THE STRATEGIC ROLE OF SMART CONSUMERS IN RESHAPING ENERGY INTO SMART DECENTRALISED SYSTEMS

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ABSTRACT

Traditional centralised energy industry is facing a deteriorating profitability, rising operational and maintenance cost while environmental concerns and dissatisfied customers are hitting record high. Furthermore, smart technologies shifting control to the smart and demanding consumers. The carbon-free decentralised energy generation is currently categorised as an "innovation" and is associated with diminishing risks as new technical capabilities acquired with smart technologies i.e. smart meters, smart appliances and etc. The physical world of everyday objects (things) are gaining communication channels on the global cloud network (internet), sharing information (big data) with each other and with people forming a novel technology known as Internet of Things. With these smart digital based technologies, business models of the most founded and traditional industries are under substantial force for change that is capable of disrupting its strategies and in extreme circumstances restructuring it completely. This may include decentralising traditionally centralised industries bringing about a wave of new services. The purpose of this research is to explore the strategic role of smart consumer in transforming the traditional energy system to a decentralised one through the technological innovation; Internet of Things.

***Keywords**: Internet of Things, Strategy, Smart energy, Smart meters, Smart consumer, Decentralised energy, Centralised energy.*

INTRODUCTION

The climate change is undoubtedly a critical and a high-priority global threat and it demands a serious response. The scientific facts behind climate change are strongly associated with the emission of greenhouse gases with carbon dioxide (CO_2) being in the lead. However, the rate of CO_2emission to the atmosphere was exponentially increased with James Watt patenting his innovation for an efficient steam engine in 1769. Prior to the industrial revolution, the level of concertation was stable at 280 parts per million for carbon dioxide equivalent (ppm CO_2e) while present level is 430 ppm CO_2e and is anticipated to reach 550ppm CO_2e by 2035. Hansen et. al. (1981) model estimated the global temperature rise to exceed 2°C. According to the Stern Review (2006), there is 77% chance that this estimate may well occur at the level of 550ppm CO_2e. The associated economic cost of 2°C rise could be equivalent to a loss of up to 3% of global GDP. While, using business-as-usual scenario, the global warming could be in the range of 5 – 6 °C with devastating loss of productivity of 5 – 10% of global GDP (Friends of the Earth, 2010).

The route to decarbonise our ecosystem is extensively debated and it is more likely that no one technology will form the magical solution (Al gore, 2016). Nevertheless, with over 50% of the world population lives in urban areas and as the world continues to urbanise, with estimated increase of 66% by 2050, sustainable development challenges will be extra directed towards cities (UN, 2014). This puts extraordinary pressure on energy industry to meet the vast increase in demand with its inefficient and wasteful technologies.

However, the rise of renewable energy as a sustainable source, with desirable economic values to be captured, is stronger than ever with technology innovation driving cost low. With the direct threat to industry profitability, energy executives have no option but to re-assess their business strategies in the view of disruptive technologies which may provide an opportunity to sustain future market position before it transforms into a threat. Nevertheless, to capitalise on this opportunity, the senior leadership needs to redefine its new competitive advantages and determine the required capabilities and pathways to nourish them.

LITERATURE REVIEW

The Traditional Model – The Risk of Centralised Energy

The vision of central system could be traced to the first electricity company of Thomas Edison and John Morgan in 1870s known today as General Electric (Yakubovich et. al., 2005). They imagined the electricity as primary commodity produced centrally instead of trading equipment to produce electricity for own use at home. In 1892, the company revolutionised its business model to become founded on metering demand and billing structure with different rates of charges (Provoost, 2013). By 1920, the company was supplying to 32 states at which negotiation with federal state and regulators was initiated to recognise electricity supply as natural monopoly. Nowadays, according to Greenpeace (2005), centralised generation and distribution energy model is applied to meet resource demand of 93% of today's energy worldwide. Interestingly, Edison's model was attractive for its environmental rewards since it places its pollutions outside cities.

In the UK, the key energy providers supply to approximately 90% of the domestic customers and generate about 70% of total electricity (CMA, 2016). However, the centralised system is responsible for 65% loss of global energy input to the system (61.5% heat waste and inefficiency and 3.5% through high-voltage transmission and distribution). The inefficient end use of recipients is only responsible for 13% of losses which is equivalent to fifth of what is wasted at generation and transmission (Greenpeace, 2005).

The International Energy Agency's analysis reveals that investment in the EU energy system is estimated to reach £442 (~US$ 648) billion to only improve the efficiency (IEA, 2003). Ofgem UK has approved nearly £6 billion and the US energy sector spent $15 billion (IEA, 2003). The direct cost of improving and running the energy system and network is passed on to the consumers through billing. According to Ofgem, only 37% of the bill pays for the actual generations while cosmetic improvements, expensive operation and maintenance of outdated infrastructure are loaded onto the consumers. Evidently, the 1930s originated technologies are inappropriate and out-of-date for the next generation challenges. Walt Patterson, Royal Institute of International Affairs said: "We can be pretty certain what unsustainable electricity looks like – it looks like most of the world's present-day electricity systems" (Greenpeace, 2005).

Energy companies are challenged with their realities of being neither "sustainable" nor "affordable". However, they recognise that our society is reliant on energy in such a way that it becomes the heart of its existence, prosperity and wellbeing. This translates into continuous need for consistent supply of power "availability" (Edens, 2014). Unfortunately, high energy costs have generated customers' dissatisfaction caused by the perception of profiteering suppliers. Ofgem's (2015) report indicates that customers' satisfaction with the UK energy providers is at 50%, that is considerably lower than other industries such as banks and telecoms. To add to the problem, customers' complaints have intensified by more than 50% since 2011. The existing operation and business model was described by CEO of the German utility company RWE, Peter Terium as "collapsing under us" (Basden et.al., 2014)

The Energy Economics Power of IoT

With over 3,600 citations, Estrin et. al. (1999) reports on the idea of a network of sensors that coordinate among themselves large data gathering for decision making. This network has extended its existence to be in mobile devices, tablets, cars, fridges, chairs, toys and in theory everything creating what is known today as the Internet of Things (IoT). The important element in this concept is the term "things" which indicates the changing nature of new products and services. It is the new capabilities gained from connectivity and the new hidden value within the data that generates the innovative competitive advantages.

Utilising and analysing both customer-created and machine-generated data holds the prospective to improve our utilities industry, incentivise advances in productivity, reduction in cost, and designing new energy services. The National Intelligence Council (NIC), USA, identifies the IoT as one of the six civil technologies that has the potential to disrupt the power industry by 2025 (NIC, 2015). According to Iansiti and Lakhani (2014) "Nest (Google) will not only play in the $3 billion global thermostat sector; it will help shape the $6 trillion energy sector". Renewable energy and big data are pushing the development of smart grid, which is expected to produce Gross Value Added (GVA) of £13 billion by 2050 (EY, 2012) with substantial contribution into jobs creation.

However, decentralised energy future is a powerful vision that brings significant opportunities and risks. However, smart meter system is the core driver of data but then how frequent it is collected in real-time will define its size, complexity level, and required level of management. Regardless of complexity, the smart meter (big data) returns various benefits to suppliers such as demand management, services improvement and customer understanding.

A smart grid makes effective use of its connectivity to better understand customer's behaviour and requirements to improve system's reliability, economics and sustainability – generation and distributions (Cisco, 2013). The big data (IoT) will enable enhanced utilisation of asset as it allows for automatic detection of systems' faults for scheduled maintenance and in some circumstances self-recovery procedures. This will significantly decrease the system vulnerability to security threats and blackout. The technology also offers the most needed foundation for the network to shift from one-way flow of energy to a flexible flow (two-ways) to adapt with green resources.

The power of enhanced performance with connected systems, people, and data analytics is well supported by all experts in the industry. GE estimates the potential gain from 1% gain in "performance" in major global industries to account for about £24.3 (US$ 32.3) trillion over 15 years (Evans and Annunziata, 2012). To put this in perspective, it is equivalent to 46% of today's global economy output. Major benefits of the IoT in the energy sector are extracted from incorporation of smart technologies that enable enhanced system efficiency, reduced negative impact on climate, reduced dependency on scarce resources, and thus lower cost (Cisco, 2013).

Smart Cities, Buildings and Infrastructure

Cities were and will continue to be the place for economic growth, opportunities and modernisation. The International Finance Corporation (IFC, 2015) claimed future cities to be accountable for 90% of the world's population growth, 80% of CO_2 emissions, and 75% of energy consumption. However, future cities first sign of smartness is driven by growing their economic capabilities, productivity and defeating their negative impacts on the ecosystem by increasing their support structure for the greener modern resident's life style.

EU-FP7 project known as "transform" (2015) states a perfect vision for a smart city as "*A city that provides its users with a liveable, affordable, climate-friendly and engaging environment that supports the needs and interests of its users and is based on a sustainable economy*". They need to demonstrate smart approaches in all aspects of their services as demonstrated in Ernst & Young (2016) framework which emphasised on the citizen being in the centre and thus any effective development in the infrastructure or services layer must have an active approach to involve them. They (EY, 2010) defines smart as "*intelligent new technology" that has potentials to construct the necessary foundation for "a more efficient energy system*". A smart energy system that actively evolving the energy system in term of production, delivery and usage of energy. By utilising data and the new IT paradigm to create three strategic components; smart grids (generation, transmission, and distribution), smart control (meters) and smart appliances (suppliers and customers).

This forms the principles for the development of Smart Energy City vision (Transform, 2015) defined as "*highly energy and resource efficient, and is increasingly powered by renewable energy sources; it relies on integrated and resilient resource systems, as well as insight-driven and innovative approaches to strategic planning. The application of information, communication and technology are commonly a means to meet these objectives*". The smart city also made of smart building, and a network of 5G capabilities. Nokia predicts that rapidly we will live in a domain of sensors that exceeds the number of people by 100 times (Nokia, 2015). New products and gadgets controlled through mobile applications are purchased by smart consumers at disrupting rate driving cost low but also speeding the adoption of electronics appliances for home automation.

The network of sensors will have the capability to monitor the environment and learn about the occupants' behaviours and alter it according to their needs i.e. heat, light and use of appliances (RaEng, 2013). In addition, power generation at residences has wide varieties of solar photovoltaics applications, from domestic rooftop to medium-scale level. The connectivity of individuals, products, home appliances and adoption of small-scale clean-energy systems empower building and consequently cities to transform itself to become an efficient ecosystem (Droege, 2010).

The Rise of Smart Customer

Today's "know it all, want it all" customers, demand far more from utilities which is a substantial challenge for the industry. A challenge that must be addressed appropriately otherwise facing the risk of losing for competition i.e. entrepreneurs from within sector or non-traditional entrants.

The first digital wave of smart technologies adoption is the "smart meter" enabling data gathering in the energy sector at precedential level. Power businesses realised the importance of utilising these data to gain insight, visibility of customer consumption and provide intelligence for maintenance and operation. However, data needs to be analysed and exploited to drive new value for customers and consequently enhance the prospect of continuous long-term success. This is evident in the difference in attitude between high and low performing companies in the sector. The high performing ones are more strategic about being customer oriented and thus reformed to supply valuable services to their customers (EY, 2013b).

The era of classical centralised network with one-way flow of electricity to a "passive" customer is under a shift. Ernst & Young (2011) found that most utilities' customers had a neutral or poor view of their providers, on a global scale. They highlight that customers view the relationship as a transactional, cold and distant. Customers went to the extent of describing the polarized and unbalanced relationship as a "hostile" one. In addition, poor relationships with suppliers, concerns with data sharing and low willingness to pay are just few to mention, the UK results in key areas are summarised in Table 1.

Table 1. UK's customer attitude toward utility providers and smart energy.

Relationship with suppliers	Data sharing concerns	Willingness to pay for smart meter	Familiarity with smart energy	Perception of smart energy	Attitude to manage energy	Privacy concerns
Negative	Negative	Negative	Ambiguous	Positive	Positive	Positive

[Source: EY, 2011]

The implicit connection between these factors is trust, that affects all aspects of the new sharing economy and is key to growing the energy industry. An industry that had long focused only on technology and economic of scale, these can be barriers in the new sharing economy model, if executed solely (Hinshaw and Kasanoff, 2012). The regular headlines are condemning the industry for high prices, high profitability and mis-selling which are experienced by customers in poor services, inaccurate billing, and competitive offers limited to new customers or leavers.

With the complex nature of energy industry, gaining trust from the smart customer does not depend on brand and reputation only, but must be extrapolated to become an integral part of its stakeholders' relationship management; community, government and investors. Ultimately the new economy model depends on the customer being in the centre of interest.

METHODOLOGY

Research Goal

In this study, the aim was to explore how smart technologies and consumer's power drive the energy sector to a smart energy. The paper identifies the current status of energy industry, assess the impact of centralised business models on the energy market and finally discuss the role of smart consumers in the future of smart energy

Sample and Data Collection

The participation in the survey was limited to the UK residents only to ensure that all respondents experience the same political, economic, technologic, environment and social factors. The sample technique is non-probability sampling known self-selection sampling chosen with consideration of the research purpose as shown in Figure 1. The questionnaire compromised of 20 questions with 5 questions to determine the demographic representation of the 112 completed forms. However, 105 was included in the analysis and only 7 were rejected due to the fact that respondents did not complete the survey in full. The breadth of coverage of over 100 participants means that the results of the author survey is representative, and can therefore be generalised to the population Saunders et. al., (2009).

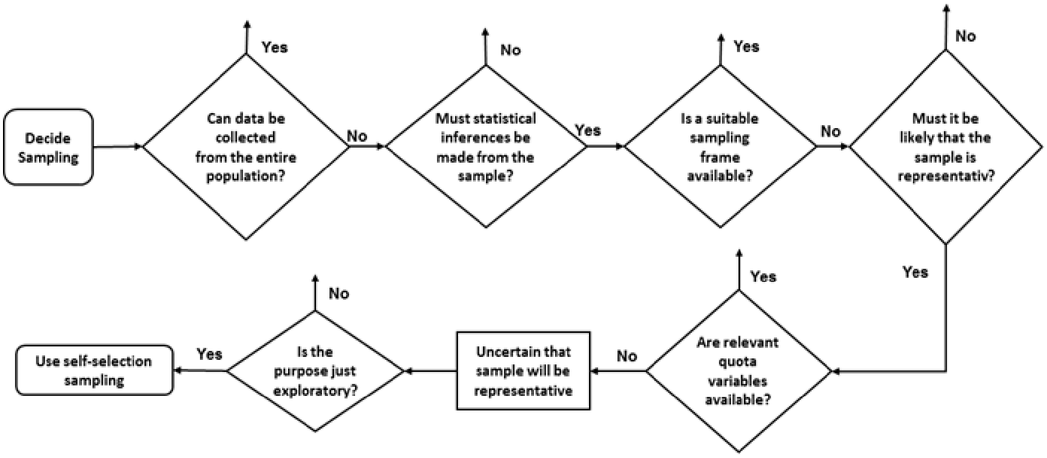

Figure 1. The relationship between sampling technique and the research purpose

RESULTS AND DISCUSSION

Demographic Representation

The majority of the respondents falls almost equally among three age categories; 25 to 34 years (25.7%), 35 to 44 (29.52%) and 45 to 54 (21.9%) as shown in Figure 2. The concentration among these groups could be due to the fact that most of the data were collected through professional networks.

The survey data were made of 65.5% male respondents and 34.5% of female respondents. The majority of survey respondents are in full-time employment 92% with only 3% not employed and 5% are retired. The majority are married couples 67.31% while the rest consists of 16.35% single 11.54% in a relationship and other status is 4.81%. Also, independent children 43% [of which 1-2 children 36% and 3 or more 7%] and with no dependent children being 57%.

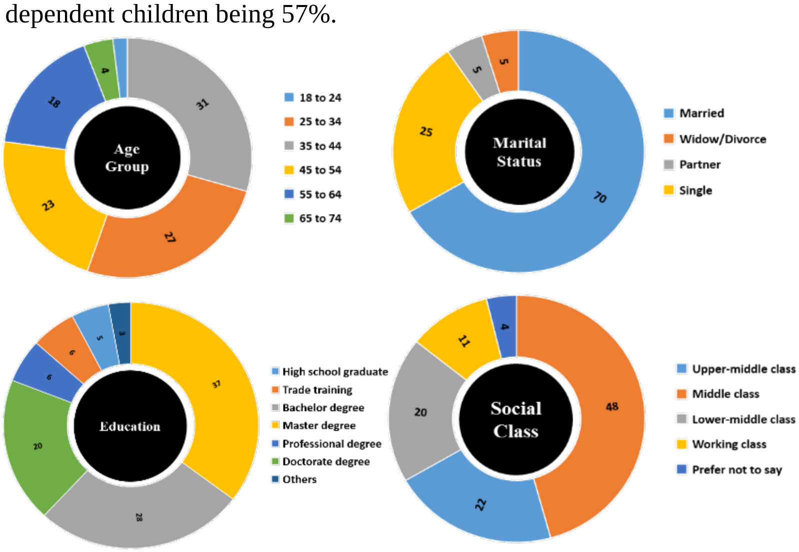

Figure 2. The demographic representation of the survey respondent

Attitude Towards Climate Change

The results show that people are well aware and consequently concern about the impact on the environment that could be caused from our activities as individuals, businesses or society. The respondents reveal high-level of concern about the environmental impact with 88.6% agree to be concerned (32.4% of them are extremely concerned). Only 2.9% of the respondents showed poor or no concern. The result is in agreement with literature which indicates the rise in knowledge about the environmental issues and thus the researcher attempts to measure their energy consumption awareness and level of engagement with energy as part of the questionnaire survey.

Level of Engagement with Energy

79% monitor their energy consumption using traditional and smart meters while just 11.4% use smart meter which indicate low adoption rate, see Figure 3 (top). However, this shows that the mainstream of society is actually engaged – even at basic level – and has a level of awareness of their energy usage. However, the traditional meter, unfortunately, does not provide linkage or information about the household activities and energy consumption while the smart meter users would benefit from this insight. However, perception on energy consumption of activities at home clearly indicates that reduction in energy cost is a common objective among the vast majority of public, 94.3%, and reducing impact on environment is a second strong driver for 71.4%. It is indisputable fact that financial benefits are the key motivator as it has bearing on people need to reduce bills and cost of adoption greener solutions.

Furthermore, the survey results confirm that the majority of people 82.9% are extremely or reasonably concerned about high consumption of energy. the author can not make direct relation between high level of motivations and actions to achieve the objectives. However, other research suggests that people with high drivers can be reacceptance to change. Thaler and Sunstein (2008) suggest that such a response is not to be ignored as it may "imply that people would be open to strategies that would help them achieve these goals. In other words, they are open to a nudge." In fact, public might be appreciative of clear and consistent signals from government and businesses.

However, the positive attitude of public towards the environment and energy usage/impact need to be facilitated. The hefty initial cost of renewable systems topped the list of barriers for home installation at a rate of 90.5% of respondent choice. Lack of proper information and government funding has equally been identified by almost 50% of the respondents. The later influence people perception of economic payback/benefits from installing green systems broaden the barriers to include extra dimension – these barriers are presented in Figure 3 (bottom).

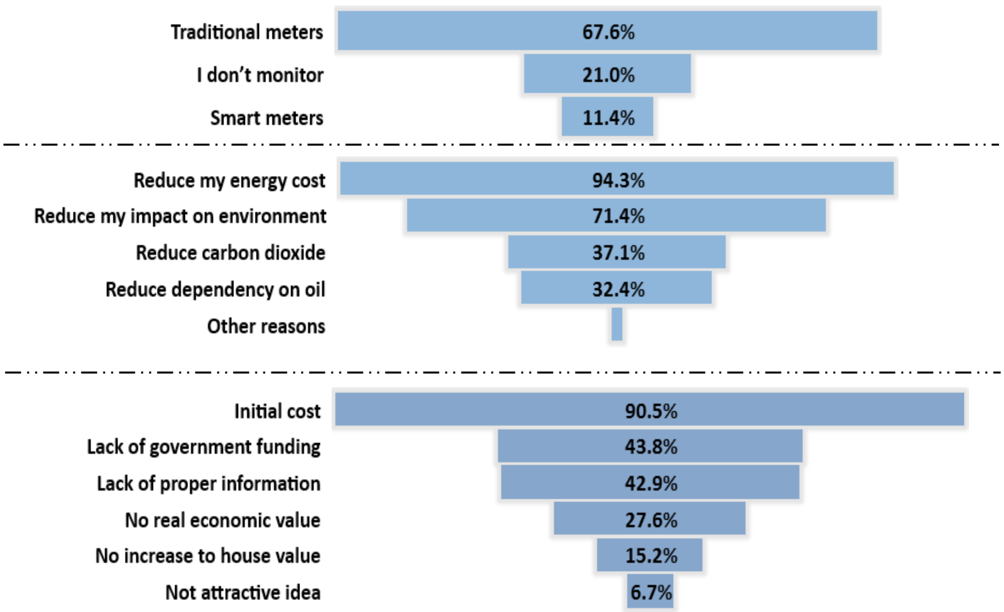

Figure 3. The perception of energy usage for key routine activities in homes

Importantly, our survey findings show that customers put great importance on the environment and thus have negative attitude towards centralised system and it is clear that renewable resources are much preferred. Customers are responding to technology in the energy sector positively. Smart meters are perceived as a mean to gain control over their energy, reduce bills, receive information and share data with suppliers. Furthermore, customers are willing to adapt new behaviours when incentives are high-enough to compensate for any shortage in personal comfort. These incentives can either be measured in monetary terms but also could be in decreased negative impact on climate, reduced dependency on oil and etc.

Smart Energy Transformation

To deal with the challenge of transforming the energy system, smart grid development is accepted as a key milestone. The intelligent network is expected to develop pioneering approaches to cope with the renewable intermittency nature which threats the conventional system stability. This enormous task has been managed by means of shifting some of the balancing requirements to be local at the source of production. This increases the level of communication prerequisite, involve the end users as active consumers by increasing the level of engagement. This is made possible through smart technologies and appliances.

This business opportunity is great to all stakeholders and stimulate the decentralised energy production model. The customer value proposition in decentralised energy has never been more attractive since the cost of solar photovoltaic are getting cheaper while performance is getting better. In addition, with the increased rate of market penetration of storage technologies, the utility sector is gradually approaching its tipping point at which the price of renewable energy from micro-generators is cheaper than the national grid's price.

As customer shift to the adoption of decentralised systems, the competition landscape presents the centralised model with further challenges; profitability slump, cost rise, and possibly threat of becoming unsustainable. Senior executives within the sector are required to re-establish their pillars of success around five strategic commitments:

- *Commitment 1*: to redesign operation strategy for new competition that requires efficiency and effectiveness.
- *Commitment 2*: to renewables through enhanced technical capabilities to adapt and respond to intermittency.
- *Commitment 3*: to design for a smart grid with capabilities to exchange data and to allow bi-directional flow.
- *Commitment 4*: to increase their consumer focus and understanding of smart consumers' requirements.
- *Commitment 5*: to innovate new business models that enable them to capture benefits from decentralisation.

CONCLUSION

The rise of decentralisation of energy generation and distribution at local places is presenting a change force to the utility industry from the traditional centralised generations. Energy sector including the big six providers can not rely on passive customers for growth and profitability. The technological advancement of connected products and services allows customers to turn into smart users and to reclaim some control over their energy. This control is defined by them being able to generate rather than just consume. Solar systems are more effective, cheaper and can be stored for effective utilisation and thus decentralisation is a viable cost effective option.

The utility sector is required to have an open-mind approach to decentralisation and allow renewable sources to grow organically within their operation by resourcing new capabilities to enable new strategic thinking for operation and business models. This is not necessarily an easy choice and/or risk-free option when it comes to implementation. However, climate change is a continuing reality and people are very well informed and concern about the short and long term effect. As a result, consumers seek opportunities to feel as "good citizen".

With the increase of smart customer who hold new value proposition and with government intention to lower barriers for greener energy (including decentralised energy). There is no more important time for energy executives to act swiftly to re-strategise and innovate to adapt for a possible future that is very different.

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