and the company concedes that natural gas may only be a niche market as a transportation fuel.

"I'm not sure America is set up" for widespread use of passenger natural gas vehicles given all the infrastructure needed to get supplies to customers, Andrew Littlefair, Clean Energy Fuels' chief executive officer, said by phone. "There are a lot of reasons it would make sense to look at that again, but I don't know that I'm ready to say that's going to happen."

Pickens, who made his first fortune as an oil wildcatter five decades ago, had high hopes for natural gas because he believed crude supplies were peaking. In op-eds, media interviews and meetings with politicians including then-President Barack Obama, Pickens said the nation's heavy-duty trucks and fleet vehicles should run on natural gas. The U.S. could reduce its reliance on oil imports and use more wind and solar power, he said.

Pickens, 89, wasn't able to comment, according to Jay Rosser, a spokesman for BP Capital LLC, the energy hedge fund Pickens founded.

Shale Boom

By 2011, U.S. oil output began to surge with the shale boom. Three years later, prices for crude, diesel and gasoline were tumbling. While natural gas has become a staple for domestic power plants, supplanting coal, the prospect for cheaper alternatives made it less attractive as a vehicle fuel.

In April, the most recent month for data from the Department of Energy, liquefied natural gas sold for $2.52 per diesel-gallon-equivalent, compared with $2.55 for diesel. That's hardly a bargain, considering Pavel Molchanov, an analyst at Raymond James Financial Inc., estimates that trucks that run on LNG cost about $30,000 to $50,000 more than a comparable diesel rig.

Even though natural gas has remained cheap—trading at $2.948 per million British thermal units at 8 a.m. in New York on Aug. 15—using it to fuel vehicles is "not something that has taken off," said Salim Morsy, an analyst at Bloomberg New Energy Finance in New York. "Gasoline and diesel are undoubtedly the cheapest in total cost of ownership, but as technology improves and batteries get cheaper," the number of electric cars will at least double.

The number of plug-in autos in the U.S. almost tripled between 2008 and 2015, government data show. Tesla, the company founded by billionaire Elon Musk, has introduced three models since 2012, and other manufacturers are jumping into the market. Volvo AB has said all its new cars from 2019 will be hybrid or all-electric, and BMW AG is developing a self-driving electric to replace the 7-Series as the company's flagship in 2021.

Natural gas vehicles have seen their share of the auto market shrink. Chesapeake Energy Corp., one of biggest U.S. gas producers, eliminated the team working on natural-gas vehicles in 2013. Honda Motor Co. discontinued a natural-gas-fueled model of its popular Civic sedan in 2015.

Last year, with oil locked in a prolonged price slump, Pickens sold about 4 million shares of Newport Beach, California-based Clean Energy Fuels, which operates more than 500 natural gas filling stations across the country. While the company has declined in value, Tesla traded at a record high in June.

Still, Littlefair sees opportunities for growth, especially in the fleets of vehicles owned by municipal governments trying to reduce tail-pipe emissions and operating costs. Dallas Area Rapid Transit, which uses 537 buses and 123 shuttles that run on natural gas, this month extended its operation and maintenance contract with Clean Energy Fuels. California cities including Los Angeles and Fresno also have contracts with the company.

Clean Energy Fuels is also seeking a way to expand its reach by using natural gas extracted from landfills and farms to supply filling stations.

Few Stations

While companies including AT&T Inc. and Ryder System Inc. use natural gas in trucks that make short trips and return to the same depot each day, limited infrastructure has prevented wider use. There are 1,828 natural-gas filling stations in the U.S., compared with almost seventy times as many conventional gas stations and around 38 times as many non-residential plug-in stations and charging outlets for electric vehicles, government and industry data show.

It can cost $1.8 million to build a filling station that supplies compressed natural gas, according to the National Renewable Energy Laboratory. Electric vehicles, in contrast, can be plugged into a home outlet.

"The infrastructure would be costly" for widespread use of natural gas vehicles, said Lee Klaskow, a senior analyst for transportation and logistics at Bloomberg Intelligence. "You would have to have some huge cost savings."

Nuclear Power's Woes Imperil U.S. National Security, Moniz Says

Posted August 15, 2017, 7:49 A.M. ET

By Ari Natter

The decline of the U.S. nuclear-power industry puts America's security at risk, according to a report being released Aug. 15 by former Energy Secretary Ernest Moniz that calls for greater federal

investment.

The report from the Energy Futures Initiative and obtained by Bloomberg News says a commercial atomic power sector is necessary to keep uranium-processing technology away from terrorists and other bad actors as well as support nuclear-powered Navy vessels.

The report by Moniz, a nuclear scientist who served as energy secretary under President Barack Obama, calls for expanded government loan guarantees, tax incentives and research on nuclear technology. The report doesn't mention President Donald Trump, who is proposing cutting nuclear research funding and killing the loan guarantee program.

Nuclear power makes up about 20 percent of U.S. electricity generation, but the industry has been struggling. Five nuclear plants, with a combined capacity of 5 gigawatts, have closed early since 2013, and an additional six plants are scheduled to shutter early over the next nine years. Of the two new nuclear plants under construction in the U.S., one was halted by Scana Corp. last month and backers of the other, Southern Co.'s Vogtle plant in Georgia, are seeking additional aid from the federal government.

Westinghouse Electric Co., the nuclear technology pioneer that is part of Toshiba Corp., went bankrupt in March, after it hit delays with its AP1000 reactors at each of those plants. After it declared bankruptcy, Westinghouse—whose technology is used in more than half the world's nuclear power plants—said it shifted its focus from building reactors to helping dismantle them.

Trump pledged to help the industry and Energy Secretary Rick Perry is conducting a study of the electric grid aimed at helping so-called baseload power plants, which includes coal and nuclear. But Trump's budget also proposed deep cuts to the Energy Department, including shuttering the loan guarantee program Moniz says should be expanded and cutting research spending.

Moniz, who served as Energy Secretary from 2013 to January 2017, also serves as CEO of the Nuclear Threat Initiative, a nonprofit organization that works for nuclear disarmament, securing nuclear materials, and nonproliferation.

The U.S. needs companies and engineers that can both build and run nuclear enterprises, Moniz, a nuclear physicist himself, said in the report. The U.S. Navy's reactors require supplies and qualified engineers, and American nuclear scientists fill vital national security roles, it said.

Companies, such as BWX Technologies Inc. of Lynchburg, Virginia manufacture nuclear components for both the commercial nuclear industry and naval reactors. If the commercial business collapses, that may mean one less company able to process highly enriched uranium, according to the report.

Shrinking Enterprise

"A shrinking commercial enterprise will have long term spillover effects on the Navy supply chain, including by lessened enthusiasm among American citizens to pursue nuclear technology careers," according to the report.

In addition to extending a tax credit for new nuclear power and the Energy Department's loan guarantee program, the report says the federal government could also direct the Federal Energy Regulatory Commission to "place a greater emphasis on the national security importance of nuclear power and its associated supply chain."

Coal and nuclear power "need to be properly compensated to recognize the value they provide to the system" and "should be recognized as an essential part of the fuel mix," FERC Chairman Neil Chatterjee said Aug. 14

Brazil's Solar Expected to Grow With State's New Regulation

Posted August 15, 2017, 03:56 P.M. ET

By Michael Kepp

A new solar energy regulation in Brazil's Sao Paulo state is expected to encourage more small and large-scale solar systems to be built and help those under construction come online more quickly.

"The now-clear rules for licensing solar [photovoltaic] systems in Sao Paulo state will lower project risks and boost solar PV investments there," Alexandre Franceschi, project development manager of the Cobra Group, a solar developer building a large-scale system in the state, told Bloomberg BNA.

The regulation is significant because Sao Paulo accounts for over 30 percent of Brazil's gross domestic product and is among the most solar-powered states in a country that's trying to boost usage of the renewable source.

The Sao Paulo State Environmental Secretariat (SMA)'s previously issued solar system licenses on a project-by-project basis without clear or standardized guidelines to inform developers about the need or specific type of license. Under the Environmental Secretariat's new regulation, issued Aug. 4, small-scale solar systems—those with installed capacity of fewer than 5 megawatts—need only be licensed if their installation requires cutting vegetation or if they are to be located in government-protected areas.

Sao Paulo has the second-largest number of such systems in terms of installed capacity among Brazil's 26 states.

Those systems are small rooftop and ground-mounted systems that homeowners and small businesses install to supply their own electricity. The systems sometimes use net metering—a billing mechanism that credits solar energy system owners for the excess electricity they add to the grid.

Developers of medium-to-large–scale solar systems, those ranging in capacity from 5 megawatts to 90 megawatts, must submit a simplified environmental study to get a license under the new regulation. Developers of ultra-large-scale systems—ground-mounted systems with a capacity of over 90 megawatts— must submit a preliminary environmental study (RAP), which has far fewer requirements than an environmental impact assessment for projects with a potentially substantial environmental footprint.

Developers of solar PV systems that need licenses still must first get a preliminary permit and then comply with SMA-imposed conditions to get installation and operating licenses that are required to come online.

The new regulation "is a positive initiative that other states should adopt," Rodrigo Sauaia, CEO of

the Brazilian Photovoltaic Solar Energy Association (Absolar), told Bloomberg BNA Aug. 14.

Cobra Group's solar system, currently under construction, will have an installed capacity of 120 megawatts. The company also has a license to build a second 150-megawatt solar system there.

"Now that SMA analysts have standardized licensing rules to follow, they will be able to more quickly decide if a solar PV project is feasible and should be licensed, and under what conditions," Franceschi told Bloomberg BNA. "And this will speed up the completion of solar PV projects being planned or now underway."

Brazil's latest 10-year energy expansion plan said large-scale (non-rooftop) solar power, which accounted for just .01 percent (21 megawatts) of the electricity mix in 2016, would account for 4.5 percent (9,660 megawatts) by 2026.

Big Oil Follows Silicon Valley into Backing Green Energy Firms

Posted August 15, 2017, 8:20 A.M. ET

By Anna Hirtenstein

Major oil companies are joining Silicon Valley in backing energy-technology start-ups, a signal that that those with the deepest pockets in the industry are casting around for a new strategy.

From Royal Dutch Shell Plc to Total SA and Exxon Mobil Corp., the biggest investor-owned oil companies are dribbling money into ventures probing the edge of energy technologies. The investments go beyond wind and solar power into projects that improve electricity grids and brew new fuels from renewable resources.

While the money involved is small—a fraction of the $7.5 billion that venture capital and private equity injected into the clean energy industry last year—the funds support work that may evolve into major income streams in the decades ahead as governments work to limit fossil-fuel pollution and global warming.

"In the energy industry, small companies have quite a lot of disruptive power," Geert van de Wouw, managing director of Shell Technology Ventures, said in an interview. "We always have to look over our shoulder to make sure that we stay ahead of the game."

Following is a list of the projects the biggest oil companies are supporting:

Shell Technology Ventures

The unit of Royal Dutch Shell Plc splits its spending between oil and gas technology and clean energy equally. The green share may increase to about 60 percent in the years ahead, according to van de Wouw, declining to detail his annual budget. The fund's total size is "hundreds of millions of dollars," he said. It has put money into:

• Kite Power Systems, a maker of a kite that flies on wind currents to generate renewable electricity;

• Glasspoint Solar Inc, a company that has developed a way to make steam for enhanced oil recovery with solar energy; and

• Sense, a start-up that creates devices that monitor home power consumption.

Total Energy Ventures International SAS

The unit of the French oil major Total SA has invested $160 million to date with almost three quarters flowing into North America, according to the fund's CEO Francois Badoual. It only takes minority stakes. It has invested in:

• AutoGrid, a California-based company that designs smart-grid software;

• United Wind, a company that leases wind turbines to retail customers and small businesses; and

• Off Grid Electric, a Tanzania-based installer of rooftop solar panels that works in low energy-access areas in Sub-Saharan Africa.

"We try to detect and invest in innovation," Badoual said. "The shift can accelerate at a pace which is difficult to really foresee, but you have to be ready and to adapt."

BP Ventures Inc.

BP Plc's VC fund has invested $325 million to date. It tends to skew more towards chemicals or fuels, rather than renewable electricity. It has funneled money into:

• Tricoya Technologies, a maker of a technology that changes the chemical structure of wood chips to make a building material that's more durable and energy efficient;

• Fulcrum, a producer of bio-jet fuel made from municipal waste, which raised $30 million from BP; and

• Solidia, a company that is working on reducing the carbon footprint of concrete.

"BP Venture's goal is to be both an investor and an end-user of the technologies in which we invest," said Jonathan Tudor, managing director of the fund. "That requires a longer-term commitment because we look beyond a quick financial return. We take an active role in the evolution of these companies and want to see their new technologies commercialized and deployed into BP's existing businesses."

Exxon Mobil Corp.

Exxon has a different approach to frontier technology. It prefers to conduct research internally and with partners rather than buy minority stakes in start-ups. It's studying biofuels, carbon capture and storage, energy-efficiency processes and energy-saving materials, according to spokesman William Holbrook, and is working with:

• Synthetic Genomics Inc., which studies how to make biofuels from algae; and

• FuelCell Energy Inc., which is developing carbonate fuel cells to capture CO2 emissions from natural gas plants while also producing electricity.

"We conduct R&D through in-house efforts, via partnerships with other industries and by funding academic and other nongovernmental research projects," Holbrook said by email. "These studies help inform the company on emerging technologies, define our potential contribution to the science, and assess the future applicability of the technologies to our businesses."

Chevron Corp.

Chevron has been investing in start-ups since 1999 and divides its portfolio between oil and gas, advanced materials, communications infrastructure and information technologies and emerging and alternative energy. On the latter, it has invested in the following:

• Acumentrics, a fuel cell company that can make its products from ceramics;

• Ensyn, a maker of fuels and chemicals from residue from forests and agriculture; and

• Inventys, a developer of carbon capture technology that traps CO2 from industrial gas streams.

The fund "serves as a window and an on-ramp" for emerging technologies, said Chevron spokesman Kent Robertson by email. The technologies are "well aligned with projected energy needs."

Statoil Energy Ventures

The unit of Norway's state oil company, Statoil ASA, has invested $20 million since February 2016. It only funds renewable start-ups, listing among its investment themes wind, solar, storage, transportation, energy efficiency and smart grids. To date, it has put money into:

• ChargePoint Inc., an electric-vehicle charging point operator based in California;

• Oxford Photovoltaics Ltd., a solar technology company that is developing panels with perovskite. The substance could make traditional photovoltaics as much as 30 percent more efficient; and

• Convergent, a large-scale energy storage developer working on projects with lead acid, lithium-ion and flywheel batteries in the U.S. and Canada.

"In the transition into clean energy, it's not clear who would be the winners and losers," said Bala Nagarajan, investment director at Statoil Energy Ventures. "So for us, the investment is a means to understand which business models and which technologies are likely to be more successful. These investments help us position ourselves in the right part of the value chain."

Of course the oil companies have always dabbled in other forms of energy, backing solar after the 1973 oil crisis. Exxon backed nuclear power in the 1980s. Shell vowed to push into renewables ahead of the landmark Kyoto Protocol on climate change in 1997.

Those efforts fizzled when dips in the oil price sharpened the industry's focus on costs. More recently, Shell has taken big stakes in offshore wind projects, BP revived its wind business and Total pressed into solar through an investment in SunPower Corp.

Big Oil's push into venture capital adds to the sense that technology is moving rapidly in the energy industry, leaving a question mark over what will dominate supply for the first time in almost a century.

"A lot of these companies are still figuring out how to get involved on a larger scale," said Rick Wheatley, head of leadership and innovation at Xynteo Ltd., a consultant that advises Shell, Statoil and Eni SpA on sustainability and long-term planning. "They invest in start-ups to learn and to demonstrate intent. For the cost of a drilling campaign, they can invest in dozens of start-ups."