Smart Electricity Distribution Networks, Business Models, and Application for Developing Countries

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Abstract

The electricity distribution industry in the developing world is dominated by public sector utilities. These utilities are technically and economically inefficient and face large financial losses that prevent further development of the networks. The reforms are introduced to unbundle the vertically integrated utilities and introduce private investment and management, but these efforts often fail due to poorly designed market and incentive models. Focusing on the electricity distribution in developing countries, we propose a business model based on organizing the utilities into distinct activities and businesses. In many developing countries political economy and weak investment

conditions do not favour full privatization of utilities. However, in some activities 'competition for the market' and 'management contracts' can provide a partial role for the private actors. The model is based on the concepts of enterprise innovation, emphasizing external collaboration and partnerships and can be operationalized via specialization, where some specific tasks are outsourced. The proposed model can also be applied to developed countries as the energy sectors of both developing and developed countries are undergoing transformation due to new technologies such as communications, distributed generation (DGs), and active demand response.

Keywords: Electricity network, privatization, energy sector reform, business model, developing countries

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1. Introduction

Access to modern energy services is crucial to human well-being and to a country's economic development. However, globally nearly 1.2 billion people are without access to electricity. More than 95% of this population is either in sub-Saharan African or developing Asia, and around 80% are in rural areas (IEA, 2015). In future, developing countries will account for an increasing share of total world energy consumption due to their economic growth, along with accompanying structural changes. As per the World Energy outlook 2016, Non-OECD demand for energy rises by 71% from 2012 to 2040 (WEO, 2016). On the other hand in the more mature energy consuming OECD economies, energy rises by only 18% in the same time span of 2012 to 2040.

The rapid increase in the share of developing countries in global energy consumption emphasis the need for new electricity sector and reform models to improve efficiency and productivity. Many developing counties are in some stage of reforming and developing new laws and regulatory framework for their electricity sectors, for transforming public utilities into market-oriented and regulated entities (Jamasb et al., 2017; Saleem, 2007). However, despite various market and regulatory reforms, the distribution sector continues to be weakest link in the electricity value chain and suffers from basic drawbacks such as high losses mainly due to lack of full-cycle measurement of electricity supplied, particularly to the subsidized categories of consumers, lack of accountability and an over-loaded and ageing network infrastructure (Scott and Seth, 2013).

Technological progress in telecoms sector brought about large benefits to many consumers in developing countries who were deprived of reliable service or lacked access altogether. However, similar progress and benefits in the electricity sectors of the developing countries

are yet to be achieved. Thus, it is imperative for developing countries to explore new and smart networks and business models for the following reasons:

- To break the vicious circle of low investment, poor customer satisfaction and in turn low realization which is the source of poor financial health of various power distribution companies.
- The present emphasis towards low-carbon future makes distribution sector different than the conventional by having distributed generation, renewable penetration, demand side management and storage facilities as important segment of the system (Soares et al., 2012). This will make distribution grid a crucial element of sustainable electricity sector of the future. Already, the growing role of distributed resources in the electricity system is leading to a shift in the fundamental business model paradigm of the industry.
- Distribution sector is undergoing transformation due to emergence of digital innovation and its impact to monitor, observe and automation of system, ICT/smart grid application making communication as top priority etc. Thus, it is imperative to provide a regulatory framework that allows development of new business models along with emerging technologies.
- Another important driver for new business model is change in the policy perspective, including environmental regulation to century-old economic regulation, as renewable generation both as main source of generation as well as distributed generation is needed due to environmental concern.

These drivers motivate shifts in policy objective and the need for new business model in electricity distribution for a future sustainable electricity sector and to reduce the entry barriers for new private and specialist players in developing nations. The present paper aims

to critically analyze the distribution sector in developing countries. It then proposes a new business model based on entrepreneurial theory and economics in the light of the emerging developments in the ICT and smart technologies. The proposed model is expected to overcome the significant challenges in this sector faced by developing countries. The model is based on developing enterprise innovation emphasizing external collaboration and partnership and can create considerable employment opportunities and also, open up new markets for other players in IT, communication, insurance, education and training, and social networking etc.

The next section outlines the context of electricity distribution sector in developing countries. Section 3 presents the basic economic principals of a new business model and then describes the constituent components of the model in some detail. Finally, Section 4 is the conclusions with some policy suggestions.

2. Electricity Distribution Challenges in Developing Countries

2.1 Background

Despite considerable reform efforts, in the form of unbundling, corporatization, and regulation of the electricity sector in many developing countries, the distribution segment is experiencing substantial financial losses undermining the critical role and financial viability of the distribution utilities. Bhattacharya and Patel (2011) and Patel (2008) discuss the prevailing systemic flaws and sector vulnerabilities. As a result, many distribution sectors in developing counties are characterized by inefficiency, low productivity, frequent supply interruptions, etc. (see, e.g., Jamasb et al., 2015; Thakur et al., 2006). The social objectives, such as electrification or cross subsidies have traditionally yielded large inefficiencies in the

sector. It is generally accepted that the quality of institutions affects the economic performance of countries (Acemoglu *et al*., 2002). Dramani and Tewari, 2014 examines performance of institutions and electricity sectors in Ghana and gave the findings that institutions influence the reserve margin, installed capacity, reliability and efficiency of distribution companies over time. Regulators are established but they are still appointed by the Government, thus shows inclination towards Government. They are still following cost plus regulation and offering no incentive for improving performance.

Such factors contribute to significant technical and financial losses in the system, and lead to erosion of creditworthiness of the government utilities[1]. For example, in India, the electricity sector's after-tax losses (excluding state government support and subsidies to the sector) stood at Rs 618 billion ($10.13 billion) in 2011. This is equivalent to nearly 17% of India's gross fiscal deficit and around 0.7% of its GDP (Pargal and Banerjee, 2014). However, when subsidies are included as revenue for the utilities, the losses fall by more than half to Rs 295 billion ($4.83 billion). Distribution companies (Discoms) had an outstanding debt of Rs 4.3 trillion ($70 billion) as on 30 September 2015 (MoP, 2016). This in turn would adversely affect the overall sustainability of the electricity sector including its ability to mobilize the much-needed capital investments to extend and modernise the networks.

Financial viability of the electricity sector is one of the key drivers of performance toward universal electricity access. In most of the developing countries electricity prices are much below the full supply cost. This is the main reasons for utilities ongoing financial distress and infrastructure decapitalization. The outcome is the inability of utilities to expand and maintain services, especially in remote, rural and poorer areas. Barriers to expanding access

[1] Electricity generation and distribution have traditionally been with the public sector in developing countries, even with the introduction of various power sector reform measures, ownership is still predominantly with respective governments.

to electricity have been broadly categorised as financial and economic; capacity and technical; and policy and institutional (Sovacool, 2012; Watson et al., 2012; Nepal and Jamasb, 2012; Chaurey Akansha et al., 2012).

Given the poor financial performance of distribution utilities in developing countries, it is imperative to devise strategies to reduce network energy losses as part of the efforts to improve financial viability of the networks. One approach is electricity sector reform and market liberalisation, of which privatization is considered a lynchpin (Dobozi 2016). However, privatization of the sector in general and of the networks in particular without effective regulation does not provide positive results, on sector reform outcomes, other than improving the government fiscal position through privatization receipts and reduced fiscal subsidies[2] (Jamasb et al., 2015).

Revenue sustainability is imperative for operating and maintaining a distribution network, thus, ensuring sustainable growth of the distribution sector requires significant focus on private sector participation. Admittedly, the pricing methodologies and regulation of distribution network services need to accommodate the adoption of smart network technologies (see Li et al., 2015; Brunekreeft et al., 2015). This not only helps to make the Discoms financially viable but they can invest in new technologies to become smart utilities. Recognizing the need for privatization in both urban and rural areas to improve service, reduce losses and increase customer satisfaction, it is important to take up this activity in a methodical and integrated manner to ensure that the various layers of information are

[2] In India, this has motivated some private actors to invest in power distribution business in the form of distribution franchise (DF) model. TERI (2010), Task Force (2012) and Chaurey et al. (2012) have reported successful involvement of DF for local power distribution in rural settings that these schemes have enhanced energy access using "pro-poor public-private partnership" model ("5Ps").

analyzed and understood by all stakeholders – i.e. the regulators; franchisors, distribution utilities and franchisees (private entrepreneur/company).

2.2 Case for Smart Distribution Networks and Business Models in LDCs

The conventional electric utility business models are poorly adapted to tap the full potential value of emerging technologies such as distributed generation, energy efficiency, and demand-side response to meet the societal demands for reliable, affordable, and cleaner electricity supplies. This recognition has motivated a search for more suitable business models for distribution utilities (Perez-Arriaga et al., 2013). In addition, in order to deliver low carbon sustainable economies, emerging paradigms such as Energy Systems Integration (ESI) suggest holistic approaches that identify the potentials to integrate different energy vectors such as electricity, gas, and fuel. This integrated system will in turn exploit the synergies with other infrastructures such as transport, water, and communications systems (see Ruth and Kroposki, 2014; O'Malley et al., 2016). Such whole system view of the energy sector and its linkages with other infrastructure sectors that are in need of improvement in most developing economies can be beneficial for these countries. Even, the developed countries are presently under the transition phase of inculcating the above concepts.

Therefore, development of new and innovative business models both for develoed and developing countries are important for the energy sector in developing as well as developed countries as it is undergoing transformation due to the emergence of new energy efficient technologies, ICT applications on grid, distributed generation (DG), changes of consumer demand and environmental concerns (Poudineh and Jamasb, 2014; Valocchi et al., 2010; Giordano and Fulli, 2012; Hall and Foxon, 2014, Hall and Roelich, 2016). A number of reform models have been proposed for electricity system restructuring in the developing

world to meet the requirements of state and central government policies as well as the social and market needs (see, e.g., Tripathi et al., 2016).

Due to the absence of an appropriate business models for distribution sector in developing world, various developed smart technologies such as time of day (TOD) or time of use (TOU)[3] pricing, commercial losses reduction (excluding theft), and demand side management are not being utilized towards development of the sector. An appropriate distribution business model would help commercialization of new technologies and would shore up revenues in order to capture value from current technologies. Thus, developing a suitable business model, which can harness new technologies by launching appropriate ventures, is essential for the electricity sector.

The distribution system in developing countries has generally been developed in an unplanned and haphazard manner making it incapable of meeting the objective of meeting the growing demand by the economy and consumers in an orderly and planned manner. This has, over decades and years, created inefficient distribution systems compounding the many challenges that the sector faces. The need for radical restructuring of the power sector and innovative solutions has become imperative (Tankha et al., 2010). As a result, The World Bank and other international funding agencies, governments of developing nations, have been taken various reform initiatives such as unbundling, corporatization, privatization and outsourcing of various services of the distribution sector.

[3] All smart technologies are capital intensive; distribution companies are not able to mobilize sufficient capital towards developing sound state-of-the-art electricity distribution infrastructure. This has demanded the adoption of outsourcing and service providing to ensure sufficient capital investment in the distribution sector.

The challenges in the network utilities are multi-faceted. These may broadly be classified as arising out of a set of technical, governance, and economic issues as described in the following:

- ***Technical challenges***: High level of aggregate and technical network energy losses (AT&C)[4], poor quality, low reliability etc. High population and demand growth rates combined with the lack of investments to modernise and extend the service has a negative effect on quality of service, reliability of the system and has caused substantial opportunity costs in terms of foregone social and economic growth of developing countries.
- ***Governance challenges:*** These include operational and maintenance difficulties, inability to provide 100% metering, compensating cross subsidy, inappropriate billing practices, faulty billing methodologies, outsourcing of different activities, controlling the decaying financial health of the sector and its distribution utilities (IEG, 2016), poor performance, inability to attract private investors etc. The above factors often give rise to a difficult relationship with the sector regulator. Even the high rate of work-related accidents is an obstacle to implement the operating procedures from Developed Countries.
- ***Economic challenges***: The electricity sectors in developing countries exhibit various types of inefficiencies in different parts of the system such as low plant load factor, high network energy losses, low quality of service, and low investments, etc. However, the economic main source most of these inefficiencies can be traced back to

[4] Sometimes the T&D energy losses would not account for all the losses occurring in the networks. Therefore, the concept of Aggregate Technical and Commercial (AT&C) losses was introduced that captures both technical and commercial losses as a more accurate and true indicator of total network energy losses.

failure to implement cost reflective pricing to end-uses. This inefficiency normally originates from the distribution segment and then spreads to the rest of the electricity system. When structural and institutional reforms are accompanied by pricing reform the sector function on sound economic principals. This also includes innovation in the sector in a broad sense that includes the use of new technologies as well as new business opportunities and models.

3. A Smart Distribution Network Business Model for Developing Countries

3.1 Business Economics of Smart Networks

The underlying differences between developed countries and developing countries need to be considered whenever a new model for reforming the sector is proposed (Nagayama, 2007). Since 1990s, many developed and developing countries have embarked on market oriented electricity sector reforms. In developed economies the main aim of reforms was to improve the efficiency of sector and reducing the excess capacity. Many developing economies faced significant un-met demand as a barrier to economic growth. Therefore, the aim was to attract investments to improve access and reliability. The significant differences in the pre-reform conditions and structure between developed countries and developing countries were too great to use a generic reform model (Jamasb et al., 2017).

At the same time, in many developing countries significant energy subsidy arrangements are in place. This means when prices are deemed to be too low by the utilities, capital investments required to improve the service may not make commercial sense. Therefore, addressing the trade-off between the price changes to be achieved by liberalization and the investment promotion, priorities must be established in consideration of the long-term growth

of demand and the economy.

Even in developed countries, electric sector reforms, and in particular smart grid projects, are carried out through trial and error and there are still many unsolved problems such as integration of renewable resources and demand response. Likewise, in developing countries, the introduction of electric sector liberalization policies should be carefully considered, taking into account the economic development situation and various political factors existing in each country. The form and timing of the introduction of the reforms should be in light of the particular circumstances of the individual countries.

New business models in the electricity sector must also adhere to the particular and complex structural, governance, and economic features of the sector. A fully deregulated electricity sector consists of competitive (generation and retail supply) and regulated (transmission and distribution) activities. The sector regulator plays an important role in defining the operating environment of both types of activities and the interfaces between them. The boundaries between the competitive and regulated activities are not fixed and can be changed. Indeed, technology and regulation often define the boundaries between the market and regulation.

The proposed business model for the distribution sector is broadly in line with the concept of enterprise innovation model as described in Giesen et al. (2007). This approach emphasizes external collaboration and partnerships. Enterprise model innovation can also be accomplished via specialization, wherein organizations can focus on their core competencies or high-margin activities and outsource the rest. Such instances have been used with success in other sectors.

Some notable examples are Nike, Skype and Bharti Airtel who have challenged the traditional business models for reengineering their economies of their business. ‘Bharti Airtel’ an Indian telecommunication company has successfully used the enterprise business

model for its business and decided to focus more on consumer satisfaction and outsourced the rest of its operations. This concept converted most of the fixed capital expenditure into variable operating cost based on how much network capacity Bharti Airtel was consuming. This revolutionary cost structure reduced Bharti Airtel's price per minute to an unbeatable $0.02, and gave the Indian giant more flexibility to improve its offerings (Amarsy, 2015). Another case involves capturing value from early stage technology from Xerox Coorporation, where a successful business model creates a heuristic logic that connects a technical potential with the realization of economic value (Chesbrough, and Rosenbloom, 2002).

However, any new business model emerging must ultimately conform to at least some of the basic tenants of theories of the firm and business economics such as core competence and transaction costs, as well as economies of scale and scope and the potential growth. Specialisation can take advantage of core competence of a wider and more diverse set of firms to participate the broader electricity distribution sector. On the other hand, while some economies of coordination may be lost to partnerships and networks, these can be outweighed by the benefits of the expertise and innovations of the actors in the partnership structures. In addition, the market should provide the individual actors with the potential to achieve a size and portfolio of services (e.g. in areas of the aforementioned energy systems integration) that allows the firms the opportunity to innovate and to grow.

3.2 Framework for a Smart Network Business Model

The major activities of within the electricity distribution utilities in developing countries which present a potential commercial value for new business models can be found within the following areas:

- Infrastructure built-up and asset management
- Organizational structures development

- Data collection, data analysis, trading practices
- Operational processes and policies formulations
- Work management, asset management and demand-side management
- Financial and business model development, system and technology development
- Billing and collection, awareness programs
- Theft control, power retailing, reactive power supply, Volt/VAR control etc.

Each of the above activity areas provides an opportunity for a potentially distinct business. Hence, a suitable business model that will integrate the above actions into a distinct business is essential in current times. This can also help to bring the much-needed investments over the next decade in line with the worldwide emergence of smart networks business models as essential tools to capture value.

A competitive business can be introduced in feeder, distribution transformer, load scheduling, insurance business, time-of-day (TOD) and time-of-use (TOU) pricing, voltage control, and reactive power management through a proposed model. If the above mentioned activities are separated into distinct businesses; various schemes for infrastructure improvements, various goals of franchisee model, smart grid based initiations, strengthening of distribution sector, eradication of present power sector issues etc. can all be expected to be integrated into a single model. Taking this into consideration, a new business model for developing countries power distribution sector is proposed. Figure 1 shows a schematic overview of the complete proposed model and its main components in greater detail.

In the proposed model various major tasks that need to be carried out for power distribution have been defined as outsourced units. The model as a whole complies with basis principals of economics of firm, business model innovation, and energy systems integration. The outsourcing is proposed in terms of public private partnership (PPP), distribution franchise

(DF) or Built-Own-Operate-Transfer (BOOT) model or Opex/Totex model. The distribution business has been divided into three units namely; Physical Infrastructure Unit (PIU), Distribution Management and Maintenance Unit (DMMU) and Control-Operation-Revenue Management Unit (CORMU).

Independent regulation has come to play an indispensable role in the liberalised electricity sectors. The regulators oversee the effective functioning of the wholesale generation and retail electricity markets. On the other hand, they set the rules for governing the pricing of network services and the conduct of natural monopoly network utilities. Regulatory framework and standardisation is important for making distribution system efficient and independent protecting interest of all stakeholders such as consumers, utilities, private developers, social community.

It is important to note that all business components would need to be integrated and linked to each other through information flow and exchange. Internationally, the multi-sided-platform (MSP) business model has attracted attention as a result of the spread of the Internet as it represents an efficient way to create business value out of interaction amongst different arms (Valocchi et al., 2010). The following sections describe these components and their functions as part of the proposed business model.

3.3 Physical Infrastructure Unit (PIU)

This unit would encompass the total physical entities and components needed to build a smart distribution system. Various components of PIU would include: Discoms, metering company (MCOM), information technology company (ITCOM) and communication company (CCOM). Various roles and functions of each of these physical components are explained in the remainder of this section.

3.3.1 Distribution Companies

Discoms may either be a fully government owned or a corporatized government owned company or a private company. This company would act as the parent distribution company and will be responsible for building all the basic infrastructures needed for electrical supply such as distribution towers/ poles, conductors, transformers etc. It will also be responsible for any up-gradation or augmentation or expansion works.

3.3.2 Metering Company (MCOM)

Metering infrastructure represents an essential need to ensure better operation and control and use of new technology for the distribution system. For instance, the prepaid meters would lower commercial risk and give consumers better control for managing their loads.[5] For this, the meters would be needed at various input and output nodes. Meters would also be needed at sub-station to know inflow and outflow of distribution, at feeders at both input and output (I/O) to calculate feeder losses, I/O metering of transformers as well as at other power system components to account for device losses.

It is proposed that a separate company MCOM (that may not be necessarily be manufacturing the meters) be allotted the task of managing the metering function in a particular geographical area of the Discom as a separate entity, thereby reducing the burden on Discom towards mobilizing large capital requirements for the metering activity. Various MCOMs may approach the Discom for getting the metering contract of a particular area through the consultants called metering technology consultants (MTC) hired by them. MTCs may approach the Discom and based on the features of the metering arrangements as proposed by

[5] Many countries using prepaid cards for mobiles and in the same way pre-paid metering can be introduced in developing countries. In developed countries pre-paid card for electricity are common.

the consultant, Discom may select the metering company considering various norms and standards duly provided by the government.

3.3.3 Information Technology Company (ITCOM)

Managing network database imposes an essential task for network planning, construction, operation and maintenance works. With the growing competitive environment in distribution, data management is fast becoming a challenging task. Here, IT plays an important role in tackling the data management issues. Such automation should necessarily be preferred over manual activities and this distribution automation (DA) can provide power utilities with a long-term competitive advantage through better power reliability and improved customer service (Gutschow and Kachieng, 2005). Activities such as works asset management system (AMS), work management system (WMS), meter data management system (MDMS), outage management system (OMS) etc. can be better managed and integrated through automation by the use of IT.

Again, a range of commercial works such as billing, salary calculation for employees, loss accounting, debt addressing etc. can also be achieved through automation where IT plays a dominant role. Hence, IT imposes an urgent requirement in the distribution sector, and it is proposed that this segment also be outsourced as a separate entity in the power sector. The necessary contract mechanism may be followed similar to the contract proposed for MCOM, and the ITCOM may also be allotted the contract of a particular area through IT consultant (ITCs).

3.3.4 Communication Company (CCOM)

CCOM plays a dominant role in completing the infrastructure needed to build a strong distribution system. The data, which is being measured at various metering points, must be sent to a data centre for centralised analysis and feedback. This can be achieved through a

communication system such as power line carrier communication (PLCC), supervisory control and data acquisition system (SCADA), or phasor measurement unit (PMU) based wide area data transfer system. Apart from these, various other activities such as wide area monitoring, home display, TOD/TOU display, awareness programmes etc. also required an assured communication system.

Furthermore, the demand response (DR) is also increasingly an integral part of the power system and market operational practices (Medina et al., 2010, Faria et al., 2013), and is considered a key focus area which needs communication. Thus, communication system would be an important component for distribution system with huge capital investment required for creating the necessary communication infrastructure. If the Discom itself decides to organize a communication system, it will require huge capital. Hence, the process of creating communication infrastructure can also be outsourced to a separate company that may specialise in the design and installation of modernised communication technologies. Its operation can also be ensured in a similar manner as that of MCOM and ITCOM. The proposed CCOM implementation may also deploy use of communication technology consultants (CTCs).

3.3.5 Insurance Company (ICOM)

As various players such as ITCOM, MCOM, CCOM etc. would participate in a new business; there exists a risk of contingent and uncertain losses. In order to ensure the safety of the various players with respect to their investments, a dedicated insurance company may be constituted or some currently existing insurance companies in other sectors can also take part. These will also provide risk coverage to the assets being transferred from the Discom to different feeder franchisee (FF) and distribution transformer franchisee (DTrF). Furthermore, an insurance company (ICOM) can potentially take responsibility for all such risks and exigencies.

3.3.6 Independent Regulator (IR)

An independent regulator (IR) is normally a non-profit organization responsible for formulating various policies and standards required for distribution business set up, operations and control, and would need to be free from political control. There is an extensive literature on economic regulation of T&D networks in general and in developing countries in particular (see, for instance, Laffont and Tirole, 1993; Laffont, 2005; Estasch and Wren-Lewis, 2009; Jamasb, 2006).

3.3.7 Project Finance Agency (PFA)

Massive investment is required for setting various physical components required by MCOM, CCOM, ITCOM as well as Discom; the much-needed financial help may be sought from a dedicated organisation designated as the project finance agency (PFA). In order to prevent the monopoly of financing, it is suggested that the current lending agencies in countries[6] may also continue their financing, although it needs to be limited as rising financial debt has already escalated the risk of financial contagion (Pargal and Banerjee, 2014). Hence a separate entity is proposed in the business model for providing financial supports to the entities that requires loans.

3.4 Distribution Management and Maintenance Unit (DMMU)

A DMMU is proposed for taking up the responsibility to carry out the tasks of power management and network maintenance in the distribution sector. Carrying out the maintenance and management work for various major distributions system components by a single entity is more likely to be efficient, and outsourcing of the maintenance and management work for major components such as distribution feeder, distribution transformer

[6] In India this is covered by Power Finance Cooperation (PFC), rural electrification corporation limited (REC), India infrastructure finance company (IDFC) etc.

etc. can bring better results in the sector. The capital expenditures needed by the Discoms towards distribution management and maintenance works can thus be saved and can be mobilized towards infrastructure development.

In the proposed model, the feeder franchisee (FF) will take part in power trading (both active power trade and reactive power trade) business through the distribution traders, and the FF will be the sole owner of the allotted feeder for the contract period. It will be responsible for all the maintenance and power management activities of the concerned feeder, and would carry out the power business with the distribution transformers connected to specific feeder and connected high tension (HT) consumers as its end-customers.

Similarly, the distribution transformer franchisee (DTrF) will be the sole owner of the allotted distribution transformer for the contracted period, and will be responsible for all the maintenance and power management activities of the concerned distribution transformer. It is only the end entity that will carry out the business with the residential and commercial consumers connected to the allotted transformer. It is further suggested that the FF as well as DTrF can avail nuances of power management, device maintenance as well as manpower hiring through business process outsourcing (BPOs).

The proposed model also suggests setting up of distribution VAR trader (DVTr) for the task of reactive power management[7] and energy service company (ESCO) for energy efficiency. Hence, it is proposed that while DVTr will be technology oriented, the ESCOs would also need to be oriented towards the efficiencies brought about by the market and economic mechanisms.

[7] There is a recent interest in reactive power as one of the several ancillary services to ensure system reliability and security. Separate entities such as distribution power trader (DPTr), distribution VAR trader (DVTr) and energy service company (ESCO) respectively are being discussed internationally (El-Samahy et al., 2008).

3.5 Control, Operation and Revenue Management Unit (CORMU)

Control, operation and revenue management impose an essential need for the effective functioning and sustainability of the power distribution business. Hence such a unit would be an important segment of the distribution system. Furthermore, the control, operation and revenue management has been proposed as separate unit to prevent their participation in any of the commercial activity of the distribution business. Different segments of this unit may function in a non-profit organization mode. The following sections describe various internal elements of the proposed CORMU.

3.5.1 Revenue Management Engine (RME)

The role of RME is to focus on revenue management related activities needed by the Discoms. The RME will be responsible for energy pricing in consultation with the independent sector regulator (IR), for billing and collection, for consumer management, for providing new connections in consultation with the Discoms, and for vendor management etc. Apart from energy pricing, various other activities of the RME may be carried out through the BPOs.

3.5.2 Distribution System Operator (DSO)

The distribution system operator (DSO) would be the brain of the distribution unit, and would take up all the control and operational tasks by managing data centre and control centre. DSO can also take care of renewable energy based distributed generation (DG) which are being promoted by all countries by making renewable purchase obligation (RPO) mandatory on power distribution companies (Shereef and Khaparde, 2013). In many countries failure of policies and business models occur due to insufficient incentives to local distribution companies, renewable power installers and users (Buesing and Yang, 2013). Hence creation of a DSO is expected to overcome this issue.

Also, the DG penetration causes frequent voltage problems at the distribution end. These require local solutions as reactive power cannot be transported over long distances (Mallet et al., 2014). Such problems should, therefore, be managed by DSOs instead of TSOs in coordination with DVTr, which are proposed in this business model.

3.5.3 Social Networking Engine (SNE)

SNE is proposed to be responsible for all the social activities as well as social responsiveness needed for the betterment of consumers, employees, vendors and other stakeholders. Also, the task of power trading and power retailing may be conducted through a unit named trade and retail cell (TRC) of SNE. Various awareness dissemination programmes including the media advertisement may also be implemented by the SNE through its internal segment that may be named as awareness and advertisement cell (AAC). Other tasks that SNE may be assigned would be obtaining the consumer rankings, something that is essential for use based pricing. Consumer ranking may also be linked to setting up high tariff rates for unscrupulous consumers having low rankings will motivate the end users towards making efficient use of electricity.

3.5.4 Training Institution (TI)

Lack of institutional capacity and skills has long been one of the major challenges in the distribution sector in developing countries and so also is the adequate manpower training. What is required is a critical mass of skill formation in technical, financial, legal and project finances aspects of the distribution sector. It is proposed to set up a training institute (TI) that provides technical, financial, legal as well as managerial training needed across various nodes of the distribution sector. The proposed TI may also carry out various other important activities such as publications and collaborations, policy formulation, pricing methodology-based research.

4. Conclusions

The paper analysed the background of power distribution sector of developing nations, which is striving hard to explore the private participation with the objective of harnessing efficiencies. It is evident that most of the adopted models face various governance as well as technical challenges, and are far from being appropriate. Thus, despite having adequate organizational structures, utilities are still unable to run their business effectively.

The proposed smart business model is expected to overcome significant challenges, and will likely lead to following benefits:

- Provide a platform to small players who are technologically sound and interested in power sector.
- Introduce competition at various levels of power distribution, and hence increase productivity.
- Create job opportunities; open up an education and training business.
- Reduce the tariff structure over long-term, improve power quality, stability and system reliability.
- Business will not only open market to private actors in power sector but would also lead to new markets for other players in IT, communication, insurance, education and training, social networking, metering companies, energy traders, retailers, scheduling coordinators, system operators, non-governmental organisations (NGOs) etc.
- Various BPOs, which are financially sound could be attracted to hold specialized activities like consumer management, social networking, various O&M works, and

awareness programmes etc. in distribution business, thus benefiting the sector with huge private capital investment and specific specialization.

- It will facilitate renewable integration with distributed generation options, in conformity with newer environmental requirements.
- Implementation of micro grid will be easier.
- The most vital concern of power sector i.e. loss reduction will be in sharp focus.
- Demand side management will be initiated automatically.
- Average billing rate (ABR) will be realised at different nodes automatically, thereby making the sector more transparent.
- This model will be suitable for implementation in both the urban as well as the rural areas in comparison to the existing PPP and DF models, which are focused only for the urban areas.

Power sector plays important role in the economy of developing nations. In order to sustain 7-8% economic growth to end the present day poverty, developing countries needs to be enhanced at least two time existing installed capacity. At the same time, ageing network, smart technology and global demand of climate change mitigation needs substantial investment in the sector. This presents a significant challenge to the Governments, but is also a historic opportunity to the Governments to usher in innovative business models to meet expectations and attract much needed private investment in the electricity sector. For a commercially viable sector of this scale, new and innovative business models would be necessary. The proposed model is a humble suggestion in this endeavour that is likely to affect the lives of 79% of the global population.

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