Development of Global Oil Giant's Renewable Business

Ruoshui Li[†]

Nicholas School of the Environment,
Duke University

21^{st} May, 2020

As the impact of COVID-19 pandemic rages all over the world, global oil demand has slumped to a 25-year low. The following production disputes between Saudi Arabia and Russia deepened the supply-side crisis and led to a historically low oil price of $24.88 /barrel in Mar.$18^{th}$. Consequently, major oil companies have swallowed significant loss in net profit: U.K.-based Oil & Gas company BP posted a $0.8 billion replacement cost profit (a proxy for net profit) in its first quarterly financial report, compared to $2.4 billion for the same period in 2019[22]; American giant ExxonMobil reported a $610 million loss due to $2.9 billion in write-downs tied to falling oil prices, and this is the company's first loss in decades[25, 68]; The French energy company Total earned a $1.78 billion net profit in the first quarter, down 35% from the same period last year[33]; Royal Dutch Shell is likewise facing a $2.9 billion net profit loss for the first quarter, and it's also the only company among world's Big Oil (BP, Chevron, Eni, ExxonMobil, Shell and Total) that decided to reduce dividend attributable to shareholders, for the first time since World War II. All these reflect a challenging energy market condition full of uncertainties. However, even when all oil companies are cutting costs to improve the financial situation, their renewable energy businesses are mostly spared untouched[59]. BP reaffirmed its ambitious goal to become a net-zero carbon emitter by 2050 or sooner[21]; Shell and Total, amid the crisis, successively announced to be the second and third oil giant that makes such commitment[13, 12]. It seems that the collapse in oil price essentially drives Oil & Gas giants to invest more heavily in renewable energy projects. We are interested in seeing how those fossil fuel companies have embraced clean energy projects for the last decades and whether they can transit deeper toward carbon-free model in the darkest moment of the oil industry.

[†]E-mail: ruoshui.li@duke.edu. This is an informal essay I wrote after three European oil giants announced their net-zero goal during COVID-19 pandemic. I was interested to see how those fossil fuel companies have invested in renewable energy projects to transit towards cleaner energy sources. Therefore, I did some researches and wrote this casual literary notes.

BP (British Petroleum)

Two decades ago, BP first made a public commitment to extend substantial focus on alternative energy resources, as a giant fossil fuel company. The company rebranded itself as "Beyond Petroleum" to convey its willingness to diversify energy portfolio. In 2005, BP launched a new Alternative Energy business, with targets to invest $8 billion over the next 10 years in "generating and marketing low-carbon power" from clean resources like solar, wind, biofuel, or natural gas[18]. And it indeed met the goal even 2 years ahead of schedule: according to BP's 2013 Sustainability Report, the company has cumulatively invested $8.3 billion in alternative energy area[20]. However, the vigorous developments were partially impaired by the Deepwater Horizon accident in Gulf of Mexico. The oil spill in April 2010 has significantly affected BP's sustainable corporate image and forced the company to sell off $75 billion of assets to pay tremendous bills from individuals, businesses, and governmental entities[50]. Coupled with the fact that solar industry had radically involved to a low-margin commodity market, in 2011, BP announced its intention to wind down remaining solar operations and move out of its 35-year-old solar business[19]. Additionally, as the company met its $8 billion commitment in 2013, BP decided not to make another public commitment on future alternative energy spending. Specifically, for current wind and biofuel businesses which could be financially self-sustaining, the strategy is to optimize their financial and operating performance. While biofuel operations are possible to expand, additional wind farms planned to build in the U.S. are all sold in the market[20].

After 2013, much of BP's renewable investments are related to biofuels in Brazil. By 2019, the company has created a leading bioenergy company through a 50:50 joint venture with Bunge in Brazil, which can produce 2.3 billion liters of ethanol equivalent per year[23]. Conversely, the number of wind sites under BP's operation has dropped from 16 in 2013 (1558 MW installed capacity) to 13 in 2017 (1432 MW) and reached 9 in 2019 (926 MW). However, in 2018, BP and Tesla cooperated on a pilot program to install high-storage battery system at one of the company's wind farms, aimed at examining efficiency of wind energy storage. This will enable BP to make better informed decisions when evaluating potential returns to wind industry and battery applications[10]. Remarkably, solar energy was back to BP's renewable power mix as a cost-effective backup source in 2017. Partnered with Europe's largest solar development company – Lightsource, BP re-invested $200 million in development and long-term management of large solar projects after several year's financial recoveries[67]. Different from its investment six years ago, Lightsource BP now focuses on becoming a solar power generator rather than a manufacturer of hardware. Based upon all efforts devoted into its renewable businesses, in February 2020, BP set a second ambition to become a net-zero carbon emitter by 2050 or sooner[21] and reasserted its resolve to execute net-zero strategy during COVID-19

pandemic. According to CEO Bernard Looney, though expenses are cut everywhere, the pot of money for energy transition investments ($500 million) is untouched[60]. Indeed, in March, Lightsource BP closed on a $250 million financing package for a 260MW solar project in Texas, and in April secured another power purchase agreement for a 132 MW solar project in Arkansas, both reflecting BP's confidence in solar industry amid extreme uncertain times.

Royal Dutch Shell

Shell first entered alternative energy market in the early 2000s, when Shell Renewables formed a joint venture with Eskom, South Africa's national electricity supplier, to set up the world's largest solar rural electrification project[63]. Next, the oil company made increasing investments in solar power, wind power, hydrogen, and forestry (disposed in 2003), though only accounts for approx. 1% of the company's total capital expenditure[71]. However, starting 2006, Shell began to sell off its solar division: in February 2006, Germany company SolarWorld acquired all of Shell's solar crystalline operations business[4]; in November 2007, Shell paid Singapore engineering company Environ Energy-Tech Service to take over its multi-billion-dollar solar business in India and Sri Lanka[6]. Afterward, in May 2008, Shell announced to withdraw itself from London Array Wind Farm, which was the largest wind farm project in the world[5]. Ultimately, in March 2009, the European oil giant proclaimed that it will no longer invest in renewable energies including wind, solar and hydropower. Instead, the company will focus purely on oil, gas, biofuels and part of carbon capture and storage projects[37]. Similar to but different from BP, the primary reason of Shell to scale back renewable business is its lack of profitability. According to Shell's executive director of gas and power, many renewable technologies "did not offer attractive investment opportunities" for a profit-making company[71]. Though wind and solar business remain competitive under substantial subsidies in many markets, Shell considered biofuels closest to their core business, and did not expect further significant investment on solar or wind projects[71]. Notably, before Shell sold off its wind business, the company held shares of 11 wind power projects with 1100 MW total installed capacity.

Things reversed in 2016. In a few years, wind energy prices have dropped by 66%, and solar power prices have dropped by 85%[57]. In some districts, building new wind plants is cheaper than operating existing coal or natural gas plants. Meanwhile, restricted by increasingly tightened carbon regulations, renewable projects were massively deployed all over the world. Though failing to foresee such massive success in clean energy sector, Shell established New Energies in 2016 and re-entered the alternative energy market. New Energies, which bringing Shell's existing biofuels, electrical activities, and new wind or solar resources together, is a separate division of the company to invest in renewable power. Upon first established, only $200 million annual capital expenditure was assigned. However, one year later, in 2017, Shell's

CEO announced the plan to spend up to $1 billion on the company's renewable division each year before 2020[64]. Subsequently, in 2018, the upper bound of expenditure was further expanded to $2 billion and $4 billion[70]. Though this still occupies a small proportion of Shell's total investment including Oil and Gas business, such an upgraded energy portfolio signaled Shell's slow move on decarbonization route. Specifically, the development of Shell New Energies is a combination of organic growth and acquisitions: In 2017, the company bought Europe's biggest vehicle charging network NewMotion. In 2018, Shell successively invested on the Borssele III, IV offshore wind farm projects in Netherlands and formed 50:50 joint ventures with French company EDF Renewables to build new off-coast wind farms in the USA. In the same year, New Energies acquired Silicon Ranch Corporation, which is a developer, owner, and operator of solar energy assets in America. Those new businesses are in different sectors from Shell's existing area; however, the company has been working to bring these newly acquired businesses into compliance with its control framework[28].

Shell also took measures to improve its operational efficiency to reduce carbon emissions of the company. Starting 2019, Shell set strict targets to reduce carbon intensity of its energy product: by 2035, average GHG emissions from each unit of energy sold by Shell needs to be decreased by 20%; while for 2050, the goal is to decrease by 50%[61]. However, recognizing that the transition is too slow to meet the 1.5° Celsius goal of the Paris Agreement, Shell announced the ambitious net-zero emission goal in April 2020, despite the tense market atmosphere[13]. This target also shifts the energy products' 20% goal of net carbon footprint reduction in 2035 to 30% and the 50% goal in 2050 to 65%[13]. Shell therefore becomes the second oil giant (after BP) to embrace such a goal. Clearly, the collapse in global oil prices has not disrupted the company's plan on energy transition.

Total

France's biggest oil company Total has been active in solar energy since 1983. In 2001, Total along with French gas company Gaz de France (GDF) and research institute IMEC created Photovoltech, a photovoltaic cell manufacture company, and held half of its shares[29]. Total also owned 50% shares of another European top-tier solar energy operator company – Tenesol and further announced to acquire all Tenesol's operations (outside of France's overseas departments and territories) in April 2011[30]. Through the two joint venture affiliates, Total built valuable experiences in making solar PV power reliable and competitive. One of the company's boldest move occurred in May 2011, when Total announced acquiring 60% shares of SunPower, a U.S.-based manufacturer and designer of solar panels, through a $1.37 billion transaction[47], and injected another $1 billion into the company over next five years[44]. This investment was significant not only because it created a global leader in solar industry, but also in that it

reversed the trend seeing that BP and Shell both considerably scaled back their renewable energy businesses and cut down green investments. Though hit by competition from lower-cost Chinese panel producers, SunPower was able to stay in the market to design, manufacture, and deliver high-quality solar products. Through the affiliate with SunPower, Total also became a top-three solar player with 6 GW installed capacity[31]. In 2014, the affiliate remarkably built the world's largest PV power plant in America, with the capacity of 700 MW[2], further expanding Total's operations on renewable energies. Next, Total extended to energy storage area in 2016 through the acquisition of Saft Groupe, a world's leading manufacturer and designer of nickel batteries and primary lithium batteries for industrial application[7]. In the next year, following the acquisition of 23% share in EREN Renewable Energy (EREN RE), Total Eren was founded to complement the company's clean energy portfolio. Notably, EREN RE has developed an installed gross capacity of 650 MW renewable projects globally before the acquisition, including diversified assets in wind, solar and hydro[8]. By cooperating with EREN RE, Total accelerated its growth in solar energy and started entering the wind power generation segment. The goal of Total Eren is to achieve 5 GW of installed capacity in 5 years. In 2019, Total Eren formed a joint venture with Petrobras to develop onshore wind and solar power projects in Brazil, further making a big point to diversify into wind industry[32].

Since first playing a dominant role in solar industry in 2011, Total has actively participated in the development of renewable energies. In the company's climate report for 2017, Total proposed a goal to have low-carbon businesses account for close to 20% of its portfolio in 2035[32]. To achieve this target, the giant indeed acquired a series of companies to diversify renewable projects under its operation all over the world. By 2019, Total has 3 GW of renewable generation capacity that is 100% operated. In March 2020, Total becomes the latest oil giant that investing in floating wind generation. Even facing intensified market condition, it is still on the process of acquiring floating wind projects off the Wales coast[62], and plans to invest $1.5 billion to $2 billion more in renewable energy area[40]. Ultimately, on May 5^{th}, Total officially announced its ambition to get to net-zero emissions by 2050, from its global production business to energy products used by its customers [12]. So far, all European oil giants have embraced the net-zero emission goal, amid the time with disrupted economies.

ExxonMobil

Unlike their European peers, two U.S.-based oil giants – Chevron and ExxonMobil have largely deviated from the transition to renewable energy businesses.

ExxonMobil has long shown least interest in alternative energy investments, even though it once actively sought for diversified energy resources and was the pilot in groundbreaking researches related to carbon emissions half a decades ago. Back in the 1970s, Exxon was among

the first players who recognized the emerging threat of climate change. It then launched extraordinary research into fossil fuels' carbon emission and its impact on the earth[51]. Under the cross-cutting effects of the oil crisis, the oil giant also worked on various ways to secure clean energy for future 30 years[35]. In 1973, the Exxon-funded company Solar Power Corporation started to manufacture, and ship solar panels to oil platforms, mountaintop telecommunications stations and recreational boats in the U.S. or Australia[42]. In addition, Exxon also looked at potential nuclear power to ease its dependency on oil and gas[42]. However, as the oil crisis in the 1970s replaced by oil surplus one decade later, Exxon's engagement in alternative energy stagnated and the company eventually chose to sell Solar Power Corp in 1984[39]. Meanwhile, the oil company curtailed its advanced carbon-dioxide research, then suddenly put efforts on denying research results of its own scientists and manufactured doubt about global warming reality by stressing the uncertainty of publications had once confirmed[51]. Exxon has refused to comment on the underlying reason for such a traumatic reversal. However, its contract with Indonesian state oil company on exploiting Natuna gas field might play a role in the switch. Their cooperation was broken in early 1980s due to the Natuna's greenhouse gas problem: the reservoir was contaminated with more carbon dioxide than normal[52]. The interrupted gas production timely reminded Exxon of the dawning risks that highlighting carbon emissions and greenhouse effect actually run against the company's ambition in fossil fuels. According to InsideClimate News[52], Exxon spent years researching possible remedies to the gas field's high emission rate but found them either costly or ineffective. One of the world's largest deposits of natural gas was therefore laid aside in several years. Starting the late 1980s, Exxon gradually worked at the forefront of anti-climate crisis to prevent actions on reducing carbon emissions. In the following decades, the oil giant has also been skeptical and reluctant about almost all renewable projects. From 2000s to early 2010s, the only significant move of ExxonMobil is to ally with Synthetic Genomics, a leading biotech company, to develop biofuels from photosynthetic algae[26]. During a shareholder speech in May 2015, the CEO of ExxonMobil mocked the renewable industry by claiming that the company hadn't invested in the area for long because they "choose not to lose money on purpose"[43].

Things started to change in 2016. Driven by the proposal from 63% of its shareholders, ExxonMobil was forced to disclose the influence of climate change on its businesses as well as the company's plan to meet 2-degree Celsius scenarios in annual reports[16]. Not until then did ExxonMobil's CEO publicly admitted the adverse effects of carbon emission and climate change. In March 2018, ExxonMobil made a public commitment to contribute $20 million over five years in funding a new Stanford Strategic Energy Alliance, which is aiming at improving energy access, security, and technology[9]. The same year in November, the giant announced a 12-year agreement with Demark company Ørsted A/S to buy 500 MW of wind and solar power to support operations at one of its Texas oil fields[58]. And this is the first contract

signed by ExxonMobil in renewable energies. In May 2019, the oil giant claimed to invest up to $100 million over the next ten years to "research and develop advanced lower-emissions technologies" cooperated with U.S. national labs[11], primarily focus on carbon capture and storage technologies. More recently, as the company's financial situation severely affected by COVID-19 pandemic and oil price slash, ExxonMobil has reported a $610 million loss and planned to largely reduce 2020 capital or operating spending. Occupied only a small portion of its energy portfolio, the oil giant's nascent renewable investments are left out of the plan without mention.

Chevron

Different from ExxonMobil, Chevron at least devoted some efforts in building its image of "unsung hero" among oil companies in renewable business[15]. In 2000, the giant acquired PG&E's Energy Services and created Chevron Energy Solutions. The division helped Chevron to engage in development of energy efficiency solutions, utility infrastructure projects and renewable energy projects[1]. In the next few years, Chevron Energy Solutions completed hundreds of alternative energy projects over the world to increase facility energy efficiency, reduce energy expense, and ensure power reliability[55]. In 2006, vice chairman of the company announced that Chevron had become the biggest producer of geothermal energy in the world[3]. Next, in a literature announcement released in 2007, Chevron claimed to have spent approx. $2 billion between 2002 and 2006 on investments related to clean energy technologies. However, the number of actual investments was considered misleading[15], since the company only reported a $60 million investment in alternative energy projects in its Corporate Responsibility report for 2004. It seems unlikely for the oil giant to pump approx. $1 billion, which is around 10% of its capital expenditure, into renewable businesses between 2005 and 2006. In 2008 and 2010, Chevron successively launched "Will You Join Us" and "We Agree" campaign to highlight the company's standpoint in world's key energy issues. The former used a "Human Energy" slogan to feature how behavior efficiency and innovation can power human progress, while the latter displayed how the company is taking responsibility, as an oil company, to develop renewables, support communities and protect environments. However, only 3 years later, Chevron's movement started to lose momentum. In 2013, the company pulled back funding for its biofuel projects[14]. Next, in 2014, Chevron sold its business unit focused on renewable power plants development[38] and had California company OpTerra Energy Services to acquire its Chevron Energy Solutions division[27]. Additionally, in 2017, Chevron sold its primary geothermal operation assets in Southeast Asia[34]. Though the company claimed that it was making strategic decisions to "focus on supporting Chevron's upstream and downstream businesses" rather than abandoning renewables[38], people consider the low returns compared to its core oil and gas

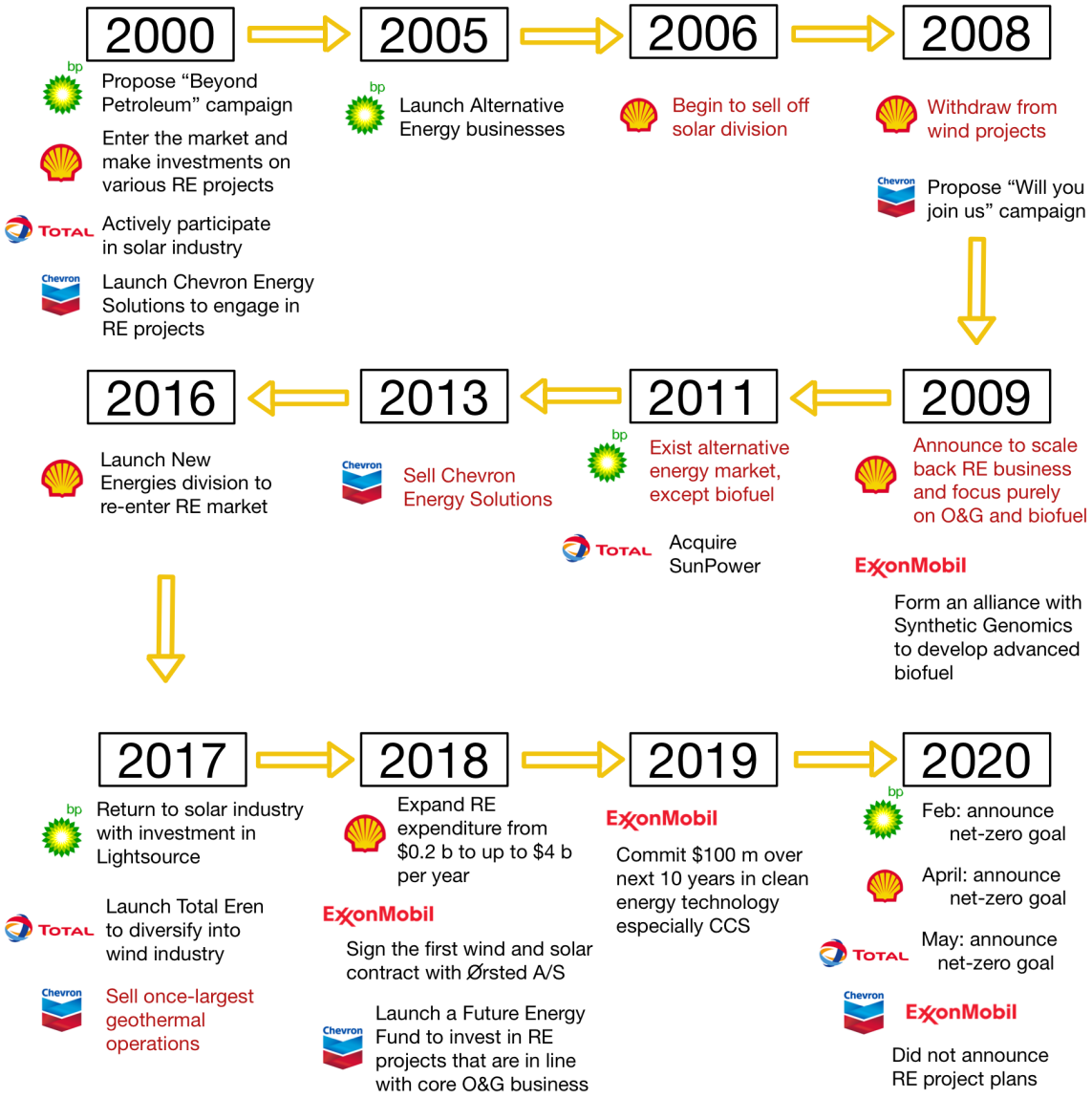
businesses drove the giant to slow down developments in alternative energy industry[14].

The company's next influential investment in innovative clean energy technology did not occur until 2018. As the renewable products rapidly ramp up to a level that has a huge influence on the whole energy industry, also driven by its investors and stakeholders' growing interests in climate change issues[48], Chevron for another time actively involved itself at the edge of clean technology area. However, different from BP and Shell, who intensively invested in global solar and wind projects to diversity their clean power resources, Chevron focused specifically on breakthrough technologies or business models that can lower life-cycle carbon emissions of its oil and gas products, including technologies that help create efficient value chains[48]. In 2018, Chevron launched a Future Energy Fund with $100 million, then invested in EV charging company ChargePoint, battery storage company Natron Energy, and carbon capture company Carbon Engineering in the next two years. The EV charging technology has already been applied in some of the company's pilot service stations and captured CO2 was used to enhance recovery rate in Chevron's oil wells. Though largely lagged behind bp, Shell or Total regarding clean energy deployments, Chevron has adopted a strategy to concentratedly invest in renewable areas that are in line with its core oil and gas business. In this way, the company is seizing transition opportunities to produce synergies between renewable techniques and their upstream businesses. Overall, Chevron 's investment in renewables has been minimal compared to its European peers, with more focus tends to be cost-cutting within their core business, and no clear target or vision been announced during the engagement. As the economic activities frozen during COVID-19 pandemic in recent months, Chevron has announced to reduce its capital spending plan by 20%[24], mostly comes from upstream unconventional. Just like its U.S. peer ExxonMobil, the oil giant's investments on alternative energies are neither included in cost-cutting plans nor highlighted to be spared. Whether Chevron will gradually withdraw from current renewable investments like it did in 2014 or stick to this low-risk industry remains to be seen.

Discussion

All three oil giants in Europe – BP, Shell, and Total have now made public commitments to get to net-zero emissions by 2050, while two U.S.-based companies – ExxonMobil and Chevron are showing no sign of embracing such objective. Will the recent COVID-19 pandemic and slashing oil price be a right moment for them to revise the business model and turn the direction toward renewable energy, or for European giants to strengthen their investments in clean energy industry further? Looking at the development of each company's green business over the past 20 years may give us some insights.

Back to the early 2000s, as the world increasingly be familiar with the looming climate crisis, the need to explore alternative energies gained traction in oil company's thinking. Almost



Note that oil giants invested a series of RE projects related to solar, wind, EV battery and carbon capture & storage from 2015 to 2020, which are not listed in the figure

Figure 1: History of five Oil giants' RE business

all oil majors actively increased their activities in renewable energy area. During that period, biofuel, whose production process is mostly related to oil company's core operations, was the primary target. Against strong incentives and mandatory consumption levels in many key markets, oil giants each invested in their own supply resources and initiated researches in advanced products like ethanol and algae feedstocks[49]. Renewable projects that are deviated from oil company's core business like wind, solar, geothermal as well as carbon capture and storage were also in prosperity. However, starting in 2006, these initial investments were largely retrenched due to a lack of operational overlap or profitability and the increased competition in the industry. Without strong resolve from company leaders, also with the hope to save more values for shareholders, all oil majors except Total have announced to scale back their investments on non-biofuel renewable projects and focus more on core oil and gas businesses.

The next prosperity in Oil company's alternative energy engagement occurred in 2016 and 2017. After their first withdrawal in the late 2000s, several changes were observed in the market: first is the rapid involvement of wind and solar industry. The economic argument for developing new renewable positions was indeed week when BP and Shell exited the wind or solar market, even when CEO of ExxonMobil mocked at the renewable industry because of its low-profit return. However, in the wake of its rapid development in recent decade, the cost of deploying wind or solar power to provide electricity has decreased by 66% and 85%, respectively. The fear of losing money in renewable investments was fading. Another important moment that drove oil majors to re-enter alternative market is the oil price slash starting in 2014, due to a sudden oversupply of shale oil from USA and Canada. The oil price plummeted more than 50% from $115 per barrel in June 2014 to less than $50 per barrel in early 2015 and then to approx. $30 per barrel in early 2016[46], leading to top companies reporting sharp declines in profits. Under such a tense situation, renewable projects or clean energy foundations became a haven for investors to put their money. According to a report released by Mckinsey, in the first quarter of 2015, many clean-tech funds handily outperformed the S&P. And renewable companies, due to their relative stability and less sensitivity to price fluctuation, were doing well in collecting money from the market[56]. The last change in the market is related to government policies in promoting zero-carbon energy recourse deployment out of the environmental considerations of fossil fuels. Aimed at reaching the Paris Agreement's goal of holding the rise in global average temperature to well below 2°C above pre-industrial levels, the European Union implemented a bloc-wide carbon tax to encourage companies actively investing in alternative energies which produce lower or zero GHG emissions. In all, seeing that alternative energy has become an industry with lower involvement expense and higher stability, also under the triple pressure from government, public and shareholders to reduce carbon emissions, for the few years after 2016, almost all oil producers were shifting their business models toward a more sustainable direction, either through renovating abandoned renewable businesses or actively investing in

cutting-edge clean energy technologies.

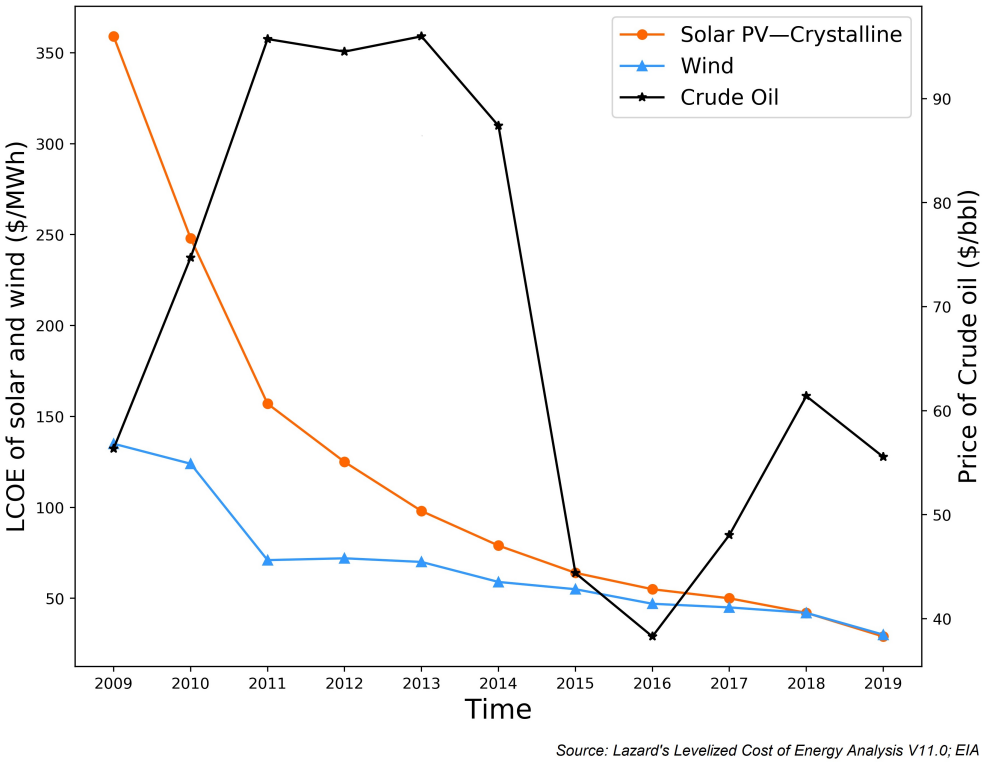


Figure 2: Evolution of solar, wind and oil expense from 2009 to 2019

Notably, from 2016 onwards, the oil giants' resolve in developing renewable businesses has in fact gone through some changes and gradually been strengthened. This is especially true for Shell. When its New Energies division first established in 2016, annual capital expenditure available for new businesses was only $200 million, while in the same year Shell's spending plan on core oil and gas businesses is $30 billion[45]. Company insiders once claimed that Shell didn't expect the new businesses to last for a decade or more and hoped to play down the importance of its New Energies division. Though pushing itself at the leading position of low-carbon transition, the oil major did not want to get so far in front where investor returns would be diluted[45]. However, only two years later in 2018, Shell has raised the upper bound and publicly committed to spending at most $4 billion a year on green energy projects. BP, Total, Chevron, and even ExxonMobil also gradually enhanced the level of their investments in more diversified areas from 2016 to 2020. One reason for their raised confidence in alternative energy industry might be continuously decreasing expenses. However, on the other hand, the sustained low oil price and downward oil demand also catalyzed oil companies' green investments[69]. Shell once expected oil price to recover back to over $100 per barrel, even it will take several years[66]. However,

lacking upward supporting power, crude oil price never exceeded $80 per barrel in the next few years after 2014. Added to the fact that the global demand for fuel also lagged as energy supply became increasingly abundant, vehicle industry which benefited from enhanced efficiency required less oil, and economies in some of the largest importing countries were weakening, giant oil companies increasingly saw the looming collapse of their old business models and recognized the necessity to adjust wrongheaded strategies to diversify into green energy. Jump to March 2020, though induced by different factors, global crude oil price again plumped to an extremely low level. Compared to the last crisis in 2014, when oil giants hesitantly stepped toward large-scale renewables, the three European oil majors almost instantly announced or reaffirmed their resolves to stay in the renewable industry and continue pursuing their carbon reduction goals. This, from the other perspective, reflect that current solar, wind, and other renewable businesses are financially credible and publicly supportive enough for oil companies and their shareholders to confidently stick to the industry.

From early 2000s to 2020, European oil giants existed and re-entered what then became the major growth renewable market, to invest in alternative energies. While two U.S. giant oil companies, which already lagged their European peers regarding clean energy strategies, focus more on developing edging technologies that will benefit their core oil and gas businesses. Indeed, ExxonMobil and Chevron are working on reducing life-cycle carbon emissions of their energy products, however, they are still skeptical and reluctant about the future of solar or wind projects. Throughout the whole process, the economic argument of exploring renewable projects seems to be a critical point. From the original withdrawal in order to ensure profits and save values for shareholders, to European companies' re-entering due to lower commitment price and depressed oil price, or the U.S. majors' little nod to clean energy technologies for cutting core business expenses, all reflected that oil giants were making investments decisions not only based on emission-reducing goal or social responsibility, but most importantly on the relative profitability of green projects. Therefore, when considering whether two U.S. companies will significantly change the business model and invest in solar panels or wind farms, the expense of renewable projects and future oil price will be essential factors. For one thing, if crude oil price sustains at a relatively lower level compared to pre-COVID value, ExxonMobil and Chevron might be forced to incorporate cheap and low-risk green energy resources into their portfolio managements, amid the call of long-term green recovery from the whole society[53]. For the other, the engagement expense for companies to enter renewable market needs to remain at a low level. Solar and wind projects have always been highly subsidized by the government. However, as subsidies are seeing to retreat during the next few years, how commitment will U.S. companies and also European giants be, or what business model they will be adopting at that time are still unknown questions. This also raise the necessity of advanced technological innovation in continuously reducing solar and wind power costs.

Some people have argued that even though Shell, BP and Total all made public commitments to work toward net-zero carbon emissions by 2020, their definition and counting methods are different. Neither do they have a credible plan to reach the ambitious goal[65]. Whether their business operations, value chains and use of fossil fuels allow them to meet net-zero emissions are also not clear[41]. Some researchers even claimed that these oil giants are overstating their ambitions[54]. In addition, the arguments regarding how many investments in clean energy area is needed from oil giants to make a big different have been continuously raised. Despite that oil majors have invested a growing amount of money on green projects, people criticized that what they have done is just a nice but little nod to renewables[45]. It's unlikely that significant change in the company will occur given that annual spending on renewable divisions accounts for only a small portion of total investments oil companies pumped into oil & gas exploration[45, 36, 17].

In all, throughout the past twenty years, major oil companies have suppressed plans of increasing oil & gas production and ramped up investments on alternative energies to diversity company portfolio and cut emission rates. Under the current challenging crude oil market condition and uncertainties around future commitment costs of renewable projects, whether they can make it to the next stage of energy transition remains an open question. Future expenses of renewable projects (if not considering government subsidy) and crude oil price, which together affect the hedging value of renewables, might be the key factors for major oil companies to make investment decisions.

Reference

[1] Chevron energy solutions. https://www.crunchbase.com/organization/chevron-energy-solutions#section-overview.

[2] Our expertise in solar energy. https://www.total.com/energy-expertise/exploration-production/renewable-energies/solar-energy.

[3] Chevron claims energy debate. http://news.bbc.co.uk/2/hi/business/4716334.stm, February 2006.

[4] Solarworld acquires shell's solar business. https://www.renewableenergyworld.com/2006/02/02/solarworld-acquires-shells-solar-business-42840/#gref, February 2006.

[5] Shell pulls out of london array wind farm. https://www.renewableenergyworld.com/2008/05/02/shell-pulls-out-of-london-array-wind-farm-52368/#gref, May 2008.

[6] Environ energy buys solar biz of shell overseas in india, lanka. https://www.thehindubusinessline.com/todays-paper/tp-corporate/Environ-Energy-buys-solar-biz-of-Shell-Overseas-in-India-Lanka/article20180155.ece, April 2011.

[7] Total takes control of saft groupe after the successful tender offer. https://www.total.com/media/news/press-releases/total-takes-control-saft-groupe-after-successful-tender-offer-which-will-be-re-opened-july-19-august, July 2016.

[8] Total partners with eren renewable energy to expand its renewable business. https://www.total.com/media/news/press-releases/total-partners-eren-renewable-energy-expand-its-renewable-business, September 2017.

[9] Exxonmobil to join stanford strategic energy alliance. https://corporate.exxonmobil.com/News/Newsroom/News-releases/2018/0301_ExxonMobil-to-join-Stanford-Strategic-Energy-Alliance, March 2018.

[10] Tesla and bp test battery storage at us wind farm. https://www.bp.com/en/global/corporate/news-and-insights/bp-magazine/tesla-bp-wind-farm-us.html, April 2018.

[11] Exxonmobil to invest up to $100 million on lower-emissions r&d with u.s. national labs. https://corporate.exxonmobil.com/News/Newsroom/News-releases/2019/0508_ExxonMobil-to-invest-up-to-100M-on-lower-emissions-RandD-with-US-National-Labs, May 2019.

[12] Total adopts a new climate ambition to get to net zero by 2050. https://www.total.com/media/news/total-adopts-new-climate-ambition-get-net-zero-2050, May 2020.

[13] What is shell's net carbon footprint ambition? https://www.shell.com/energy-and-innovation/the-energy-future/what-is-shells-net-carbon-footprint-ambition.html, April 2020.

[14] Peter Waldman Ben Elgin. Chevron defies california on carbon emissions. https://www.bloomberg.com/news/articles/2013-04-18/chevron-defies-california-on-carbon-emissions, April 2013.

[15] Tom Bergin. *Spills and Spin: The Inside Story of BP*. July 2011.

[16] Jeremy Berke. The world's largest oil and gas companies are getting greener after fighting with shareholders for months. https://www.businessinsider.com/exxon-shell-bp-announce-renewable-energy-and-climate-initiatives-2017-12, December 2017.

[17] Jeremy Berke. The world's largest oil and gas companies are getting greener after fighting with shareholders for months. https://www.businessinsider.com/exxon-shell-bp-announce-renewable-energy-and-climate-initiatives-2017-12, December 2017.

[18] BP Corporation. Sustainability report 2005. bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/sustainability/archive/archived-reports-and-translations/2005/bp-sustainability-report-2005.pdf, 2006.

[19] BP Corporation. Sustainability review 2011. https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/sustainability/archive/archived-reports-and-translations/2011/bp_sustainability_review_2011.pdf, 2012.

[20] BP Corporation. Sustainability review 2013. https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/sustainability/archive/archived-reports-and-translations/2013/bp-sustainability-review-2013.pdf, 2014.

[21] BP Corporation. Bp sets ambition for net zero by 2050, fundamentally changing organisation to deliver. https://www.bp.com/en/global/corporate/news-and-insights/press-releases/bernard-looney-announces-new-ambition-for-bp.html, February 2020.

[22] BP Corporation. Q1 2020 numbers and highlights. https://www.bp.com/en/global/corporate/news-and-insights/bp-magazine/1q-2020-numbers-and-highlights.html, April 2020.

[23] BP Corporation. Sustainability report 2019. https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/sustainability/group-reports/bp-sustainability-report-2019.pdf, 2020.

[24] Chevron Corporation. Chevron announces actions in response to market conditions. https://chevroncorp.gcs-web.com/news-releases/news-release-details/chevron-announces-actions-response-market-conditions, March 2020.

[25] Exxon Mobil Corporation. Exxonmobil reports results for first quarter 2020. https://corporate.exxonmobil.com/-/media/Global/Files/investor-relations/quarterly-earnings/earnings-announcements/2020-earnings-announcements/1q-earnings-release.pdf, May 2020.

[26] ExxonMobil Corporation. 2009 summary annual report. http://www.annualreports.com/HostedData/AnnualReportArchive/e/NYSE_XOM_2009.pdf, 2010.

[27] FMI Corporation. Sale of chevron energy solutions. https://www.fminet.com/news/2014/09/16/sale-of-chevron-energy-solutions/, September 2014.

[28] Shell Corporation. New energies. https://reports.shell.com/investors-handbook/2018/integrated-gas/new-energies.html.

[29] Total Corporation. Energie solaire : Photovoltech investit pour doubler sa capacitÉ de production. https://www.total.com/media/news/press-releases/energie-solaire-photovoltech-investit-pour-doubler-sa-capacite-de-production, November 2008.

[30] Total Corporation. Total poursuit son dÉveloppement dans l'Énergie solaire. total.com/media/news/press-releases/total-poursuit-son-developpement-dans-lenergie-solaire, April 2011.

[31] Total Corporation. Integrating climate into out strategy. https://www.total.com/sites/g/files/nytnzq111/files/atoms/files/integrating_climate_into_our_strategy_eng.pdf, May 2017.

[32] Total Corporation. Integrating climate into out strategy. https://www.total.com/sites/g/files/nytnzq111/files/atoms/files/total_rapport_climat_2019_en.pdf, November 2019.

[33] Total Corporation. https://new-publications.total.com/resultat1q2020-documents/en/1q20-results.pdf. https://new-publications.total.com/resultat1q2020-documents/en/1q20-results.pdf, April 2020.

[34] Enrico Dela Cruz. Indonesia, philippine groups acquire chevron's $3 billion geothermal assets. https://www.reuters.com/article/us-chevron-sale-geothermal/indonesia-philippine-groups-acquire-chevrons-3-billion-geothermal-assets-idUSKBN14C0OW, December 2016.

[35] John Cushman. Highlighting the allure of synfuels, exxon played down the climate risks. https://insideclimatenews.org/news/08102015/highlighting-allure-synfuels-exxon-played-down-climate-risks, October 2015.

[36] JASON DEIGN. Total gets deeper into renewables with investment in eren. is offshore wind next? https://www.greentechmedia.com/articles/read/total-renewables-eren-investment-offshore-wind, September 2017.

[37] John Donovan. Anger as shell reduces renewables investment. https://royaldutchshellgroup.com/2009/03/18/anger-as-shell-reduces-renewables-investment/, March 2009.

[38] Maria Gallucci. Chevron finalizes sale of its clean energy subsidiary, marking latest oil industry move away from renewables. https://www.ibtimes.com/chevron-finalizes-sale-its-clean-energy-subsidiary-marking-latest-oil-industry-move-1677212, September 2014.

[39] Loubna Bouamane Geoffrey Jones. *"Power from Sunshine":A Business History of Solar Energy*. May

2012.

[40] Carlos Anchondo Heather Richards, Mike Lee and Lesley Clark. 3 ways coronavirus is upending the oil industry. https://www.eenews.net/stories/1062693959, March 2020.

[41] Michael Holder. Investor group: No european oil and gas major has a credible net zero plan. https://www.greenbiz.com/article/investor-group-no-european-oil-and-gas-major-has-credible-net-zero-plan, May 2020.

[42] Anrea Hsu. How big oil of the past helped launch the solar industry of today. https://www.npr.org/2019/09/30/763844598/how-big-oil-of-the-past-helped-launch-the-solar-industry-of-today, September 2019.

[43] STEPHEN LACEY. Exxonmobil ceo makes fun of clean energy: 'we choose not to lose money on purpose'. https://www.greentechmedia.com/articles/read/exxonmobil-ceo-makes-fun-of-clean-energy-we-choose-not-to-lose-money-on-pur, May 2015.

[44] Terry Macalister. Total invests £800m in us solar power firm. https://www.theguardian.com/business/2011/apr/29/total-solar-power-renewables, April 2011.

[45] Terry Macalister. Shell creates green energy division to invest in wind power. https://www.theguardian.com/business/2016/may/15/shell-creates-green-energy-division-to-invest-in-wind-power, May 2016.

[46] macrotrends. Crude oil prices - 70 year historical chart. https://www.macrotrends.net/1369/crude-oil-price-history-chart.

[47] IHS Markit. Total acquires 60 https://ihsmarkit.com/country-industry-forecasting.html?ID=1065929483, May 2011.

[48] EMMA FOEHRINGER MERCHANT. A look at chevron's dip into clean energy investing. https://www.greentechmedia.com/articles/read/a-look-at-chevrons-dip-into-clean-energy-investing, January 2019.

[49] MATTHEW MORTON. Is there still a role for oil companies in renewables? https://www.greentechmedia.com/articles/read/is-there-still-a-role-for-oil-companies-in-renewables, March 2015.

[50] Steven Mufson. After the deepwater horizon disaster, a new bp emerges. https://www.adn.com/business-economy/energy/2018/07/16/after-deepwater-horizon-a-new-bp-emerges/, July 2018.

[51] David Hasemyer Neela Banerjee, Lisa Song. Exxon's own research confirmed fossil fuels' role in global warming decades ago. https://insideclimatenews.org/news/15092015/Exxons-own-research-confirmed-fossil-fuels-role-in-global-warming, September 2015.

[52] Lisa Song Neela Banerjee. Exxon's business ambition collided with cli-

mate change under a distant sea. https://insideclimatenews.org/news/08102015/Exxons-Business-Ambition-Collided-with-Climate-Change-Under-a-Distant-Sea, October 2015.

[53] Climate Home News. Cop26 climate talks postponed to 2021 amid coronavirus pandemic. https://www.climatechangenews.com/2020/04/01/cop26-climate-talks-postponed-2021-amid-coronavirus-pandemic/, April 2020.

[54] Edie News. Oil and gas giants overstating net-zero ambitions, study finds. https://www.edie.net/registration/regwall.asp?mid=140467&origin=https%3A%2F%2Fwww%2Eedie%2Enet%2Fnews%2F6%2FOil%2Dand%2Dgas%2Dgiants%2Doverstating%2Dnet%2Dzero%2Dambitions%2D%2Dstudy%2Dfinds%2F&title=Oil+and+gas+giants+overstating+net%2Dzero+ambitions%2C+study+finds, April 2020.

[55] Cision PR Newswire. News from chevron energy solutions. https://www.prnewswire.com/news/chevron-energy-solutions/.

[56] Scott Nyquist. Lower oil prices but more renewables: What's going on? https://www.mckinsey.com/industries/oil-and-gas/our-insights/lower-oil-prices-but-more-renewables-whats-going-on, June 2015.

[57] Michael O'Boyle. Wind and solar are our cheapest electricity generation sources. now what do we do? https://www.greentechmedia.com/articles/read/wind-and-solar-are-our-cheapest-electricity-generation-sources-now-what-do, January 2017.

[58] John Parnell. Renewable energy laggard exxonmobil to power oil exploration with wind and solar. https://www.forbes.com/sites/johnparnell/2018/11/28/renewable-energy-laggard-exxonmobil-to-power-oil-exploration-with-wind-and-solar/#1a58fa0468f3, November 2018.

[59] John Parnell. European oil majors slash spending in face of 'triple crises'. https://www.greentechmedia.com/articles/read/oil-majors-slash-spending-in-face-of-triple-crises, March 2020.

[60] John Parnell. Shell and bp slash spending but renewables largely spared. https://www.greentechmedia.com/articles/read/energy-transition-funds-survive-shell-and-bp-cuts, April 2020.

[61] John Parnell. Shell sets net-zero target for 2050, emphasizing power and renewables. https://www.greentechmedia.com/articles/read/shell-to-trigger-power-and-renewables-growth-for-new-net-zero-push, April 2020.

[62] John Parnell. Total becomes latest oil major to enter floating wind market. https://www.greentechmedia.com/articles/read/oil-major-total-inks-surf-n-turf-wind-power-deals, March 2020.

[63] DIANE Publishing. *Renewable Energy 2000: Issues and Trends*. February 2001.

[64] Julia Pyper. Shell plans to boost clean energy spending to $1 billion per year. https://www.greentechmedia.com/articles/read/shell-boost-clean-energy-spending-1-billion-2020, July 2017.

[65] Akshat Rathi. Big oil has big plans for net zero. are they credible? https://energynow.com/2020/05/big-oil-has-big-plans-for-net-zero-are-they-credible/, May 2020.

[66] Dmitry Zhdannikov Ron Bousso, Karolin Schaps. Shell expects oil price recovery to take several years. https://www.reuters.com/article/us-shell-oil-prices/shell-expects-oil-price-recovery-to-take-several-years-idUSKCN0PQ14M20150716, July 2015.

[67] Susanna Twidale Ron Bousso. Bp returns to solar with investment in lightsource. https://www.reuters.com/article/us-lightsource-bp-stake/bp-returns-to-solar-with-investment-in-lightsource-idUSKBN1E90H9, December 2017.

[68] Pippa Stevens. Exxon loses $610 million in the first quarter on write-downs tied to plunging oil. https://www.cnbc.com/2020/05/01/exxon-mobil-xom-earnings-q1-2020.html, May 2020.

[69] Evan Tarver. Why the price of crude oil dropped in 2015. https://www.investopedia.com/articles/investing/102215/4-reasons-why-price-crude-oil-dropped.asp, August 2019.

[70] Adam Vaughan. Shell says it wants to double green energy investment. https://www.theguardian.com/business/2018/dec/26/shell-says-it-wants-to-double-green-energy-investment, December 2018.

[71] Tim Webb. Shell dumps wind, solar and hydro power in favour of biofuels. https://www.theguardian.com/business/2009/mar/17/royaldutchshell-energy, March 2009.