PPHB
ENERGY INVESTMENT BANKING

MUSINGS FROM THE OIL PATCH

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Note: *Musings from the Oil Patch reflects an eclectic collection of stories and analyses dealing with issues and developments within the energy industry that I feel have potentially significant implications for executives operating and planning for the future. The newsletter is published every two weeks, but periodically events and travel may alter that schedule. As always, I welcome your comments and observations.* Allen Brooks

What Is Exxon Telling Us With Latest Management Move?

The general assumption is that he will replace current Chairman and CEO Rex Tillerson

Exxon Mobil Corp. (XOM-NYSE) has a new president and member of its board of directors effective January 1, 2016. The board was expanded to 13 members in order to accommodate the appointment of Darren Woods, currently a senior vice president, member of the management committee of the corporation and the president of Exxon Mobil Refining & Supply. While the announcement contained no reference to Mr. Woods' next management step, the general assumption is that he will replace current Chairman and CEO Rex Tillerson when he retires at the age of 65 in 2017.

Understanding the appointee's skills might reflect on the future world for energy, at least as envisioned by the ExxonMobil Board of Directors

The assumption of Mr. Woods stepping up is based on prior CEO succession moves at ExxonMobil. The announcement tweaked our interest about the significance of the selection process as we have watched numerous CEO and chairman successions at ExxonMobil during our years as an energy investment analyst. Each move, in our view, reflected the board of directors' judgement at that point in time of the skill-set necessary for managing the company in the future. In other words, understanding the appointee's skills might reflect on the future world for energy, at least as envisioned by the ExxonMobil Board of Directors. In recent years, the tenure of ExxonMobil CEOs has lengthened compared to the terms of office during the 1960s and 1970s, meaning the board wants to give the next leader sufficient time to deal with long-term issues before having to relinquish his leadership post. Mr. Woods is currently listed as 50 years old, meaning that if he does succeed Mr. Tillerson in 2017, he will be 52, suggesting he would have 13 years as the head of the company before reaching the mandatory retirement age.

In our investment career dating back to the late 1960s, we have been fortunate to have personally dealt with four of ExxonMobil's CEOs

What might this move be signaling about the future strategy of ExxonMobil, and should we heed the signal? In our investment career dating back to the late 1960s, we have been fortunate to have personally dealt with four of ExxonMobil's CEOs. Mr. Tillerson is the first ExxonMobil CEO we have not had the pleasure of personally interacting with. After reading the news of Mr. Woods' appointment and the speculation about his eventual elevation to the highest management position, we decided to go back and compile a list of ExxonMobil's CEOs since 1960 along with their education and any pertinent details of their background. The 1960s marked when Standard Oil of New Jersey, and the parent company of numerous corporate affiliates, was reconfigured to ultimately form the current ExxonMobil.

If Mr. Woods does rise to the CEO post, he will be the first CEO trained as an electrical engineer

As shown in Exhibit 1, all of ExxonMobil CEOs since 1960 were educated as engineers with the chemical engineering discipline dominating the list with four, followed by civil engineering with two. If Mr. Woods does rise to the CEO post, he will be the first CEO trained as an electrical engineer. Over the past 55 years, ExxonMobil has had only one CEO trained as a petroleum engineer, which is somewhat surprising given the role that oil and natural gas exploration and development plays in the company's business. The mix of educational backgrounds may be less important than the single message that the technical challenges of managing ExxonMobil's sprawling energy empire requires the discipline that comes from an engineering training, but there is less of a need for a specific petroleum specialization.

While virtually every one of the CEOs had received advanced degrees, most were in the business area designed to augment their engineering undergraduate education

In researching the backgrounds and careers of the CEOs, we were also struck by the geographic diversity of their birth and childhood along with their schooling. This group of successful corporate managers came from West Virginia, South Dakota, North Dakota, Virginia, Texas, New Jersey and Alberta, Canada. Where they acquired their education is also interesting as none came from the "elite" colleges of America, but they often represented schools with known energy and technical expertise. College degrees came from a universe of colleges as diverse as Stanford, Virginia Polytechnic Institute, University of Texas at Austin, University of Oklahoma, Lehigh University, University of Wisconsin at Madison and the University of Alberta, Canada. While virtually every one of the CEOs had an advanced degree, most were in the business area designed to augment their engineering undergraduate education. One CEO, Lee Raymond, attained a PhD degree before joining ExxonMobil while Ken Jamieson received an advanced engineering degree from Massachusetts Institute of Technology. It was also interesting to see the range of initial jobs these gentlemen had as those often were a precursor to the skill sets they brought to the C-suite and their achievements

in building the company. The range of initial careers at ExxonMobil spanned the oil and gas production, drilling, refinery and chemical divisions.

Exhibit 1. Exxon Mobil Corp. CEOs Since 1960

Name	Term	Education	Comments
Monroe J. Rathbone	1960 - 1965	Chemical engineer - Lehigh U.	1960 appointed CEO and Chairman of the Executive Committee; added Chairman title in 1963
Michael Haider	1965 - 1969	Chemical engineer - Stanford University	
J.Kenneth Jamieson	1969 - 1975	Civil engineer - U. of Alberta, Canada	Canadian; remained a director after retiring
Clifton C. Garvin, Jr.	1975 - 1986	Chemical enginner - VPI	
Lawrence G. Rawl	1987 - 1993	Petroleum engineer - Univ. of Oklahoma	
Lee R. Raymond	1993 - 2005	Chemical engineer - U. of Wisconsin at Madison	PhD.
Rex W. Tillerson	2006 - present	Civil Engineer - U. of Texas at Austin	
Darren W. Woods		Electrical engineer - Texas A&M	Appointed President and made a director

Source: Various, PPHB

That knowledge might have been insightful in understanding where ExxonMobil's management and its board of directors anticipated the energy business going and what the company needed to do to be successful

At the time the ExxonMobil Board of Directors selected each of these men for the highest management position at the company, their respective skill-sets were established by the successes each had achieved while climbing the corporate ladder. If one were able to know more about the career successes of the newly elevated CEO, it might have been possible to conceive what would be his goals for the company during his tenure. That knowledge might have been insightful in understanding where ExxonMobil's management and its board of directors anticipated the energy business going and what the company needed to do to be successful. For example, when Ken Jamieson assumed the CEO role in 1969, the company was in an extended period of low oil and gas prices and faced projections that U. S. oil and gas output was near a peak. For years, the prospect of no oil and gas production growth in the U.S. had driven ExxonMobil to expand internationally while at the same time aggressively diversifying into coal and other minerals in addition to other non-energy businesses. In fact, shortly after Mr. Jamieson's retirement we had lunch with him and he expanded on why the future for ExxonMobil was going to be in "hard-rock" minerals. As a civil engineering undergraduate who even spent time prospecting for gold and other minerals in Canada, Mr. Jamieson's background was appropriate for executing a corporate strategy that emphasized hard-rock minerals as its future. It was also during the latter portion of his tenure as CEO that Exxon began diversifying well beyond the oil and gas business becoming involved in enterprises such as office products (word

processors, electric typewriters, etc.), electric motor efficiency, solar power and shale oil extraction – all reflecting a negative outlook for the basic petroleum business.

Many people forget what happened to the international oil and gas industry following the 1973 Arab oil embargo of the United States and select Western countries for their support of Israel during the Seven-Day War. The rise of global oil prices and the influence of OPEC during the latter half of the 1970s and into the early 1980s created significant profitability challenges for the downstream oil and gas business along with the chemical industry. Clifton Garvin, an executive who had spent most of his career in the chemicals division, was the CEO of ExxonMobil at that time. His knowledge and skills enabled the company to successfully exploit its global downstream and chemical franchises while at the same time improving the profitability of its international chemical operations. It was also during his stewardship that ExxonMobil made last ditch efforts at commercializing some of its non-petroleum businesses before concluding that exiting made the most sense. As a result, and under the management of a future CEO, the Exxon office products business and solar energy businesses were sold. It was during this time that the company purchased Cleveland-based Reliance Electric Company in an effort to commercialize ExxonMobil's electric motor efficiency technology research and development work. Two years into its seven-year ownership, Exxon abandoned that effort, leaving Reliance Electric to sell its traditional products. Eventually the company decided to sell Reliance Electric to its managers and two private equity funds. In this case, ExxonMobil posted a $275 million gain on its $1.2 billion investment.

His knowledge and skills enabled the company to successfully exploit its global downstream and chemical franchises while at the same time improving the profitability of its international chemical operations

As the global oil and gas business struggled to recover from the collapse of commodity prices in 1986, ExxonMobil saw the distress in the industry as a good time to grow its oil and gas business. Having a petroleum engineer, Lawrence Rawl, at the helm of ExxonMobil may have been an astute move. Besides beginning to grow its oil and gas business, ExxonMobil also decided to end most of its ill-fated diversification efforts. However, after about a third of the way through his term as CEO, the Exxon Valdez ran aground in Alaska setting off one of the largest oil spills in American history and smack in the middle of some of the most scenic and protected land in Alaska. ExxonMobil's clean-up efforts were poorly organized so that the environmental mess became a huge black-eye for the company, leaving its public image in shambles. While never officially acknowledged, the mishandling of the Valdez spill cleanup dogged the balance of Mr. Rawl's tenure as CEO. The clean-up effort was shifted to Lee Raymond, who quickly turned it around and thus improved the company's public image.

ExxonMobil's clean-up efforts were poorly organized so that the environmental mess became a huge black-eye for the company, leaving its public image in tatters

He turned around the company's refinery in Aruba from losing $10 million a month to making $25 million a month in only a couple of years

Mr. Raymond started his career as a production engineer in Tulsa, Oklahoma, progressed through the engineering ranks in the refining and chemicals businesses, and later received a huge career boost after he turned around the company's refinery in Aruba from losing $10 million a month to making $25 million a month in only a couple of years. He achieved this success through cost-cutting and negotiating a deal with Venezuela to supply the refinery with extra-heavy crude oil, which was lower in cost. This performance was recognized by senior management who then handed Mr. Raymond the reins of Exxon Enterprises in 1981, the home of the company's earlier business diversity efforts. With no direction from his bosses, after studying the portfolio he began to shut down and sell various units until the entire division was eliminated.

Exhibit 2. Emphasis On L-T Downstream Profitability

Source: Motley Fool

Cost-cutting, stock buybacks and restrained capital spending all contributed to establishing ExxonMobil as the most profitable major oil company when measured by return on capital under Mr. Raymond

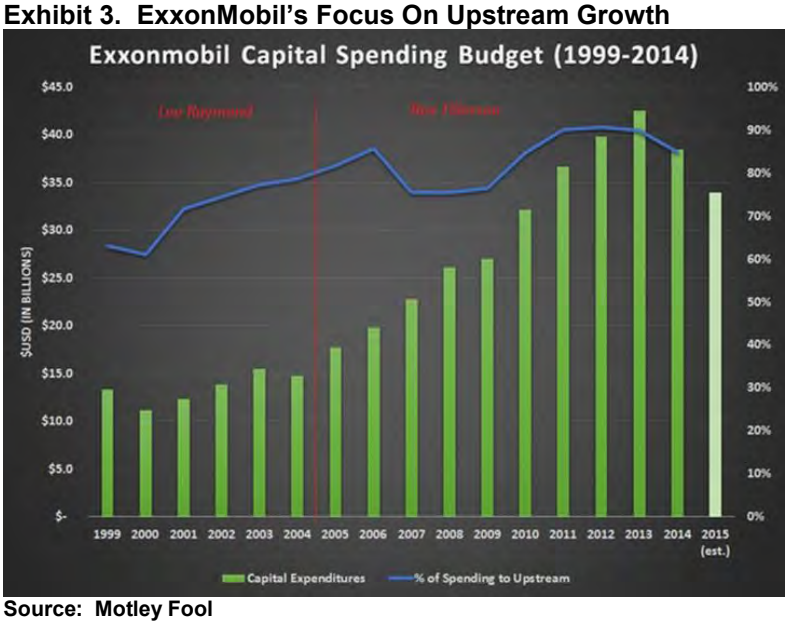
This success led to his appointment to the next higher training ground for Exxon executives. This move was due to his demonstrated ability to extract greater profitability and better capital discipline at the various business units he oversaw. This was in keeping with the new direction at ExxonMobil for improved profitability. So after fixing the Valdez spill problems, Mr. Raymond was elevated to one level below Mr. Rawl and then succeeded him, ushering in a new focus at the company that emphasized profit growth over volume increases. Cost-cutting, stock buybacks and restrained capital spending all contributed to establishing ExxonMobil as the most profitable major oil company when measured by return on capital under Mr. Raymond.

After years of wringing costs out of the company, Mr. Raymond shifted his focus during the latter part of the 1990s to growing the enterprise. He saw that political turmoil had declined in numerous countries around the world that possessed large potential oil fields that could be developed at low cost. As a

His ultimate growth investment, however, was the 1998 agreement to merge with Mobil Oil Corp.

result, ExxonMobil began pursuing deals in Russia, Indonesia and throughout Africa. His ultimate growth investment, however, was the 1998 agreement to merge with Mobil Oil Corp. This deal not only offered profit opportunities in the combined downstream businesses, but it also added oil reserves and exploration opportunities in Africa and Indonesia, two of Mr. Raymond's growth targets. His efforts to establish a foothold in Russia were successful, partly as a result of the work of Rex Tillerson who ultimately succeeded Mr. Raymond as CEO of ExxonMobil.

Exhibit 3. ExxonMobil's Focus On Upstream Growth



Source: Motley Fool

XTO, a leading domestic exploration and production company, was best known for its leadership position in the American gas shale revolution, something Mr. Tillerson admitted ExxonMobil's planners had missed, putting the company behind the rest of the industry

Mr. Tillerson, although schooled as a civil engineer, has spent most of his career with the oil and gas production side of the company, including stints with Yemen, Khorat and Russia, and then eventually heading ExxonMobil Development Company, which he oversaw for seven years. In 2006, Mr. Tillerson was appointed CEO and chairman of the company. His major corporate move has been the purchase in 2009 of XTO Energy for $41 billion in an all-stock acquisition. XTO, a leading domestic exploration and production company, was best known for its leadership position in the American gas shale revolution, something Mr. Tillerson admitted ExxonMobil's planners had missed, putting the company behind the rest of the industry. This huge bet came about a year after natural gas prices had dropped below $7.50 per thousand cubic feet (mcf). They were holding in the $3.50/mcf range at the time the deal was struck. Since then, the surge in gas shale output (helped by XTO's success) coupled with demand weakness has driven natural gas prices below $2/mcf. Just as it will take time for this major corporate bet to pay off, so too will it be for Mr. Tillerson's joint

The results of the moves will benefit a future ExxonMobil CEO

venture agreement to explore the highly-prospective Russian Arctic for oil and gas. The agreement is caught up in the political battles between Russia and the West that has resulted in significant economic sanctions being imposed on Russia limiting the ability of the joint venture to operate. We expect both of these initiatives will pay off in the long-term, which is the nature of the oil and gas business, but the results of the moves will benefit a future ExxonMobil CEO.

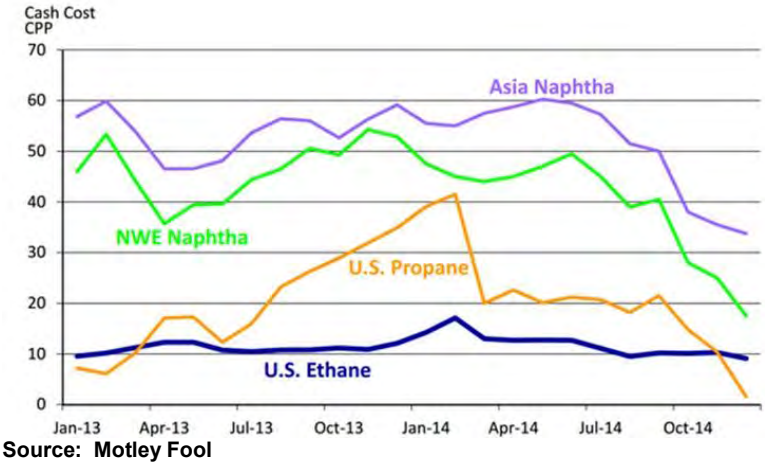
We believe this record of success can be attributed to ExxonMobil's hiring practices and personnel development efforts

As we have highlighted, the skills of the respective ExxonMobil CEOs have varied over time, and the moves each made in response to the issues facing the company during their tenures in most cases contributed to the successes of the company over a very long time period. We believe this record of success can be attributed to ExxonMobil's hiring practices and personnel development efforts. It is also a tribute to the wisdom of the board of directors to select a CEO who possessed the necessary skills to navigate ExxonMobil through the anticipated business challenges it was likely to encounter. These accomplishments may also speak to the success of the company's corporate planning efforts and long-term focus.

Under this scenario, the company's profit growth will depend more on actions to improve the performance of the company's downstream and chemical operations than what it will earn from better commodity prices that benefit upstream profitability

Using all this history and analysis as a guide, what conclusions might we derive about the energy future ExxonMobil directors anticipate by their selection of Darren Woods as the likely next CEO? Remember, his education is as an electrical engineer, but his career has been spent primarily in the chemicals, refining and transportation sectors. We would sum up the implications for ExxonMobil's future by assessing how the idea that oil prices will stay "lower for longer" will impact the company's businesses. Under this scenario, the company's profit growth will depend more on actions to improve the performance of the company's downstream and chemical operations than what it will earn from better commodity prices that benefit upstream profitability. Lower for longer is the result of continued oil and gas oversupply along with reduced economic growth both in the U.S. and globally. Both of these macro industry factors are proving intractable and will require much longer to correct than previously thought when the downturn began. Lower future oil and gas consumption may also be a sign of greater success for the anti-fossil-fuel campaign of the environmental movement, which now includes a legal attack against ExxonMobil for its supposed lying to shareholders over its knowledge about the climate change impact from burning the company's products.

Exhibit 4. The New Focus Chemicals and Downstream?



Source: Motley Fool

We believe his skills, honed over his 23-year career with ExxonMobil, signal a different era for the oil and gas industry

It is not a given that Mr. Woods will succeed Mr. Tillerson. If he does, however, we believe his skills, honed over his 23-year career with ExxonMobil, signal a different era for the oil and gas industry, and may reflect a permanent change in the profitability sources for the company. We believe other energy CEOs should contemplate this message as they plan for their future.

Paris Conference Message: We Changed World's Energy Mix

Mr. Hansen is popularly credited with being the "father of global warming," since retitled "climate change."

The cheering for the global climate change agreement had not even died down before its critics were hard at work pointing out the shortcomings of the plan. One of the most prominent critiques of the conference outcome came from former NASA scientist and Columbia University adjunct professor, James Hansen. Mr. Hansen is popularly credited with being the "father of global warming," since retitled "climate change." In 2013, Mr. Hansen retired from NASA and government service so he could become a climate change activist and protest, something banned for government workers. His subsequent activism led to several arrests outside the White House as he protested against mining and the Keystone XL pipeline. But possibly this most vitriolic comments about climate change were directed to the agreement reached earlier this month in Paris by close to 200 nations to reduce carbon emissions.

"It's just bullshit for them to say: 'We'll have a 2C warming target and then try to do a little better every five years.'"

"It's a fraud, really, a fake," Mr. Hansen told a columnist with *The Guardian* newspaper on the day the Paris agreement was proclaimed. "It's just bullshit for them to say: 'We'll have a 2C warming target and then try to do a little better every five years.' It's just worthless words. There is no action, just promises. As long as fossil fuels appear to be the cheapest fuels out there, they will be continued to be burned."

His criticism was not unnoticed and prompted a question to U.S. Secretary of State John Kerry from ABC News the next day about the comments

Mr. Hansen's criticism of the Paris agreement, while similar to others, was probably from the most high-profile person to push back. His criticism was not unnoticed and prompted a question to U.S. Secretary of State John Kerry from ABC News the next day about the comments. Sec. Kerry responded: "But with all due respect to him, I understand the criticisms of the agreement because it doesn't have a mandatory scheme and it doesn't have a compliance enforcement mechanism. That's true.

"But we have 186 countries, for the first time in history, all submitting independent plans that they have laid down, which are real, for reducing emissions.

"And what it does, in my judgment, more than anything else, there is a uniform standard of transparency. And therefore, we will know what everybody is doing.

"The result will be a very clear signal to the marketplace of the world that people are moving into low carbon, no carbon, alternative renewable energy. And I think it's going to create millions of jobs, enormous new investment in R&D, and that R&D is going to produce the solutions, not government."

Even though the world has embarked on the 'Yellow Brick Road' of energy change, the journey will take much longer than the three and a third hours of the Wizard of Oz movie – more likely five decades or more

In reality, Mr. Hansen, while criticizing the Paris agreement for its lack of aggressiveness, specificity and legality with respect to carbon emissions, was acknowledging several pertinent facts about the reality of the state of the energy business. First, even though the world has embarked on the 'Yellow Brick Road' of energy change, the journey will take much longer than the three and a third hours of the Wizard of Oz movie – more likely five decades or more. While people are likely very familiar with the story of Dorothy, her strange friends and their visit to the wizard that is told in the movie, they probably don't know that it wasn't a big winner in 1939, the year of its release. The film lost out in that year's Academy Awards competition for the Oscar for Best Picture, which went to Gone With The Wind, and it was largely a box office bust, collecting only $3,017,000 in global ticket sales against a production cost of $2,777,000.

Black will be our future

Without trying to stretch the analogy too far, there are numerous similarities between the movie and the climate change movement. For example, the difficulties that beset Dorothy and her dog, Toto, at the start of the movie, including the tornado that carries her away from Kansas, are all filmed in sepia-toned (black and white) film, while the Land of Oz, where she is deposited by the storm, is in brilliant Technicolor. Certainly, climate activists will tell you that if we continue on the road we are traveling, bad things, including economic devastation, will befall us. Black will be our future. However, if we do the right things with regards to reducing our carbon

emissions, our future will become full of brilliant colors! The world's beautiful future can be summed up by the Academy Award winning song, "Somewhere Over The Rainbow."

1939 audiences were too sophisticated to accept the story as a straight-forward fantasy, so the story was shifted into a lengthy and elaborate dream sequence

Interestingly, the original movie producers, in planning their adaptation of L. Frank Baum's book, The Wonderful Wizard of Oz, felt that 1939 audiences were too sophisticated to accept the story as a straight-forward fantasy, so the story was shifted into a lengthy and elaborate dream sequence. That story-telling framework would probably sit well with climate change skeptics who believe climate change activists are dreaming with their arguments for radically changing our economy!

The shift to renewable energy sources is expensive

A second point about the state of the energy business is the shift to renewable energy sources is expensive, despite the arguments about how much the cost of solar panels have declined and storage batteries improved. An op-ed article in last week's *Wall Street Journal* by Benny Peiser, director of the London-based Global Warming Policy Forum, discussed how the lack of a legally-binding climate change treaty from the Paris conference has freed Europe from "the restrictions of the Kyoto Protocol – which runs out in 2020 – and opens the way for more flexible and less damaging policies."

While the European Union's 28 member nations pledged in October 2014 to cut carbon emissions by 40% below 1990 levels by 2030, that pledge would only be supported if all major emitters adopted legally binding targets.

Citizens in Denmark and Germany now pay the highest electricity rates in Europe,

With the United States refusing to accept a legally binding agreement, Mr. Peiser wrote: "The toothless nature of the Paris agreement finally allows EU member states to abandon unilateral decarbonization policies that have damaged Europe's economies and its international competitiveness." Citizens in Denmark and Germany now pay the highest electricity rates in Europe, and the German industrial sector is struggling with the high cost of power, which has made many companies less competitive and prompted them to shift production abroad in order to compete.

"For the first time, it would appear that Europe's climate policy is moving in a more rational and realistic direction than that of North America."

Mr. Peiser smugly points to Europe's advantage and America's disadvantage due to the respective positions of its respective leaders during the Paris agreement negotiations. He writes: "In contrast to Europe's conditional pledge, Mr. Obama's go-it-alone policy is unconditional. For the first time, it would appear that Europe's climate policy is moving in a more rational and realistic direction than that of North America." So if the Obama administration's approach to climate change is not altered, it looks like their policies will result in a loss of U.S. economic competitiveness, further restraining our currently projected low economic growth future.

Even Rex Tillerson of Exxon Mobil Corp acknowledged that the best way to regulate carbon emissions is for there to be a revenue-neutral (fully-refundable) tax on carbon emissions

Mr. Hansen's view is that until and unless greenhouse gas emissions are taxed across the board, it will be virtually impossible to force down emissions quickly enough to avoid the worst of the ravages of climate change. It is interesting that this July, six major energy company chief executive officers, including those of BG Group plc (BRGYY-OTC), BP plc (BP-NYSE), Eni SpA (E-NYSE), Royal Dutch Shell plc (RDS.A-NYSE), Statoil (STO-NYSE) and Total SA (TOT-NYSE), wrote in a letter this summer to Christiana Figueres, executive secretary of the U.S. Framework Convention on Climate Change, that they favored an open and direct dialogue on climate change and carbon pricing. Even Rex Tillerson of Exxon Mobil Corp (XOM-NYSE) acknowledged that the best way to regulate carbon emissions is for there to be a revenue-neutral (fully-refundable) tax on carbon emissions.

An example of this rigidity lies in the abuse leveled at Mr. Hansen for embracing a role for nuclear energy in a carbonless world

This is a major concession by leading energy executives, but the offer seems to be failing to gain much, if any, traction. The climate change activists' agenda appears quite rigid, which hurts efforts to improve the climate change discourse that could lead to agreement on steps for limiting carbon emissions. An example of this rigidity lies in the abuse leveled at Mr. Hansen for embracing a role for nuclear energy in a carbonless world.

In reality, the issue is being anti-fossil fuels and not about seeking a path to a carbonless energy future

Bill McKibben, climate writer, college professor and founder of 350.org (named after the belief that 350 parts per million of CO2 will mark a tipping point in climate change), was interviewed recently and admitted that while nuclear power should play a role in reducing carbon emissions, the people within his movement couldn't embrace it because it would have confused them. As a result, by rejecting a role for nuclear power, the members would have a much easier time supporting an anti-fossil fuel mantra that is central to his organization. In reality, the issue is being anti-fossil fuels and not about seeking a path to a carbonless energy future.

…who argued that nuclear needs to be a major part of an energy solution, but not the only part

The greater, and more frustrating reaction against realism in the climate debate came from a critique written by Naomi Oreskes, an author and professor of the History of Science and Affiliated Professor of Earth and Planetary Sciences at Harvard University, who labeled four leading climate scientists (James Hansen, Kerry Emanuel, Tom Wigley, and Ken Caldeira), who argued that nuclear needs to be a major part of an energy solution, but not the only part, as climate change deniers. Dr. Oreskes not only distorts the argument these scientists put forth but she falls back on claims that nuclear power is extremely dangerous, was developed to offset its use as a military weapon, and depends on government subsidies for its commercialization as reasons not to employ nuclear energy in any plan to decarbonize our power system. None of the scientists Dr.Oreskes labels as "deniers" believes nuclear

power is the only solution. Rather, as they stated in a letter written to UN officials organizing the Paris climate change conference, nuclear energy should play a role.

The world's experts in radiation biology have agreed that exposure to even high levels of radiation poses a surprisingly small human health risk

With respect to Dr. Oreskes' claims against nuclear power, based on 70 years' worth of studies about the survivors of Hiroshima and Nagasaki, the world's experts in radiation biology have agreed that exposure to even high levels of radiation poses a surprisingly small human health risk. This conclusion has been supported by other studies related to people living in areas around the Chernobyl and Fukushima nuclear power plants.

Not only have these studies been discredited by other peer-reviewed studies, but most highly respected climate scientists argue that wind and solar energy alone can't do nearly enough to impact climate change

Linking government support of nuclear power as a deliberative attempt to demonstrate the peaceful use of nuclear energy to offset its military use is purely an argument Dr. Oreskes employs designed to cloud people's thinking about the issue without providing any substantive proof of the claim's validity. While pointing to government support for nuclear power as one of its failures, she ignores the fact that renewable energy sources are all dependent on government subsidies and mandates. Lastly, Dr. Oreskes relies on studies by Mark Jacobson of Stanford University that claim to show that the United States can power its economy totally with wind and solar power. Not only have these studies been discredited by other peer-reviewed studies, but most highly respected climate scientists argue that wind and solar energy alone can't do nearly enough to impact climate change.

Their agenda also includes wealth redistribution, which has little to do with the use of energy

What is sad about the climate change activists' agenda is that it has gone well beyond adjusting consumer habits with respect to their energy consumption. Instead, they have developed a grand plan to transform society, meaning not only changing energy economics, but also restricting our slate of choices via mandates and banning the use of certain fuels. Their agenda also includes wealth redistribution, which has little to do with the use of energy but fits the moral belief of the activists. Unfortunately, their moral agenda fails to consider the positives that are derived from the use of fossil fuels to bring cheap energy to the world's impoverished people.

One of the disappointing aspects of the climate change debate is the unrealistic view that the globe's energy system can be switched from dirty to clean with the flip of a switch

One of the disappointing aspects of the climate change debate is the unrealistic view that the world's energy system can be switched from dirty to clean with the flip of a switch. To underscore the challenges of shifting energy supplies, we wrote an extensive article in the June 10, 2014, *Musings* from which we quote below. We are also reproducing two charts that illustrated that article. That article discussed a potential new energy supply – Low Energy Nuclear Reaction (LENR). There are some new developments with LENR that merit discussion, but we will save that for a future article.

In that June 2014 *Musings* we wrote:

Each transformation takes decades and is rarely understood as it happens

"The role of energy in the history of the world has been marked by long cycles with each succeeding fuel possessing more energy mass per unit than the fuel it was displacing. This characteristic led to the new fuel being cheaper and more efficient, enabling advances in its contribution to the growth of the economy and the improvement in people's lifestyle. Each transformation takes decades and is rarely understood as it happens until the new fuel has gained roughly half the energy market. In some cases, it has taken 50 years of overlap before the new fuel reaches that 50% share.

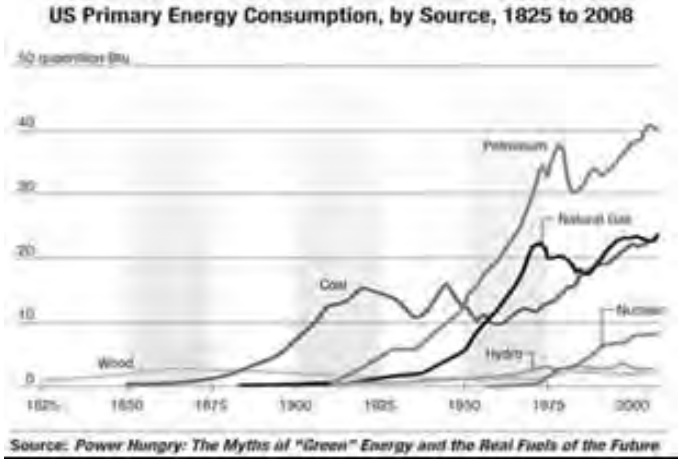
Steam power helped displace the animals that had been relied upon for centuries to provide power

"For thousands of years, energy was measured by the power of humans. Mankind then moved to harness the power of animals that they domesticated. Fire was discovered to be an effective weapon of protection from wild animals and eventually for cooking food, but it was much later that fire was used to create steam to power mechanical devices. Humans found that wind could be captured and turned into energy for tasks such as lifting water in wells. Controlling rivers and streams afforded humans early opportunities to harness the power of flowing water to power machines to grind grains and cut wood. Earlier, man began burning biomass (wood and peat) for protection and warmth and eventually to heat water to produce steam to drive mechanical devices. Steam power helped displace the animals that had been relied upon for centuries to provide power, and which are still relied upon in many countries around the world for power. From wood and peat, humans switched to burning coal, which contained a greater amount of energy. From coal, humans transitioned to burning oil and natural gas that had even greater energy content per unit. Possibly more important, the oil age created the potential for energy to power mobility. Although nuclear power's raw material is dangerous after its transformation, it too assumed a role in the nation's and world's energy mix.

Many people believe it has been the growth of carbon emissions in our atmosphere that has contributed to global warming, which certain scientists have projected will eventually lead to catastrophic environmental conditions for the planet

"As our energy transition has advanced, the use of fuels with more concentrated energy content has also resulted in the release of greater amounts of carbon into the atmosphere. Many people believe it has been the growth of carbon emissions in our atmosphere that has contributed to global warming, which certain scientists have projected will eventually lead to catastrophic environmental conditions for the planet. For those who believe in this disaster scenario, the outcome can only be avoided by the cessation of burning fossil fuels. For them, our future will be tied to an economy totally dependent on renewable fuels like wind, solar and water-based energies such as tidal movement and hydro-power. Their objective in mandating the total elimination of fossil fuels from our energy mix condemns the economy to a world similar to the

Exhibit 5. Energy Transformation Of United States



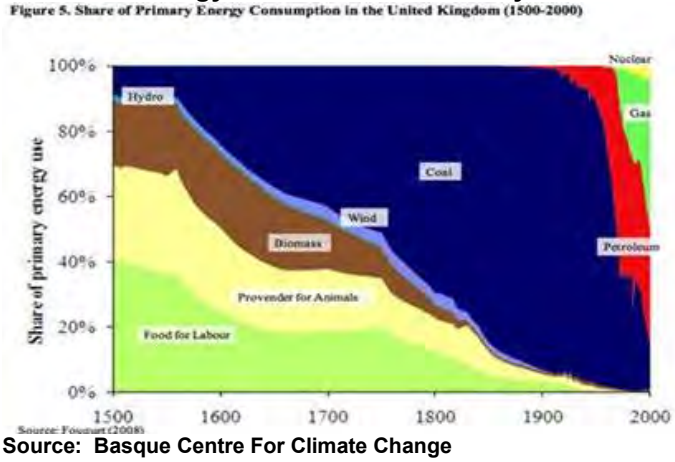
Source: Robert Bryce

To avoid this, those renewable protagonists count on significant technological breakthroughs for batteries and other energy storage mediums

past when due to these energies being intermittent, economic and social progress struggled to advance. To avoid this, those renewable protagonists count on significant technological breakthroughs for batteries and other energy storage mediums in order to address providing power to people at any time they want or need it, something that fossil fuel-based energy facilities ensure. We question whether people desire or will be happy with an economy and a lifestyle tied to intermittent power."

As pointed out above, the world needs continuous power supplies and certainly desires power on demand. Those characteristics are not associated with renewable energy and will require significant technological breakthroughs in the area of energy storage in order for renewables to fulfill the world's power needs and desires. To understand this challenge, the

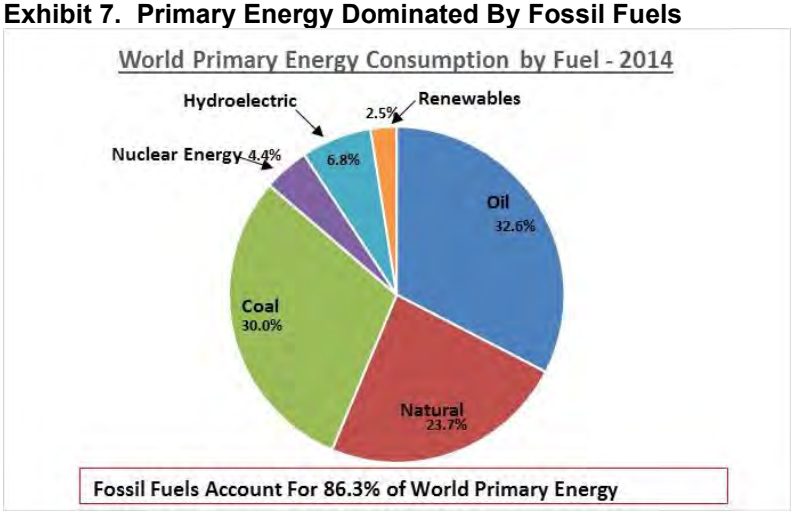
Exhibit 6. Energy Transformation History Of The UK



Source: Basque Centre For Climate Change

series of charts below highlight the hurdles for totally revamping the globe's energy supply matrix in favor of renewables. Importantly, these charts do not deal with the issue of energy sources and their application: static versus mobile, for example. They are instructive of issues the world must deal with as it struggles to achieve a carbonless environment.

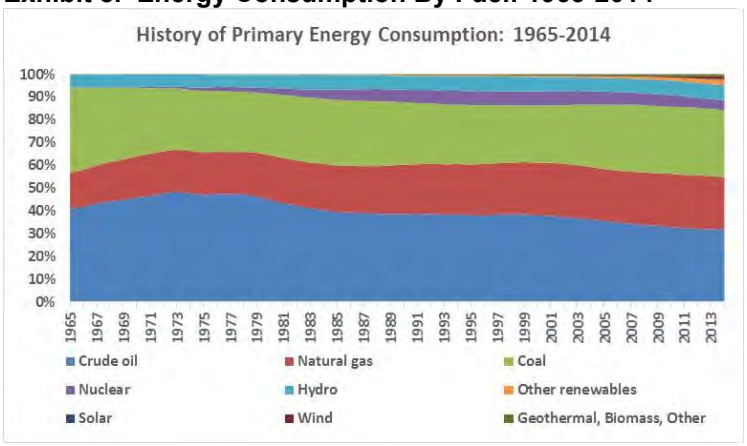
Exhibit 7. Primary Energy Dominated By Fossil Fuels



Source: BP, PPHB

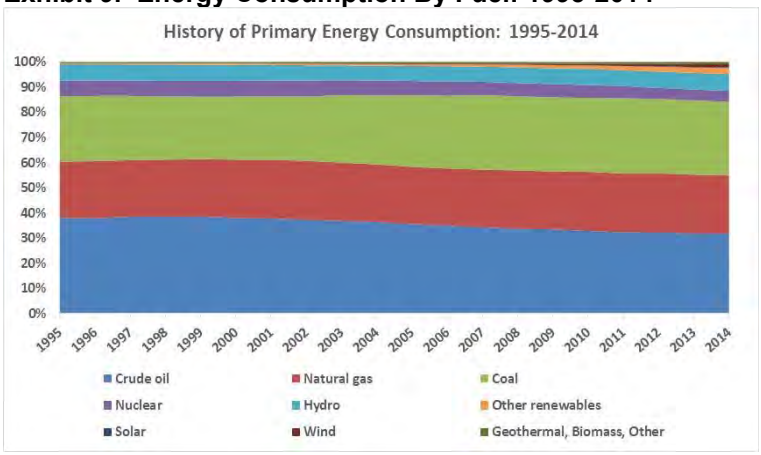
Note that the world relies on fossil fuels to generate over 86% of its primary energy. This means that transitioning to a carbonless energy world will take significant time and will be a costly endeavor.

Exhibit 8. Energy Consumption By Fuel: 1965-2014



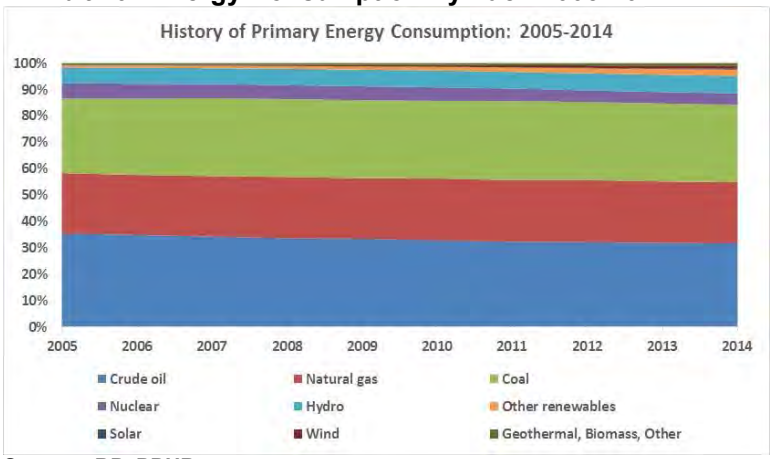
Source: BP, PPHB

Exhibit 9. Energy Consumption By Fuel: 1995-2014



Source: BP, PPHB

Exhibit 10. Energy Consumption By Fuel: 2005-2014

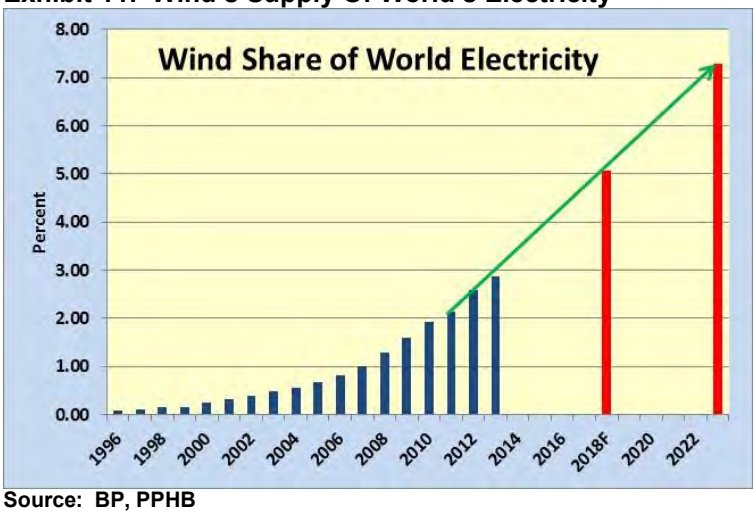


Source: BP, PPHB

It is difficult to see this transition growing to 50% of world supply quickly

As the above three charts of the world's primary energy show, the shorter the time history, the greater the penetration of renewables in supply. However, when one considers how little renewables play in the world's total primary energy consumption, it is difficult to see this transition growing to 50% of world supply quickly.

Exhibit 11. Wind's Supply Of World's Electricity



Source: BP, PPHB

This means that while wind accounted for about 2.5% of the world's electricity, as a percentage of total primary energy supply it contributed a miniscule share

Wind has been promoted as possibly the easiest renewable fuel to introduce into the world's electricity supply. Note the projection shows that by 2025, wind's share of world electricity will exceed 7%. But recent figures from the International Energy Agency (IEA) show that in 2012 the world's electricity generation totaled 22,668 terra-watt-hours (TWh), which was 14.6% of the world's primary energy supply of 155,505 TWh. This means that while wind accounted for about 2.5% of the world's electricity, as a percentage of total primary energy supply it contributed a miniscule share.

The failure to include economics in the future fuel mix discussion will lead to results such as Germany's that were the subject of Mr. Peiser's op-ed column

All of these charts ignore the economics of the respective fuels. So far, the debate over renewable fuels has been entwined in the battle over climate change policies and what our desirable fuel mix should be. That debate needs to be widened to include a realistic discussion over the costs of fuels – both renewables and fossil fuels, including nuclear, and possibly new fuel supplies on the horizon, even though those costs estimates will be speculative. The failure to include economics in the future fuel mix discussion will lead to results such as Germany's that were the subject of Mr. Peiser's op-ed column. Hopefully, 2016 will usher in a new era of a more reasoned discussion of these issues, especially since the heat of the Paris climate change conference is behind us.

What Do A Wheel And A License Have In Common?

The rules, if not modified, will establish the design features for commercial driverless cars, along with how they can be sold and who can operate them

The answer to the question above is: they are the hurdles being put in place that will hamper the development of autonomous driving vehicles. In particular, they are hurdles being put in place by the California Department of Motor Vehicles that will dictate how it will be granting permits for driverless vehicles and licensing their owners. At the moment, the rules are preliminary and are subject to public comment at two planned meetings with the first scheduled for late January 2016 and the second in February. The rules, if not modified, will establish the design features for commercial driverless cars, along with how they can be sold and who can operate them. As California is the nation's largest car market, and the center of the greatest effort to develop autonomous vehicles, the state's rules will establish the standard against which all other states will compare their proposed rules, assuming they just don't merely copy California's rules. Given the proposed rules and the reaction of the developers of autonomous vehicles, we expect other states may not copy California's rules, since by not doing so the states could benefit from securing the developer's research efforts.

These test rules forced Google to modify its latest concept driverless vehicle, which was unveiled without a steering wheel or a brake pedal

Aspects of the proposed rules work against the goals of the leading autonomous vehicle developers, such as Alphabet's (GOOG-Nasdaq) Google Inc. subsidiary and Tesla Motors (TSLA-Nasdaq), to produce fully driverless vehicles that will likely be powered by electricity. Under the rules that California adopted for the testing of driverless-vehicles on the state's roads, each test car must have a steering wheel, a brake pedal and an experienced test-driver operating it in order to be in compliance. These test rules forced Google to modify its latest concept driverless vehicle, which was unveiled without a steering wheel or a brake pedal. This model exemplified the old Greyhound Bus Company advertisement slogan: "Take the bus; leave the driving to us."

The Google model was conceived to be the perfect driverless vehicle for what is envisioned as the transportation system of the future

The Google model was conceived to be the perfect driverless vehicle for what is envisioned as the transportation system of the future. Within that system, a passenger could summon a driverless vehicle to pick him up via an app on a smart phone, and the vehicle would then take the person to his programed destination. It is the future personification of the Uber taxi system but without the driver, which Google has commented on as being a promising model. Unfortunately, the proposed California rules would ban outright driverless cars that travel with no humans onboard. Not only would that kill the Uber taxi model, it would also prevent the development of the ability for a passenger to disembark at his destination and have the vehicle then proceed to find a remote parking space, only to be summoned to pick up the passenger at a later time.

Exhibit 12. Google Concept Driverless Vehicle

Source: Google

California's proposed rule that a driverless vehicle must contain a steering wheel and a brake pedal for emergencies, goes against the grain of the technology industry that has been leading the development of these vehicles and cannot imagine a situation where the specified equipment would be necessary. It is akin to the continued existence of the emergency brake, a seldom used feature on a car, or directional signals, which many people seem to consider as unnecessary. The mandated equipment will certainly alter a passenger's experience from that of a 21st Century, space-age vehicle to merely being a passenger riding in a modern automobile.

The mandated equipment will certainly alter a passenger's experience from that of a 21st Century, space-age vehicle to merely being a passenger riding in a modern automobile

Probably the bigger inhibitor to the development of the driverless vehicle is California's proposal that requires not only that a human driver with a normal driver's license be present but that the driver must have a special state-issued driver's certificate for operating a driverless car. There are other regulations on driverless vehicles and the companies that sell them. The rules would restrict companies such as Google from being able to sell driverless vehicles to the public. Rather, consumers would only be able to lease these vehicles from the company. In addition, vehicle manufacturers like Google must certify that their autonomous vehicles comply with specific safety and performance requirements and the companies must have their cars tested by a third-party in order to receive a three-year permit for them to operate on the road. Once an autonomous car is in operation, the company owning them must submit a monthly report on the vehicle's performance.

The rules would restrict companies such as Google from being able to sell driverless vehicles to the public

More ominously, California's DMV said more rules are coming. It cited safety as the reason why the present and future rules will be adopted. One does have to wonder, however, how

much about these rules is driven by safety concerns versus how much is driven by additional fee income considerations for the state?

However, as the data shows, all the accidents were due to human-controlled vehicles hitting driverless cars

At the same time California was proposing rules for driverless cars, media reports were discussing the increase in the number of accidents involving these cars. However, as the data shows, all the accidents were due to human-controlled vehicles hitting driverless cars. The upshot is that most of these accidents have happened at low speeds so both the damage and injury levels have been minimal. The cause of the accidents seems to be that the driverless vehicles are driving by the rules, i.e., too conservatively for human-driven vehicles. Analysts are wondering whether the driverless vehicles need to be programed for situations where they should break the law in order to avoid accidents.

The data shows that Google cars have been involved in 17 minor crashes in two million miles of autonomous driving

According to a study by the University of Michigan's Transportation Research Institute in Ann Arbor, Michigan, the accident rate for driverless cars is twice as high as that for regular cars, however, they have never been at fault. The problem is cars driven by humans that fail to religiously obey the rules of the road and highway speeds, although there have been situations where the autonomous vehicle had trouble knowing exactly what to do. Because California law requires driverless car accidents to be reported, we know more about Google vehicle accidents than any other test cars. The data shows that Google cars have been involved in 17 minor crashes in two million miles of autonomous driving. Google has rejected the claim that its cars are too careful and thus cause accidents. Dmitri Dolgov, principal engineer of the driverless program says, "We err on the conservative side. They're a little bit like a cautious student driver or a grandma."

The car's cameras and laser sensors detected traffic in a 360-degree view, but didn't know how to trust that drivers would make room in the ceaseless flow, so the vehicle's driver needed to take control to complete the maneuver

The challenge for programmed vehicles is to understand, evaluate and act on the intelligence its sensors gather. The problem is when you have to depend on other vehicles doing the reacting. For example, last year, Ray Rajkumar, co-director of the General Motors-Carnegie Mellon Autonomous Driving Collaborative Research Lab in Pittsburgh, offered test drives to members of Congress in his lab's self-driving Cadillac SRX SUV. As he reported, the vehicle performed perfectly except when it had to merge into I-395 South traffic and swing across three lanes of traffic within 150 yards to head toward the Pentagon. The car's cameras and laser sensors detected traffic in a 360-degree view, but didn't know how to trust that drivers would make room in the ceaseless flow, so the vehicle's driver needed to take control to complete the maneuver.

There are other cases where driverless-vehicles have stopped sooner than a human driver for yellow lights at intersections, or

to allow pedestrians approaching a crosswalk to proceed, leading to fender benders. These situations might become more prevalent during the transition from experimental to mainstream and ultimately to a total driverless vehicle fleet. Given that the average age of the U.S. vehicle fleet is nearly 11.5 years, the transition period will last for decades. During that time, the number of accidents may actually increase, but then begin a steady decline toward zero when the vehicle fleet is composed entirely of self-driving vehicles. The pace of that transition, however, may be delayed by the adoption of the California rules.

Given that the average age of the U.S. vehicle fleet is nearly 11.5 years, the transition period will last for decades

Stretching out the transition time to a totally driverless vehicle fleet will also delay some of the anticipated economic and energy benefits envisioned. The world of a complete fleet of autonomous vehicles would allow them to be smaller and lighter, reducing the energy needed to produce them and power them. The absence of accidents would reduce the economic impact of injuries, physical damage and deaths, along with limiting or even ending the need for personal automobile insurance and the costs of accident litigation. If driverless vehicles could operate without human drivers, many families might also eliminate the need for second or third cars by being able to overlap their use of one vehicle, even though it would mean that vehicle would drive considerably more miles per year than the typical family's current vehicles do. Net-net there should be an energy savings. Lastly, fewer vehicles would mean less need for expanded highways and parking spaces, freeing up urban land for alternative uses. California's stance on driverless vehicles would seem to be slowing down the shift to our transportation nirvana and actually extending the petroleum age.

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