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Energy transitions in incumbent companies; a case study applying the MLP

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Abstract

As more and more nations around the globe start the journey on a low-carbon economy, there are so many lessons that can be learned from the fate and response of the incumbent fossil fuel companies in the European context. Flustered to the center of their existence by their nations' transition in energy, the incumbents' utilities grope for new business frameworks and ways to maintain their current business strategies. While renewable energy and digital technologies distort the power market, the incumbents are hopeful that the unresolved heating and transport electrification will provide new chances of advancements in the next phase of the low-carbon economy move. However, the race of innovation goes parallel to the new players and the former energy monopolies have to withstand a heavy burden of competition and transition. The paper was guided by the question: "How do incumbent fossil-fuel based utilities respond to the low-carbon energy transition in their business strategy?" Primarily, the essay was to discuss the business strategy and response of two European (Royal Dutch Shell and Equinor) incumbent energy producers' as a result of the wave on the low-carbon economy within a multi-level perspective. The paper wants to offer a framework of factors that slow down the transition process as analyzed within the two companies using the Multi-level perspective. Data collection and information would be done and it included the application of qualitative methods, especially paying attention to existing knowledge and company information from the annual reports of incumbents'. The study depicts how far incumbent energy producers in the world are willing to go to alter the preferred transition as well as change their initial business strategy so as to fit in the energy transition.

Keywords: Low-carbon economy, incumbent, transition, and Multi-level perspective

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List of Abbreviations

CCC	Committee for Climate Change
CCS	Carbon Capture Storage
CEO	Chief Executive Officer
COP	Conference of Parties
EEA	European Economic Area
EU	European Union
GDP	Gross Domestic Profit
IEA	International Energy Agency
MLP	Multi-level Perspective
NOK	Norwegian Krone
R & D	Research and Development
RETs	Renewable Energy Technologies
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar

1. Introduction

The conduct of incumbent energy companies is important in the transition to an energy system that is sustainable. In the standard term, they dominate a good number of the fixed capital which includes infrastructures such as grids of distribution and a large customer base. The responsibility of incumbent fossil- fuel companies have previously presented itself greatly in the austere terms of the systematic fields of action, where the coalitions of incumbent companies protect their status quo from challengers (Wassermann, Reeg & Nienhaus, 2015; Kungl, 2015). Although this portrayal may appropriately depict the field's dominant logic, there are indications of distinct, perhaps more collaborative logics that are arising in the margins. Therefore, there is a need for a more in-depth conceptualization of agency and power in social-technical transitions (Heiskanen, Apajalhti, Matschoss & Lovio, 2018, p.1).

1.1 Background

From around 1800, human beings have greatly increased their fossil fuels consumption, beginning with coal which was very common in the industrial revolution (e.g. gases & petroleum liquids). Their use has significantly risen after 1950. This drastic growth in the use of fossil-fuel has led to the consumption of a very substantial fraction (about one-third) of the reserves of the fossil fuels (Jones, 2009) and the remaining reserves (Shafiee & Topal, 2009) vary significantly.

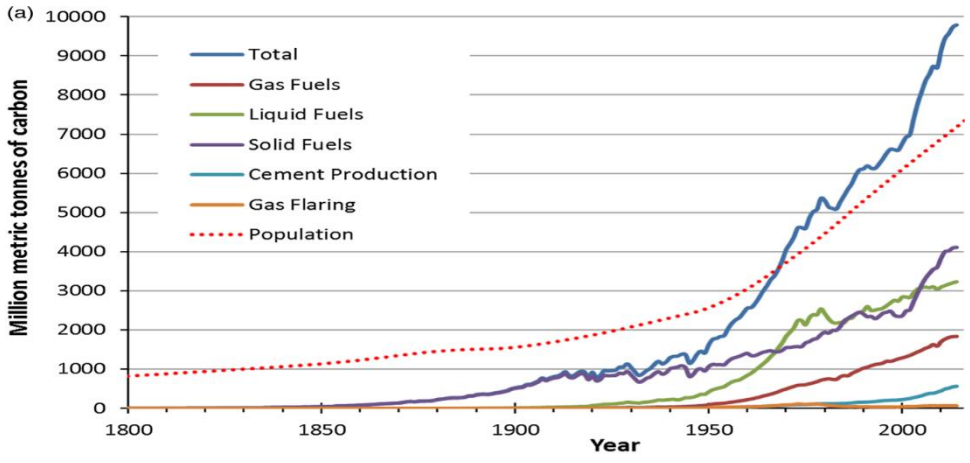

Fig. 1 Fossil Fuels Consumption. (Ringrose, 2017).

Hence, it is clear that the continued dependence on fossil fuel is not sustainable. This critical conclusion is however in conflict with the current economic and social demands of the same society. Economic advancement of modern human society, particularly since 1800, has been propelled by fossil fuels energy. Present global fossil-fuel consumption is about 82% of the globe's energy supply, with manufacturing, transport, and agricultural sectors all being greatly reliant on these somewhat available and cheap energy sources (Krausmann, et al., 2009).

The low-carbon transition

It follows from the above that fossil fuels consumption and CO_2 emissions summarize that the present situation of immense worldwide CO_2 emissions cannot be sustained. Using the Brundtland Commission on Environment and Development framework, the human society ought to attain transition to an array of sustainable energy resolutions.

There is an irrefutable consensus that this idea is the only ideal solution to the challenge of climate-energy and several efforts have been set in motion to trigger these actions. Nevertheless, in spite of this common consensus on the necessity for low-carbon energy solutions, actual progress in attaining the favored energy transition is slow and currently deficient for meeting the goals for emissions decrease (Bale, Varga, & Foxon, 2015).

Incumbent Companies Response

Utilities that are based on fossil fuels have taken up an important section in the public arena since it became industrially accessible, boosting and changing it to skylines that are new. Huge companies were framed setting up a cutting-edge conduct and method of conducting businesses, thus instituting a lobbying power when their interests demand steering. However, the incumbent oil and gas industry has constantly been under scrutiny because of the dubious and at times obscure actions against the societal groups, environment, and public policy

(Bannon & Collier, 2003). Additionally, in the present periods, the urgency of a goal-oriented transition (Geels et al, 2017) that is gradual from an economy that is petroleum derivative-based towards a low-carbon economy, has triggered a change that is imminent into an encompassing and modern perspective.

With the problem background previously addressed, the knowledge gap intended to close during the current study is to increase awareness on the response of incumbent fossil-fuel companies and the way their response influence the low – carbon energy transition.

1.2. Goals and questions

The objectives of the study are to appraise the actions taken by incumbent fossil-fuel companies to a low-carbon energy transition and compare the theory with empirical illustrations from the selected case studies. Additionally, the study will attempt to demonstrate the effects if any, of the external elements that interfere with the business strategies of the incumbent industry. For instance, sharing investment with other renewable energy companies, new clean technology departments conception, and/or lobbying in both international and national platforms to preserve the regime that is currently in existence.

The principal target of the research is fulfilling certain objectives. In order to achieve those objectives, the paper needs to comprehensively respond to the following question: How do incumbent fossil-fuel based utilities respond to the low-carbon energy transition in their business strategy?

1.3. Approach and methods

The study utilizes the qualitative research tradition for incumbent fossil-fuel dominated companies for two main reasons. First, qualitative research methodologies concentrate on the collection of extensive data that can be retrieved from the actual process of transition and can be analyzed with the use of a number of methods. In this way, the concentration lies in the activities during the transition process. Second, the purpose of the study is to appraise the actions taken by incumbent fossil-fuel companies to a low-carbon energy transition and compare the theory with empirical illustrations from the two selected case studies, as well as

attempt to demonstrate the effects if any, of the external elements that interfere with the business strategies of the incumbent industry.

This qualitative case study utilizes the case study design. A case study examines a certain situation, phenomenon, or event, focusing on as many variables as possible that are incorporated in the specific case (Creswell, 1988; Merriam, 1988). Moreover, being holistic in nature (Merriam, 1988), a case study tries to define, describe intensively and interpret the case that is being studied, using as much detail as possibly available, so that the provided picture would be holistic and full. The study will utilize secondary data sources. The data will be gathered from reliable annual reports emitted by the case study companies, newspapers, reputable agencies, institutions and governmental bodies.

1.4. Thesis outline

After Chapter 1, the study will be unwrapped as follows: Chapter 2 will start answering the research question How do incumbent fossil-fuel based utilities respond to the low-carbon energy transition in their business strategy? by developing a theoretical framework for the analysis of the two cases studies. We draw on transition theory, in particular the Multilevel Perspective (MLP), to cover in detail both the low-carbon energy transition and the response of the incumbent energy companies to this transition. With the help of the theoretical framework, we will analyse two companies in chapter 3. These companies are Royal Dutch Shell and Equinor ASA. Both have a strong position in the fossil-based eneregy system and therefore make them interesting cases to analyse their response to the ungoing energy transition in Europe. Finally, Chapter 4 will contain a disscussion and conclusions of the study.

2. Literature review

This section examines the literature relevant to the study. It follows the theoretical frameworks of scholarly works on the response of incumbent companies on the low-carbon energy approach. The rationale of the study is to ascertain the role played by incumbent companies in the low-carbon energy transition has significantly influenced the pace of the

transition. The literature reviewed will be obtained from journal articles and annual reports of incumbent companies.

2.1. Problem background

The use of fossil fuels has significantly risen since 1950 thus boosting economic and social growth, triggering multiple beneficial and harmful consequences. This drastic growth in the use of fossil-fuel has led to the consumption of a very substantial fraction (about one-third) of the reserves of the fossil fuels. They include a resource that accumulated above 0.5 gyr (billion years) of the history of the earth, petroleum liquids and coals being retrieved from the remnants of marine algae and land plants dumped and buried during the Phanezoic Eon era. Approximates for the number of fossil fuels consumed (Jones, 2009) and the remaining reserves (Shafiee & Topal, 2009) vary significantly, with a common tendency for the estimates of the reserves to rise as new resources get unearthed and developed, and as the technologies of extraction are continually improved.

Recoverable reserves also substantially depend on the prices in the market. However, consumption rates have begun to replace the rate of reserve replacement, and the human world is firmly depleting a finite and clearly non-renewable resource. For instance, (Shafiee & Topal, 2009) stated that if the universe went on consuming fossil fuels at the rates consumed in 2006, the reserves of gas, oil, and coal would only last a further 70, 40, and 200 years in that order. Moreover, arguments for reducing the use of fossil –fuels so that it may help in the control of green gas emissions (McGlade & Ekins, 2015), publicized as the carbon argument that is unburnable, will implant more constraint on the actual use of these reserves of fossil – fuel.

In that way, it is clear that fossil-fuel dependence is an unsustainable human activity. Economic advancement of modern human society has been propelled by fossil fuel energy. Present global fossil-fuel consumption is about 82% of the globe's energy supply, with manufacturing, transport, and agricultural sectors all being greatly reliant on these somewhat available and cheap energy sources. During the fossil-fuel age consumption, the mean

worldwide gross domestic product (GDP) per capita has increased from about 0.3% in 1820 to above 2% in 2005. From 1900 to 2005, the GDP rose by a 5 factor and the worldwide use of materials rose by an 8 factor (Krausmann, et al., 2009). Therefore, it is equally clear that today, fossil fuels are also basically important in the maintenance of economic growth and human populations. This dichotomy is often ignored in the discourse between those who advocate the urgent necessity to change the behavior of human beings and those who wish to sustain and maintain the current economic – social structures.

Consequently, this dichotomy will only get determined if there is universal acceptance and appreciation that the modern human society future relies on attaining a transition to low-carbon energy use. The utmost widely appreciated framework for attaining such a transition is the wedge model, where gradual phasing in of sources of renewable energy, adoption of measures of energy efficiency and applications of technologies aiming to reduce fossil fuel consumption, can enable a transition of energy to take place within the next 50 years. To attain this transition, societies will have to even up all the three sustainability components: atmosphere appreciation, getting social acceptance on new energy solutions, and the implementation of sustainable economic models of low-carbon energy resolutions (Ringrose, 2017).

Effects on the atmosphere

One of the main reasons behind the adoption of the low-carbon transition is the increased amount of CO_2 in the atmosphere. Anthropogenic global warming has been a topic of intense debate over the last decade. Natural and anthropogenic contributions to changes in the climate have also been a principal focus of publicized surveys over the last decade. It is now clear that the results of climatic changes that are man-induced are already evident and they are triggering the society to alter its behavior. However, the worldwide response to decreasing CO_2 emissions is still very low. The paper argues that the goal of attaining a widespread societal acceptance of the necessity for a transition to international low-carbon energy can be best attained through explaining the significance of protecting the atmosphere.

This can be without a doubt be done by recounting the history of greenhouse effect discovery (Ringrose, 2017).

The low-carbon transition

It follows from the above fossil fuels consumption and CO_2 emissions summary that the present situation of immense worldwide CO_2 emissions cannot be sustained. Using the Brundtland Commission on Environment and Development framework, the human society ought to attain transition to an array of sustainable energy resolutions. The Brundtland commission is formerly known as the World Commission on Environment and Development and its mission is uniting countries in the pursuit of development that is sustainable together. The commission was constituted after the United Nations realized that there was immense deterioration of natural resources and human environment and decided to rally countries to come together in pursuit of sustainable development.

There is an irrefutable consensus that this idea is the only ideal solution to the challenge of climate-energy and several efforts have been set in motion to trigger these actions. Most recently under the Paris Agreement terms made at the 21st session of the COP (Conference of the Parties) of the UNFCCC (United Nations Framework Convention on Climate Change) and the Parties to the Kyoto Protocol 11th session, in December 2015.

Nevertheless, in spite of this common consensus on the necessity for low-carbon energy solutions, actual progress in attaining the favored energy transition is slow and currently deficient for meeting the goals for emissions decrease, as stipulated in the Paris Agreement. The reasons for this limited progress are complicated and universally heterogeneous but they are rooted in the underlying sustainability principles. Without an alignment of the social and economic factors with the environmental factors, substantial progress is not likely to happen. A simple economic factor example is the extensive subsidies reduction for solar power in European nations after the economic recession that started in 2008 (Ringrose, 2017). This subsidies reduction has resulted in decreased rates of deployment, and it indicates the way

economic stimuli are required to ensure continued low-carbon energy solutions deployment. The sociological factors are depicted by both the reluctance of fossil-fuel-dependent nations to embrace new energy options (Geels, 2014) and by the psychological factors whereby humans have a tendency to resist change (incumbent companies and their clients), by stating one thing and later opting to do another. It could be a cognitive discrepancy between a desire to alter the underlying climate change causes and the reluctance to alter the behavior of energy-use which should be resolved (Stoknes, 2015). Acknowledging that low-carbon energy transition is not a smooth process in any political system and political system is a problem that is highly complex (Bale, Varga, & Foxon, 2015). This is why it is important to gain a clear picture of the response of the incumbent companies so that we can devise an appropriate solution to advance the transition.

2.2. Theoretical Framework

The study intends to contribute to the discussion on socio-technical shifts towards a low-carbon energy transition. A good number of the scholars in the discussion concentrate on radical innovations (Christensen, 1998) emergencies such as biofuels, turbines electric vehicles and solar panels. The existing regimes destabilization is assumed to occur along the way and has gotten far less analytical attention. The paper aims at addressing the existing gap in the debate on: How do incumbent fossil-fuel based utilities respond to the low-carbon energy transition in their business strategy, specifically concentrating on the incumbent industries destabilization. Therefore, it shifts the general concentration (on innovation and novelty) upside down and conducts an investigation into the way incumbents perceive transitions.

The theoretical significance lies in that a lot is known about lock-in and path dependence (Geels, 2004) but far less on the unlocking of systems and industries that are deeply entrenched. According to evolutionary economics, firms-in-an-industry gets locked inside technological regimes that have technological capabilities and knowledge and cognitive routines, sufficing the requirements of the market instead of optimizing the former (Geels, 2014b). The neo-institutional theory, on the other hand, proposes that lock-in also develops

from assumptions that are taken for granted, shared beliefs, and mindsets of the industry from regulatory institutions and from identities, norms, and missions that are shared. For instance, (Geels, 2004) proposed the 'industry regime' concept to capture these distinct core elements. The study draws from this concept in order to delineate the destabilization phenomenon.

Generally, stability refers to an entity's key attributes of continuity. For industries, stability can be perceived as the core industrial elements reproduction of the industry regime. Therefore, industry destabilization can be defined as the procedure of enervating reproduction of principle regime elements. To put it in another way, destabilization is the activity which the regime in existence loses the grip it has on firms-in-an-industry. This may take place either because the actors in the industry reorient themselves to a regime that is new or because of the replacement of incumbent actors by new entrants. As a procedure towards gaining a deeper understanding, (Turnheim & Geels, 2012) made a suggestion that destabilization is a process that is multi-dimensional. Hence, the aim of the study is to create and test a conceptual framework that clarifies further the causal mechanisms that underlie such processes.

2.2.1. The Multiple-Level Perspective

The theoretical framework that the study utilized is the MLP as discussed by (Geels, 2002). The MLP is a medium-range theory that conceptualizes comprehensive dynamic patterns in social-technical evolution (Geels 2011, p.26). The analytical model integrates concepts from science and technological studies (social networks, sense-making, innovation as a social process modeled by wider societal contexts). Further, evolutionary economics (regimes, trajectories, niches, path dependence, speciation, routines), neo-institutional theory (institutions and rules as deep structures where actors that are knowledgeable draw their actions, structure duality, e.g. structures are both actions outcomes and context, rules of the game that structure actions), and structuration theory (Geels, 2004).

The MLP conceptualizes transitions as non-linear procedures that are the result of interplays of development at three heuristic and analytical levels: micro-level, meso-level, and macro-level and the Although Kemp (1994) mentions niches and technological transitions

developing simultaneously along with society, Geels (2005) stipulates that the interconnection of regimes, landscapes, and niches is a hierarchy that is nested. To put it in another way, it is a top-down structure that emanates from the socio-technical landscape benefitting or impacting the regime and establishing windows of opportunity for the innovations in technology (e.g. niches).

The micro-level is created by technological niches, the bearing of radical innovations (variation). Since the radical novelties performance is initially slow, they appear in safeguarded spaces which protects them from the mainstream market selection. Hence, niches act as radical novelties incubation rooms. Niches are critical because they avail locations for the processes of learning. The processes of learning take place in several dimensions like user preference, technology, symbolic meaning, regulation, production systems, and infrastructure. Nitches also offer space to develop the social networks that support innovations like user-producer relationships and supply chains. These internal processes of niches will be better explained as the essay proceeds (Geels, 2004).

The meso-level encompasses the sociotechnical regimes. This idea develops upon the technological regimes concept but is broader in two respects. One, while (Nelson & Winter, 1982) view them as cognitive routines, (Rip & Kemp, 1998) extend the concept of the regime with the rules sociological category. A technological regime is the rule-set in complicated production process technologies, engineering practices, product skills, attributes, and procedures, ways of dealing with relevant persons and artifacts, methods of defining problems; all of which are embedded in infrastructures and institutions. Although the (Nelson & Winter, 1982) cognitive routines are embedded in engineers minds, these rules are more extensively embedded in the engineering practices, knowledge base, manufacturing processes, corporate governance structures, and product characteristics (Rip & Kemp, 1998). Two, social-technical regimes not only refer to the firms and engineers social group but also to other relevant social groups. Sociotechnical systems are actively established and maintained by a number of social groups. The regimes undertakings reproduce the linkages and elements found in the

sociotechnical systems because each of the social groups possesses its unique features and its selection environment, which makes their autonomy hold relative. The groups are also interdependent and relate with one another. Linkage and interdependence between sub-systems take place because social groups activities are harnessed and aligned to each other (Geels, 2004).

The macro-level is established by the socio-technical landscape that refers to extensive exogenous environmental aspects which has an impact on the sociotechnical development (e.g. environmental problems, globalization, cultural changes). The 'landscape' metaphor is utilized because of the literal meaning of associative hardness and to incorporate society's material aspects like the spatial and material arrangements of highways, cities, and electricity infrastructures. Landscapes surpass the direct actors' influence and cannot be altered at will (Geels, 2004).

The socio-logic of the three levels lies the fact that they offer distinct kinds of structuration and coordination of activities in practices that are local. The association between the three concepts can be comprehended as a hierarchy that is nested, this implies that regimes are embedded within landscapes while niches are embedded with regimes. The job in niches is frequently concentrated on existing regimes problems. Actors extend their support to niches with the hope that novelties with eventually be utilized in the regime or even in the replacement of the regime (Geels, 2004).

Embedded in the three levels of the MLP, a cluster of elements performing functions in the sociotechnical system, co-evolving and developing diverse characteristics are unveiled: infrastructures, technologies, industrial networks, market and user practices, sectoral policy, techno-scientific knowledge and cultural meanings (Geels, 2004). The fundamentals of the former are mimicked, maintained and renovated by actors which include researchers, engineers, civil society, consumers, policymakers and firms and industries (Geels, 2011), thus depicting a complex array of forces involved in sociotechnical transitions.

This process is complex, however, because the regime that exists is entrenched in a number of ways (e.g. organizationally, institutionally, culturally, economically). Novelties that are radical often contain a mismatch with the regime that is in existence and fail to easily break through. Nonetheless, niches are critical for the innovations of systems because they offer the change seeds. The principal point is that system transition or innovation comes about via the interplay between dynamics at various levels. There are multiple distinguishable phases in transitions (Geels, 2004).

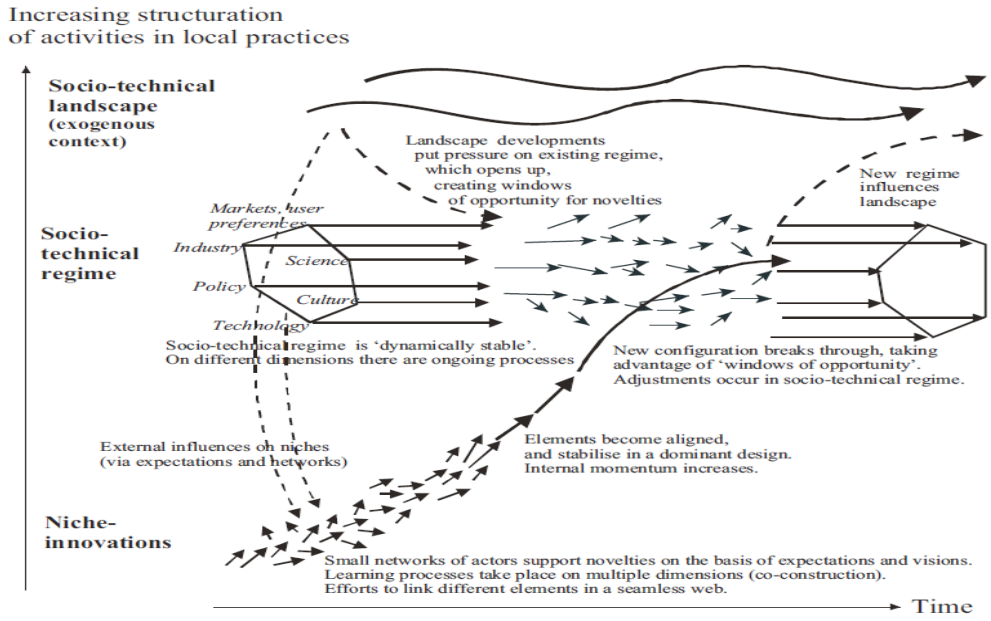

Fig. 2. MLP and dimensions interacting towards a transition (Geels, 2011)

In the initial phase, novelties unfold from niches in the existing landscape and regime developments context. There is still no dominant design and there are several technical kinds competing with one another. Actors extemporize, get involved in experiments to establish the most appropriate design, and try to discover the wants of the user. In phase number two, the novelty gets used in minute niches in the market, which provide technical specialization resources. Gradually, a community of dedicated producers and engineers arises, unanimously directing their actions to the advancement of the new technology. Gradually, engineers come up with new rules, and the new technology establishes a technical course of its own. The newly innovated technology slowly but steadily improves due to the processes of learning. As users

continually relate to the new technology and integrate them into the practices of their user, they slowly explore functionalities that are new. Phase two leads to the stabilization of rules like a design that is dominant, articulation of the preferences of the user (Geels, 2004, p.685).

Phase three is characterized by the new technology breakthrough, extensive diffusion, and competition with a regime that is established. On one hand, there are internal breakthrough drivers like performance/price improvements, spiraling up the returns to adoption, and actors that hold interests that impel for more technological expansion. On the other end, a breakthrough is dependent on circumstances that are external and windows of opportunity. The regime may fall under pressure from landscape-level changes, or the regime can have internal technical issues which may be impossible to meet with the technology available. The regime may also have negative externalities, stricter regulations or changing preferences of the user, which establish issues for the technology that exists. The principle posit of the MLP is that innovations system take place as linkages outcome between developments at several levels. As the current technology joins the mainstream markets, it joins a relationship that is competitive with the established regime (Geels, 2004, p.685).

In phase four, the new technology acts as a replacement for the old regime which is accompanied by wider dimensions changes of the sociotechnical regime. This frequently takes place in a fashion that is gradual because the development of a new sociotechnical regime requires time. Moreover, incumbents have a tendency of sticking to technologies that are old due to sunk investments and vested interests. The new regime can eventually have an impact on broader developments of the landscape. The principle aspect behind MLP is doing away with simple system innovations causality. There lacks a simple driver or cause. Instead, there are simultaneous multiple levels and dimensions processes. The innovation of systems arises when such processes link up and reinforce one another ('circular causality') (Geels, 2004, p.686).

The long MLP socio-technical transition process challenges

There are four major aspects that affect the socio-technical transition process which (Geels, Savacool, Schwanen, & Sorell, 2017) refer to as challenges. One, low-carbon transitions not only involve consumers and firms but also a broader range of actors like the media, civil society groups, local residents, political parties, city authorities, government ministries, and advisory bodies. These groups actions are driven by more than cost-benefit calculations. Their actions are also guided by conflicting values, entrenched beliefs, unequal resources, competing interests, and social relations that are complex (Geels et al. 2017, p.463).

Two, low-carbon transitions are not just about the new technologies market diffusion but also about alterations in cultural discourses, user practices, and wider political struggles. Therefore, transitions are not tame but non-linear, disruptive, and contested processes. The transitions are non-linear because the policies of climate change and innovations of low-carbon can endure accelerations, setbacks, or cycles of disappointment and hype (e.g. current climate policies in the European Union (EU)). The transitions are disruptive because they pose a threat to the business models and economic positions of a few of the most powerful and largest industries (e.g. cars, oil, agro-food, and electric utilities) which are likely to safeguard their vested interests. The transitions are contested because actors fail to come to a consensus about the distinct low-carbon solutions desirability and often their implementation is resisted (such as carbon capture, onshore wind turbines, and storage).

Three, low-carbon transitions demand negotiations that are complex and trade-offs between multiple constraints and objectives including equity, cost-effectiveness, political feasibility, social acceptance (legitimacy), flexibility, and resilience. The long-term and uncertain advantages of carbon mitigation lack salience and ought to be aligned with several other objectives in order to obtain the support of the stakeholder.

Four, low-carbon transitions are purposive or goal-oriented in the sense of dealing with the challenge of climate change. This makes the current transitions differ from historical transitions which are to a large extent emergent with the business people exploiting the commercial opportunities that the new technology provides. Since protection of the climate is

for the good of the public, private actors (e.g. consumers, firms) have construed incentives to address it owing to the problems of the free-rider and the dilemmas of a prisoner. A public good is a good that is found freely in the community and people do not have to contribute money for its production making the consumers of the good free riders (members of the public). However, when a public bad occurs and the public has to contribute to making the situation better (such as. reducing air pollution) then a prisoner dilemma occurs. One individual may accept to spend money while the other may not but the choice of one has an impact on the latter. This means that public policy plays a core role by altering the conditions of the economic frame (through subsidies, taxes, standards, and regulations) and offering support to the deployment and emergence of low-carbon innovations.

Nevertheless, substantial changes in policy involve public debate and political struggles because whatever is implemented via the state, it will rely on generating extensive political support from citizens within the democratic freedoms and rights context. The above considerations act as a reinforcement to the point that transitions to low-carbon entail relations between several societal groups (Geels et al. 2017, p.464).

	Endogenous Momentum of Niche	Regime Tensions
Techno-economic	Performance/price improvements due to Research and development (R & D), scale economies, learning by doing, network externalities, and complementary technologies	Infrastructure disruption, technical failures, and accumulating negative externalities (like CO_2 emissions)

Business	Incumbents from other sectors or new entrants have a higher likelihood of driving radical innovation as compared to traditional incumbents. Their success may result in innovation competition when other firms follow a first mover.	Incumbent industries economic difficulties, confidence loss in existing technologies and models of business, re-orientation towards alternatives
Social	Increasing support coalitions and constituencies enhance available finance, skills, and political clout	Fracturing and disagreement of social networks, key social groups defection from the regime
Political	Advocacy groups lobby for changes in policy so that the new policies can support the niche innovation like supportive regulations and subsidies	Incumbent industries eroding political influence, decreasing political support, the introduction of disruptive policies, removal of supportive policies
Cultural	Positive visions and discourses attract attention, socio-political legitimacy increase, and develop cultural enthusiasm	Negative cultural discourses lower the legitimacy of the present regimes (e.g. climate and coal change, air quality, and diesel cars)

Table 2. Regime tensions and Niche Momentum drivers (Geels et al., 2017)

2.2.2. Institutional theory

The low-carbon energy transition is a type of socio-technical transition and therefore entails profound modifications in institutions that govern the society. The energy sector can be viewed as a kind of socio-technical regime that comprises of several institutions that develop around a specific set of technologies and offer support to the advancement and utilization of these technologies. The term 'institutions' in a number of socio-technical regimes literature has been loosely defined as the informal and formal rules within a society together with relevant organizations that embody some of these rules. Besides policies, markets, regulations, and

laws, a socio-technical regime also incorporates the values, beliefs, cognitive routines, and expectations of the various actors that include civil servants, politicians, engineers, company managers, scientists, and civil society organizations (Speed, 2015). Therefore, the institutional theory provides an analytical framework that solely concentrates on the socio-technical regime an aspect that is provided in the MLP. Hence, instead of focusing on the response of the incumbents' on the socio-technical regimes, it would be more valuable to conduct a more holistic analysis.

2.2.3. Transitional Theory

Transitions theory has been advanced as a framework within which one can gain an understanding of the processes under which major social and technological changes occur within societies. The literature on the perspective has advanced a number of differentiated but extremely complementary descriptive concepts and models that are proposed and refined subsequently largely on the basis of reference that is detailed to case studies that are historical. The principal contribution of the literature is emphasizing on the drivers' multiplicity that is involved when major technical and social transitions take place, moving away from a linear 'technology push' perspective, to a 'multi-level perspective' (MLP). It also lays emphasis on the complexity that exists with interactions between institutions, social actors, and technologies; the literature has curved out the concept of the 'socio-technical regime' (Hughes, 2014).

(Geels and Schot, 2007) argued that the MLP does away with causality is linear. There is not a simple driver or cause in transitions. In its place, there is co-evolution between and within the levels, i.e. processes at multiple levels and dimensions simultaneously. Transitions occur when these processes join and reinforce one another. Therefore, transition especially the low-carbon transition cannot be considered from one aspect only. Hence, to understand the factors that underlie the response of the incumbents, it would be important to undertake a holistic analysis and this is what MLP offers.

2.3. Patterns in the innovations of systems

Sociotechnical systems are multiple and are made up of linkages between multiple elements. Patterns can be derived by making several cross-sections, concentrating on relationships between two or several elements.

2.3.1 System innovations routes

Based on the interaction between the three MLP levels, distinct routes can be differentiated in the innovations of systems: wide transformation and technological substitution

a. The route of Technological substitution

In the route of technological substitution, the sociotechnical regime in existence is at the beginning relatively stable, denoted by an increase in developments. However, in the niches, radical innovations emerge and they are relatively concealed from the regime level actors'. At the niche level, the novelty is slowly and continuously enhanced. The novelty breakthrough in the mainstream markets may take place when the novelty acquires an internal momentum that is adequate and when developments at the landscape put pressure on the regime in existence. The long-smoldering dynamic under the surface which gets followed by a breakthrough that is sudden may be defined metaphorically as 'peat moor fire.' Since novelties are created and advanced below the surface, regime actors that are already established may be taken unawares when the novelties get a breakthrough in the mainstream markets. This may result in the destruction that is creative and the downfall of firms that are already established. The breakthrough acts as a trigger to all types of transformations and adaptations in the regime resulting in a fermentation era. Therefore, this route has a character of technology push (Geels, 2005).

An example of the technological substitution pattern of system innovations is the transition from propeller-piston engine craft to turbojets in civil aviation. In the mid-1930s when the turbojets emerged, the regime of the piston engine-propeller aircraft was stable. Although there existed a few minor issues (high-speed and altitude challenges), the community of aviation was sure that the propellers and piston engines would solve them. However, since the

regime in existence was stable, the pioneers of the jet engine had a very difficult time in cultivating interest and lobbying for funds within the aeronautics community. World War II landscape development altered the environment selection and created a certain niche under which the turbojet would have to be shaped; interceptor fighters. By the end of the war, the performance of the jets resulted in a change in the aeronautic community perception and a bandwagon effect. Once the war was over, jet engines saw more development in the domain of the military (Christensen, 1998).

At the same time, in the civil aviation domain, the piston engine was still supreme. It was only in the early 1950s that the jet engines were seriously embraced by civil aviation. With the jumbo jet introduction, a new functionality presented in the aviation industry altered flying, to being an exclusive businessmen luxury item to a transport of the masses feature. One of its wider impacts on the society was in the immense tourism expansion globally. In civil aviation, the jetliners introduction led to a number of sociotechnical regime adaptations. The aircraft which was larger required runways that were longer, pilots had to acquire new skills, procedures for maintenance got adapted, there was lowering of tariffs, and airline companies had to look for new user groups, and there had to be adaptations made in regards to control of air traffic (computers and radar) (Geels, 2005).

b. Wider route of transformation

In the route of transformation, the regime ends up losing its stability and opens up in the initial phase since there are landscape changes and problems that are persistent. Concurrent changes take place on multiple regime dimensions like user preference, policy, infrastructure, technology, and culture. The existing regime loosening up encourages experimentation by actors on other options in technology. There is an extended experimentation period and maneuvering that is strategic. Such a heating up period is followed by a cooling down period that is reducing the technical options available. A specific technical option may come to be viewed as global and it ends up pushing out of the market all the other options as it gains supremacy. This is eventually complemented by the development of a

sociotechnical regime that is new. The cycles that occur at the regime level relay a significant flux, uncertainty, and multiple technologies interactions (Geels, 2005).

A good example of the wider route transformation is the transition from carriages that were drawn by horses to automobiles in the United States. In the late 19th century, the urban horse-based transportation was spiraling up prior to the rise of automobiles. The regime of horse-based transportation was engulfed by a number of problems: pollution from the droppings of horses, congestion, and high cost. These problems were worsened by developments of the landscape. Immigration bred slums where diseases and filth accumulated. The increasing concern about the health of members of the public at the end of the 19th century resulted in debates about the excrements of horses on streets, sub-urbanization and urbanizations lead to longer distances of travel and bigger cities that were difficult to meet with transportation that was horse-based. Between the 1880s and 1890s, new options for transport emerged like an electric tram, steam tram, bicycle, and electric automobiles. A few of these innovations triggered wider alterations in the sociotechnical regime (Geels, 2005).

2.3.2. The fit-stretch pattern in the function and form co-evolution

The second pattern in the innovation of systems is that the co-evolution between technical function (social) and form follows a pattern that is fit-stretch. In the early transition phase, both the function and form of technologies that are new have a fit that is close to the regime in existence. The new technologies function is frequently interpreted with categories linked with the regime in existence. Slowly but continually, technical developments result in technical forms that are novel, triggering a robust experience of the users', causing functionalities that are new (stretch pattern). The fit-stretch pattern is adequately illustrated using the automobile transition example. The early automobile developers viewed the 'horseless carriage' (fit) technology. This horseless carriage technology was also depicted in the form of early automobiles, for instance in the 1880s and 1890s were tricycles and carriages in existence fitted with an additional source of power (electric motor and battery, steam engine, and gasoline engine) (Geels, 2005).

In the 1890s and within the touring and racing context, gasoline cars came up with their own characteristic form. In touring and racing, the new cars functionalities were celebrated: flexible and private transport at a speed that was higher than usual. On the other hand, the function and form of electric cars stayed unclear since their manufacturers' interest lied in making machines that were more beautiful as compared to the articulation of the market. However, it is clear that the diffusion of cars was accompanied by the city's wider transformations (Geels, 2005).

2.3.3. Breakthrough patterns from niche to regime level

The significant step in the innovation of systems occurs when radical innovations manage to break out from the niches and join the mainstream markets where they compete with the technologies in existence and trigger changes that are wider in the sociotechnical regime. The MLP proposes that wide diffusion and breakthrough relies on linkages with the processes that are ongoing at the landscape and regime level. However, the MLP equally affirms that internal drivers and sequential performance/price improvement are an economic drivers that are well-known, but there are also social and sociotechnical drivers, an issue that is not addressed adequately in the literature on innovation. This section contributes to this point by making a distinction between three types of patterns in the niche to regime level breakthrough: technologies co-evolution, niche accumulation, and patterns related to the actors (Geels, 2005).

i. The niche accumulation pattern

The advance from niche to regime level does not take place at once but slowly, surely and subsequent steps. As a technology that is new, it penetrates and branches into distinct domains of application. According to Levinthal (1998) and Schot (1998), it is argued that the radical innovations diffusions follow the niche accumulation trajectories. A novelty is initially developed in a specific technological niche or a market niche that is specialized. Further diffusion takes place as innovations that are radical are utilized in following market niches or application domains, i.e. niches accumulation.

ii. Technologies Co-evolution

A significant pattern in innovations breakthrough from the niche level is created by linkages between several technologies. A number of authors argue on the significance of alignment, interlocking, and positive feedback between several technologies in momentum generation. Inter-relatedness, compatibility, and co-development are emerging as themes that are important in modern research diffusion. Therefore, although technologies co-evolution is a general pattern in the innovation of systems, distinct kinds of interactions that are specific between technologies can get distinguished (Geels, 2005).

A form of interlocking that is well-known is technologies complementarities. When the new technology functionality gets hampered by certain problems and constraints, linking with another technology may help in solving the problems and enhance diffusion and performance. Further, in system innovations, those interactions that are often important are hybridization and technical add-on. Therefore, new and old technologies do not have to always compete from initiation; they can form a kind of symbiosis. Another kind of interaction is sequential accumulation whereby the initial new technology behaves as a catalyst in the sense of opening up a regime in existence which then provides chances for a later technology to link up. For instance, the role played by the bicycle in the transition from horse carriages to automobiles. The bicycle resulted in the process of change in the sociotechnical regime under which the automobile got built later. The last type of interaction in multi-technology is whereby technical trajectories in competition borrow elements that are technical from each other (Geels, 2005).

iii. Patterns' that are actor-related

The MLP can be distinguished as a process approach. The explanations of the new regimes emergence are that developments that are multiple eventually join and reinforce each other. Despite the fact that processes at distinct levels can come together and create opportunity windows for the change of a regime, the actual linkages often need to be initiated by actors. Therefore, the MLP deserves to get filled with actor-related patterns that are more detailed. The more the engagement and support of actors, the higher the chances of the

bandwagon moving and stimulate breakthrough and diffusion. Therefore, actors' engagement makes diffusion a process that is non-linear with slowing down and accelerations. This means that patterns that are actor-related are significant building blocks in the understanding of slowing down and accelerations in breakthrough and diffusion (Geels, 2005).

3. Results & Analysis

The aim of the study is to illuminate the multiple economic, political, social, and cultural processes at work, in addition to the interactions between the three levels discussed above. The concentration of the transition toward RETs (renewable energy technologies) that took place between the period of 1990 – 2018, which laid foundations to the official policy for transition (*Climate Change Act*) that was adopted in November 2008 (Fabra et. al 2015, p. 87). Although the paper concentrates on the incumbent companies energy generation (Royal Dutch Shell and Equinor, further transition development may also require complementary innovations like energy storage (like flywheels, batteries, pumped hydro, and compressed air). Moreover, network expansion (to enhance capacity, connect renewables that are remote, and link to systems in the neighborhood), demand response (like smart meters, feed-in tariffs, and intelligent loads), and new market arrangements and business models (like capacity markets to enhance the security of the system).

3.1 Royal Dutch Shell

Company's profile

Royal Dutch Shell is a global oil and gas company with more than 100 years of existence. Business efforts are allocated in upstream (e.g. exploration and extraction) and downstream (e.g. chemicals, trading and transport of chemicals) processes without disregarding other areas of possible commercial value such as new energies (e.g. biofuels, hydrogen) and low-carbon sources (e.g. solar, wind) (Shell Global, 2018). With operations in more than 70 countries around the world, 3.7 million of barrels of oil equivalent extracted per day and 92,000 employees around the globe, Shell Global, one of the six "supermajors", profiles itself as one of the most powerful and dominant private energy companies in the world.

Results

Shell Global recognizes the drift of climate change, along with the role played by energy in enabling people to attain and maintain a good life quality. A principal role for society – and for Shell- lies in finding ways to offer much more energy with reduced carbon dioxide. Wherever we live, our lives are dependent of energy but for us to prosper while trying to resolve climate change, society ought to offer much more energy for an increasing global population while looking for methods to emit reduced CO_2. Shell has for a long time recognized the challenge in climate and the role that energy plays in enhancing a quality of life that is decent. The corporation believes that although developments in technology will emerge, effective cultural and policy change is critical in driving low-carbon business and consumer opportunities and choices. The low-carbon transition is best underpinned by effective government-led mechanisms of carbon "pricing" (Shell Global, 2018).

Shell welcomes government efforts to cooperatively achieve the international climate agreement and support climate goals that are long-term and balance the pressures of the environment with opportunities for development. The organization particularly supported the United Nations Paris Agreement on climate change which was adopted on 4th November 2016. The agreement seeks to reduce global warming to well below 2^0C through managing environmental and climate pressures while at the same time ensuring development in the economy. Currently, Shell may still be primarily an oil and gas company but the company has a long innovation tradition. They are aware that long-term success depends on the company's ability to anticipate the kinds of fuels and energy that people will require in the future and stable environmentally relevant and commercially competitive (Shell Global, 2018).

Dynamics of Royal Dutch Shell low carbon regime transition

Changing goals and perceptions. Last March 2017, Royal Dutch Shell stated that they were selling a huge portion of its stake in the oil sands of Canada, an extensive project that has

in the past extracted millions of barrels of gooey, sticky hydrocarbons from the ground in a procedure that looks like mining more as compared to drilling. The oil and gas giant made the announcement that it was its assets in oil-sands, for $7.25 billion, so that it would be able to double down on businesses that they have a worldwide scale and a competitive advantage. What the company failed to reveal was the in-depth reason behind the divestiture. Months of deliberations at Shell headquarters (The Hague, Netherlands) behind closed doors resulted in the top brass at the globe's largest non-state-owned oil company through sales to make the conclusion that the energy industry was significantly changing in a way that was likely to convert the profitable oil-sands into a liability (Ball, 2018).

Internal studies by Shell's group of analysts referred to as "scenarios" team, had reached a conclusion that international oil demand might spiral up in 2030. The demand for oil will spiral up between the late 2020s and the late 2040s due to an epic shift in the energy industry that is underway: a move from petroleum to electricity. Expediting the peak was a barrage of increasingly competitive fossil-fuel-free options, from wind and solar power to electric cars whose prices were falling at a faster rate than the executives of Shell had anticipated. When the peak of the oil-demand came, Shell was convinced that the prices of petroleum may start a slow slide falling too low to cover the oil-sands production costs. The scenario would not be simply another oil-price cycle, a well-known roller coaster where every down is followed by a rise. Rather, it would be the beginning of a decade-long decline in the age of oil itself – an uncharted world where oil prices might forever remain low. If such a scenario were to play out then the company would sink deep into financial misery (Ball, 2018).

Propelling the shift from petroleum to electricity are newly affordable options like wind power, solar power, and batteries. In addition to the alternatives, are the ever tougher constraints by the government on greenhouse – gas emissions: China, Europe, a large portion of the rest of the third world countries are on the move to curb carbon even as the United States President (Trump) pulls the U.S. from the accord of the Paris Climate (Ball, 2018).

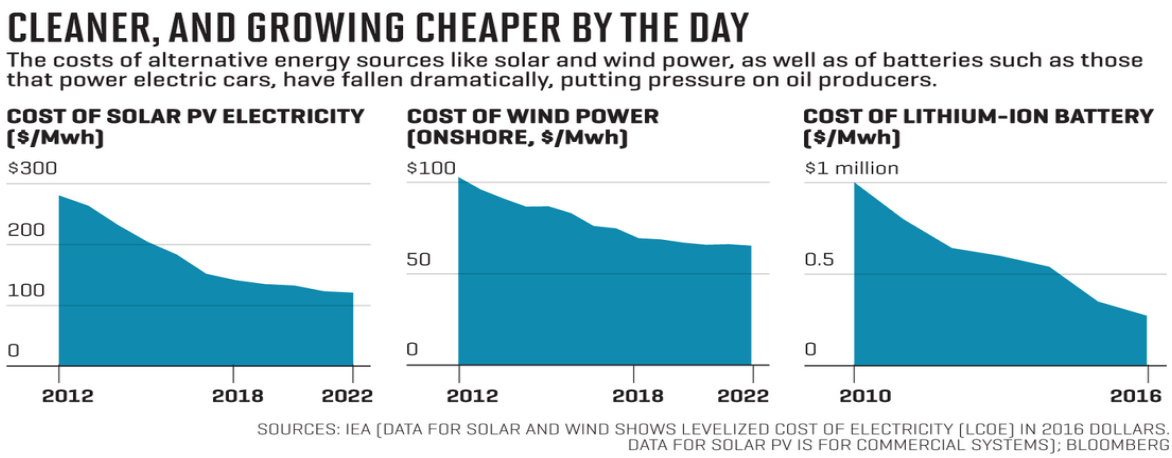

Fig. 4 The Cost of Alternative Energy Sources

If Shell did not prepare for this new socio-technical landscape, it may wind up saddled with mammoth stranded assets: buried oil and gas that the company's shareholders paid billions to unearth, but that, due to reducing demand, the corporation found itself not able to drill and sell. Shell's Chief Executive Officer (CEO), Ben van Beurden, vows that the company will not fall into such a predicament because they will not just sit there and wait but rather they will adapt. In the past, the corporation had a funnel of outcomes that it would saddle in, where an approach that was conservative would work but this is not the past. The company no longer knows where the future is headed. Hence, the company is making huge strategic bets. If the best work, the CEO will remake Shell for an era whereby petroleum will not be the principal lubricant of the international economy. The corporation will be transformed from Big Oil into Big Energy (Ball, 2018).

The initial move of the CEO is slashing the company's operating costs so that he is able to better position Shell that its competitors to profitably weigh down the tail of the Oil Age. Shell expects that the international demand for natural gases will continue increasing for a number of decades. However, the CEO is slimming down the company's portfolio of oil projects with the intention of maintaining only those powerful enough to yield good returns in a globe where the prices of oil average to no more than $40 per barrel, well below the mean price over the last decade (Ball, 2018).

Shell has been trading off projects worth billions of dollars including the oil sands that it is convinced will not be able to meet its current low-cost bar. It is remodeling its onshore shale-gas projects and deepwater oil platforms to make them simpler, a huge cultural change at a company that has for a long time prided itself more for its prowess in engineering as compared to economic discipline. Moreover, over the last two years, 12% of the company's workforce has been laid off, that is about 12,500 employees, many of these employees had joined the company happily with the tacit understanding that they will have secured a job for a lifetime however the current reality states otherwise with the job slashing far from over. (Ball, 2018).

The second gambit of the company is even harder. Ben van Beurden is propelling the company so that he can position it as a principal force – the initial ideal international player, he hopes – in the Power Age. He is propelling Shell, which attempted and was not successful in earlier forays of renewable-energy, into a deeper round of them, a facet of the wider push into electricity sale. Shell is establishing (in the North Sea) an offshore wind farm, it is part of consortia that is installing solar farms in California and Oman, and it has purchased one of Europe's largest electric-car-charging firms and a principle electricity provider in Britain (Ball, 2018).

So far, the moves the company is making are tiny in the Shell behemoth context. However, the company aspires to raise its annual spending by 2020 in what they refer to as "new energies" to range between $1 billion USD and $2 billion USD. This is a sum that, making the assumption that their plans get materialized would account for around 4% to 8% of the $25 billion USD that Shell approximated as its total spending in capital in 2017. The CEO vows that the investment in renewable energy will rise substantially over time as he propels the company to its endgame: vastly pumping more renewables through the international network that Shell uses in trade, production, and energy sale (Wetselaar, 2017).

Shell stated in the late November 2017 that it intends to reduce its energy products and energy operations carbon intensity by 20% by 2035 and about 50% by 2050. Those investors

that are concerned about the climate risk of the corporation had urged the company to take more action in mitigating and quantifying its exposure, though the company states that the move was already underway. The move by Shell is the CEO's bid to preserve the ability of the former to perform in the post-oil era in the same manner that it has always done: design and take advantage of energy markets to pick off absolute profit at each and every stage. The distinction lies in that in the future, Shell will be forced to operate its network on less dirty molecules and on more electrons that are clean (BlackRock, 2017). This is a case of how do actually develop a completely new industrial complex whereby electricity is at the core of doing things.

Direct Government Interventions. The UK government has been vehement in the low-carbon transition and then the actions of the government have directly affected the Shell energy transition. In 2006, the government publicized *The Energy Challenge*. The white paper meeting on the energy challenge that followed was aimed at reducing emissions of CO_2 by 60% (all the reductions are relative to the 1990 levels by 2050) while maintaining the supply security, making sure that every home is adequately and affordably heated, and enhancing competitive but sustainable markets. The government began with the *Climate Change Bill* legislative process which was later adopted in November 2008 as the *Climate Change Act*. It established a renewable electricity target of a 10% share by 2010 but a 20% share in 2020. The act offers a legal framework for making sure that the Government meets its commitments in handling the change in climate (Fabra et. al 2015, p.88).

The government also set up the Committee on Climate Change (CCC). It is an independent body responsible for monitoring and advising on the carbon commitment of the government (European Commission, 2017). The Act established tougher renewables and decarbonization targets than the White Paper of 2007. The Act demands that emissions get reduced by about 80% by 2050 which is different from the levels of 1990 and that the Government commits to a 5-year carbon budgets series. The government later publicized The *UK Low Carbon Transition Plan* White Paper in 2009, defining it as the initial comprehensive

low carbon transition plan to 2020 of the UK. The plan will deliver cuts in the emission of 18% on the levels in 2008 by 2020, acquiring 40% of the country's electricity from low sources of carbon by 2020 with several policies. One, 30% of the country's electricity should generate from renewables by 2020 (Carlin et al., 2017). Two, finance about four demonstrations for capturing and storing CO_2 from coal power stations. Three, facilitate the construction of new nuclear power stations (Fabra et al. 2015, p.89).

Major changes in networks, rules, and technology. In line with Shell's ambition to sell energy that is cleaner, the company is expanding to the supply of electricity for transport purposes. Shell acquired NewMotion, a Netherlands-based and Europe's largest electric vehicle networks in 2017. NewMotion operates over 30,000 private electric charge points in offices and homes in The Netherlands, France, Germany, and the UK. It also offers 100,000 charge cards that are registered to allow user access to more than 50,000 charge points that are public across 25 countries in Europe. Shell is also introducing electric points of charging on UK forecourts and in 2017 it had 10. The company is also providing their customers with smart-charging technology that aids in the integration of electric vehicles into the power grids at moments when the entire demand is at its minimum (Shell 2017, p.33).

Today, biofuels constitute about 3% of the international transport fuels and the company expects that their share will increase as the world's transitions to low-carbon energy. Shell is one of the globe's largest biofuels producers which is made from sugarcane via a joint venture with Raizen a Brazilian company owning a 50% of the latter. Ethanol can emit 70% less CO_2 as compared to gasoline. Shell is also among the largest distributors and blenders of biofuels globally (Shell 2017, p.34). The company purchases biofuels which are blended into their fuels to comply with the country's mandates and regulations.

Dynamics of the Socio-technical Landscape

The scramble by Shell underscores pressures that are unprecedented across the oil industry. The changes in the energy market are occurring more rapidly that the company would have imagined, and the changes are because the competitive fuels costs are reducing. If a

company is faced with eventually replacing its core product of oil and gas production with something completely new, it's a gigantic task, and it may consume a lot of time. A company only has to position itself in a position where it is able to make the changes when it can and without disposing of too much value for the shareholder (Ball, 2018).

Other incumbent oil companies are attempting to make the transition but are finding it difficult. The French oil firm (Total) spent $1.37 billion in purchasing a 60% stake in SunPower in 2011. SunPower is a major California-based solar-panel maker. Total also spent another $1.1 billion in the purchase of Saft in 2016. Saft is a battery maker. The stock price of SunPower has fallen by above 50% of the deal price, hugely due to the intensifying solar sector competition, and the battery business is also growing a little bit cutthroat. Norway's Equinor is making investments in offshore wind farms, exploiting its building expertise offshore oil rigs, and making investments in research into storing and recapturing carbon dioxide (Ball, 2018).

The energy alternatives surge is affecting industries that are already established all over the global economy. Major producers of electricity have been forced into restructuring in a bid to manage loses as significant numbers of customers put up solar panels on their rooftops and buy reduced grid power. Moreover, leading automakers that recently laughed off electric cars as dream pipes are currently scrambling to boost their production. Most of the fossil-fuels companies failed to see the revolution coming and it is the responsibility of the Shell scenarios team to ensure that the organization does not fall prey and it survives the current landscape (Ball, 2018).

Moreover, the demise of the Organization of the Petroleum Exporting Countries (OPEC) has severally been touted as unstoppable and on the way, OPEC has a very substantial voice and is a very important actor in the oil and gas industry. However, its volumetric share is lesser than what it used to be several decades ago but they have a critical role in the stabilization of the oil markets. In a way, stable oil markets are good for business but without the organization then there is a great chance of prices skyrocketing without warning (Mufson, 2017).

3.2 Equinor

Company's profile

Formerly known as Statoil, Equinor is a Norwegian state-owned energy company with operations since 1972. Active in more than 30 countries, 20 000 employees and a portfolio ranging from up and downstream processes, transportation, offshore windfarms to CCS, With a production of 2.08 barrels of oil equivalent, Equinor propels itself as a fresh, energetic and visionary company within the oil, gas and alternative energy business (Equinor ASA, 2018).

Results

Equinor acknowledges the ambition to reduce the average rise in global temperature rose to lower that 2^0C compared to the previous 1990 industrial levels. The transition will demand a low-carbon transition over the next number of decades and involves substantial action from each and every aspect of the society including consumers, companies, and governments. The Paris Agreement on climate change negotiated in December 2015, offers the prospect of enhanced support in policy across the globe for increasing the low-carbon solutions shift. As a major oil and gas provider, Equinor recognizes that they have a critical role to play in making the transition materialize (Statoil, 2015).

Dynamics of Equinor low carbon regime transition

Changing goals and perceptions. The company has four critical facets in response to climate change: climate policy, climate risk and portfolio resilience, management of emissions, and low-carbon technologies. In climate policy, the company has made it its duty to support the development of viable regulatory frameworks and policies to increase a transition that is orderly to a low-carbon transition. In climate risk and portfolio, Equinor wants to ensure that their business model evolves in tandem with the transition in energy which will allow them to embrace low-carbon solutions as chances instead of a threat while keeping an eye on the market, regulatory, physical, and technological impact of the climate change. The strategy by Equinor defines the company's transition from a focused oil and gas company to a broad major in energy (Statoil, 2015).

The company is in the process of transition and the changing pace is faster than it was in the past. The change has been necessary and not temporary. The international energy markets are encountering significant changes and Equinor views it as an opportunity. The company aims at aiding in the provision of significant changes that the globe needs: more oil and gas production that is climate-efficient and strong development in renewable energy that is profitable. Equinor is no longer looking for heavy oil or even considering joining oil sands resources. The company is focused on finding and producing new resources that have ever-lower emissions of carbon (Equinor ASA, 2018).

Moreover, Equinor is focused on developing renewables as a profitable and substantial part of their business. The process is well underway. The company started with offshore wind and the projects have been offering returns that are reasonable to the company and the company is maintaining the track so that it is able to provide renewable power to more than a million European households. Moreover, the company recently made their initial investment in solar energy with the Brazilian company – Statec Solar. The company's ambition is to invest nearly 100 billion Norwegian Krone (NOK) (approximately 12.44 billion USD) in new renewable energy by 2030. The company has not reduced the willingness to invest in renewable energy, the challenge is getting profitable and good industrial projects (Equinor ASA, 2018).

The changing socio-technical landscape with the boom in electric cars will increase the demand for oil from petrochemical as well as other industries and the globe will continue depending on the products and services made from oil and gas. Therefore, the company cannot completely sideline oil and gas production. However, the production will be limited to what the world requires (Equinor ASA, 2018). Additionally, the company aims to decrease the intensity of carbon in their upstream oil and gas portfolio to 8kg CO_2 per barrel by 2030. The company also expects that by 2020, 25% of its research funds will be focused on new energy efficiency and energy solutions (Equinor, 2018).

Recently, the company announced its intention to rebrand with the energy transition. The company already changed their name from Statoil to Equinor which depicts its strategy as

an energy company that concentrates on several energy sources as compared to a super major in oil and gas (Merchant, 2018). The name Equinor depicts the company's values and heritage and what the company aims to become in the future. Its future target is becoming a diverse energy company with clean energy and fossil-fuels ambitions (Dagenborg & Adomaitis, 2018). The company intends to direct 15 to 20% of its total investments to low-carbon solutions and renewables that are profitable. The Norwegian government that owns two-thirds of the shares of the company has approved the transition and hence it will take effect starting May 2018 (Petroff, 2018).

Direct Government Interventions. The government of Norway has made use of policies to influence the low-carbon transition but the most significant is the Carbon tax that is levied to the government for all oil and gas producers in the country. Norwegian carbon tax is the highest in the globe and it has assisted in ensuring that the carbon emissions by oil and gas producers are managed to a level that is not harmful to the climate (Sverdrup, 2015). Moreover, the government expects a transparency report on carbon emissions for the products and services of oil and gas companies.

Major changes in networks, rules, and technology. Currently, Equinor concentrates on offshore wind, exploiting their decades of offshore experience to create large-scale wind farms and innovate floating platform technology. The company has so far invested about 2.3 billion USD in assets of wind energy to become a section of a fast-evolving offshore wind industry. The company expects the expansion of their offshore wind portfolio over the next couple of years, costs are reducing and efficiency has dramatically spiraled up via the use of wind turbines that are larger, of better design, and operations that are streamlined. The company is also exploring new chances in geothermal and solar power where its innovations capabilities can be utilized to establish the value that is long-term. Moreover, the company is investing in low carbon technologies like carbon capture, storage is critical to decreasing overall emissions from the gas and oil sectors (Statoil, 2017).

Dynamics of the Socio-technical Landscape

An increasing number of individuals are moving from petroleum cars to electric ones especially in Norway but so is the transition in other countries. The transition is positive though it makes it more significant to avoid coal in the production of electricity. Private electrification may take place fast although it may take a while to find options for the increasing road transport, air, and shipping sectors (Equinor ASA, 2018).

3.3 MLP Analysis

The above brief case studies demonstrate a number of socio-technical perspective themes. First, the Shell and Equinor energy transition was clearly a multi-dimensional procedure, with complicated interactions between business, techno-economic, political, social, and cultural dimensions whose relative significance changes over a period of time. Secondly, the transition can be successfully analyzed as struggles between existing regimes and niche innovations. Exogenous landscape pressures (political policies, media, and electrification of cars) played critical roles in the regimes destabilization, creating windows of chances for niche innovations diffusions. The niche innovations successes also relied on endogenous drivers like supportive policies, new business creation, performance/price improvements, broad advocacy coalitions, and positive discourses. Third, the transition was attributed to surprises and it was non-linear. For instance, the car electrification boom was not expected and the expansion of intermittent renewable energies acted as a disruption to the normal fossil-fuel energy markets. The changes implied that the process of policymaking ought to be adaptive and flexible. Fourth, the transition for both companies was characterized by political and social struggles. There are policies supporting the renewables while civic groups and the media undermining the transition efforts of the two companies.

Validity of analysis

The use of MLP in the two incumbent companies in Europe has been very effective in determining the four important factors that characterize the transition to the low carbon regimen. The four factors in the transition, give a clear picture of how incumbent groups have

responded to the carbon transition and help us understand the reason behind the response of the incumbent groups. The analysis is valid because above all other aspects, it is not focused on one aspect only of the incumbent companies transition but rather multiple aspects that vary from cultural, political, social, and techno-economic. The analysis also provides us an in-depth understanding of exactly how incumbent companies are dealing with the transition to enable us to stop running into conclusions that the companies are making no effort because in real sense, most of them are refining their business strategy so they can adopt to the new business disposition.

4. Discussion & Conclusion

Discussion

The low-carbon energy transition is Europe is guided by the Climate Change Act that was adopted in 2008. The Act established tougher renewables and decarbonization targets that the White Paper of 2007. The Act demands that emissions get reduced by about 80% by 2050 which is different from the levels of 1990 and that the Government commits to a 5-year carbon budgets series. This means that the country has well embraced the transition and set up policies to guide the fossil-fuel companies in managing the CO_2 emissions in the country. However, the low-carbon transition has immensely affected the incumbent fossil fuel utilities (Shell and Equinor) by disrupting their energy markets. The prices of petroleum and oil are constantly falling reducing the companies' revenue margin.

Moreover, the government has developed policies to support renewables solutions expansion and their competition is lowering customer preference. Customers are opting for cheap and sustainable sources of energy. Additionally, the transition has surprising favored the

boom in electric vehicles which will eventually lower the consumption of petroleum. However, the oil and gas products and services are still going to be required only in much smaller quantities. The transition has also affected the popularity of such companies in the eyes of the media. For instance, Shell although they have put in place measures to advance their transition, they were faced with a lawsuit that they should hasten the move. The Friends of the Earth Netherlands hit the company with threatened legal action because as of today, the big oil has only invested 5% in sustainable energy and 95% in oil and gas (Watts, 2018). The legal suit will affect the net carbon emissions credibility of the company and may cost it its market share in the energy industry.

In response, Shell and Equinor decided to slightly alter their business strategy. The two companies decided to invest partially in the renewables while at the same time maintaining a significant share in fossil fuel sources because in reality what the companies would prefer is the government to stop disrupting their oil and gas business. Shell has invested in solar, biofuels, electric cars, wind power as a strategy to deal with the low-carbon transition while Equinor, on the other hand, has invested in wind, solar, and geothermal power. Moreover, it has changed its name from Statoil to Equinor.

Validity of the conclusions

Taking the results insights in tandem, suggests that over a period of time, dominant incumbents feel the pressure to change and exploit opportunities or identify incentives so that they are able to pursue alternative opportunities like emerging sectors. Those companies that lack resources will act more defensively with the aim of safeguarding their corporate interests and market positions. In this case, Shell and Statoil preferred to diversify (Steen & Weaver, 2017). However, incumbent companies' responses are also contingent on the scale and nature of external pressures (Geels, 2014b) as well as capabilities, resources, and managerial mindsets that exist in the company. Very few studies have addressed companies' transition to adjacent sectors (Erlinghagen & Markard, 2012; Karltorp & Sanden, 2012) although a number have argued that incumbent companies that diversify to other new sectors may play critical roles in

the transformation of the sector. Established companies like Shell and Equinor that diversify into related or adjacent sectors are likely to transfer significant knowledge and other assets which will result in not only technological variety expansion but also increased business networks, models, and strategies of innovation (Dolata, 2009; Erlinghagen & Markard, 2012).

The above statement is also acknowledged by (Geels and Schot, 2007) who suggested that incumbents like Equinor and Shell that choose to adopt niche innovations can aid in propelling them from the status of a niche to full market economy and hence contribute to the quicker implementation of new solutions. However, the diversification is not always easy as many of the incumbent companies end up making large losses while others are ridiculed by the media. For instance, Shell invested in solar panels making only to abandon the investment after drawing a conclusion that the company would not make margins that were decent. The company then invested in wind firms' development only to withdraw after concluded that wind was a waste because the mean wind farm delivered lesser margins as compared to deep-water oil. The company then zoomed into hydrogen only to put brakes after regulators determined that the company has intensely overbooked its oil reserves (Ball, 2018).

Conclusion

The objective of this study is to find out the low-carbon energy transition in Europe, the way incumbent fossil-fuels dominant companies respond to low-carbon transition and if the latter is affecting their business strategy. It is clear that a number of companies opt to diversify their business strategies in order to maintain their market share in the post-oil era. It is not possible to directly move from fossil fuels to renewables due to sunk long-term investments, vested interests and third party industries involved from incumbent companies, therefore the transition demands time, stronger social and political pressure, specific actions and multi-stakeholder involvement. Currently, incumbent companies are allocating resources expecting to catch the "wave" by developing and executing low-carbon technologies however, the former

are minuscule compared to the ones assigned to their core and mature activities. Moreover, incumbent companies' forecasts do not see any reduction in fossil fuels within the next decade, jeopardizing sustainable environmental targets. A radical sociotechnical regime change is unlikely to happen any time soon, but the former thought should not stop all the stakeholders involved in the low-carbon transition race, to keep striving for the goal set in the Paris Agreement; transitions do not happen suddenly but efforts have to start now, be consistent and not just a fashion to add legitimacy to their current activities. Finally, more research is needed to understand the success rate of the diversification of incumbent fossil fuel-based dominant companies in the energy market.

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