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Smart Grid Policy Implementation Barriers

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Chapter 1 - Introduction

Smart grid concepts have been gaining momentum as the energy transition becomes increasingly prominent in all parts of the world. As countries face new challenges in their energy sectors that in turn affect the growth of the country, the need for such an energy transition has become a key priority. The reasons pushing the energy transition are different for different countries, although one common factor that is urging the transition nearly all over the world is the need to reduce dependency on fossil fuels and promote renewable energy generation. Studies on energy transitions across the globe show that among developed countries, reducing CO_2 emissions and increasing the share of renewable energies is the key driver pushing for a structural change in the existing energy systems. Developing countries also consider these reasons to be a strong push factor for an energy transition, but there are also many additional reasons behind their push for this change.

While it may be for some similar and different reasons, both the developing and the developed world is leading an energy transition phenomenon that will not only bring about many changes to the current energy sector but will also require many changes to be implemented to bring about a remodeled energy system.

The number of energy challenges, some similar but some different, being faced by India and the Netherlands is more than a handful. As these countries strive to overcome these challenges, several new concepts are being developed and implemented. One such concept is the smart grid. Smart grids have been defined in several different ways, but in essence refer to a grid with two-way communication between the consumer and the utility provider that can monitor real-time energy consumption to predict future demand and therefore improve efficiency and productivity (Fadlullah & Kato, 2015).

Many countries have been experimenting with setting up smart grids of different scales, but a large-scale implementation of such grids still remains to be realized. Both India and the Netherlands have many stakeholders involved to build robust and successful smart grid systems. Smart grid policies are often developed and set forth by national governments in these countries but often fails or does not reach the success it aims to achieve. This may occur due to many different fallbacks in the implementation stage and this thesis aim to look into these challenges.

I. Research Objective

The aim of this research is to look into smart grid policies to identify the barriers that exist during the implementation stage in developed and developing countries. As smart grids have been a point of interest lately, particularly with the ongoing energy transition, there are many projects that are trying to be implemented in many parts of the world. The regions that are considering building smart grids have varying sociocultural, political & governance and economic scenarios which would result in different countries facing different kinds of barriers. Therefore, by identifying the barriers faced by smart grid implementation policies in developing and developed countries, a deeper understanding of the cause of the barriers could be gained which could serve as an example for future projects under similar circumstances.

II. Concepts: What are smart grids?

To compare smart grids in both developing as well as developed countries, a common, shared definition of a smart grid must be established. A detailed and well-rounded definition is stated by the U.S. Department of Energy, which could serve as a common definition to compare and study smart grids developing and developed economies, and it is defined as follows:

"A smarter grid applies technologies, tools and techniques available now to bring knowledge to power – knowledge capable of making the grid work far more efficiently...

- Ensuring its reliability to degrees never possible.
- Maintaining its affordability.
- Reinforcing our global competitiveness.
- Fully accommodating renewable and traditional energy sources.
- Potentially reducing our carbon footprint.
- Introducing advancements and efficiencies yet to be envisioned" (U.S. Department of Energy)

The figure below obtained from the International Energy Agency's paper on Smart grid Technology roadmap, shows the past, present and future scenarios of the grid systems. The most crucial feature to consider in this diagram is the expansion and interconnection of the communication networks among all the players in the system. This is exactly what a smart grid aims to achieve in simple terms. By interconnecting all the players, i.e. producers,

consumers and control centers, a multi-path communication is created which will allow optimization of the overall system.

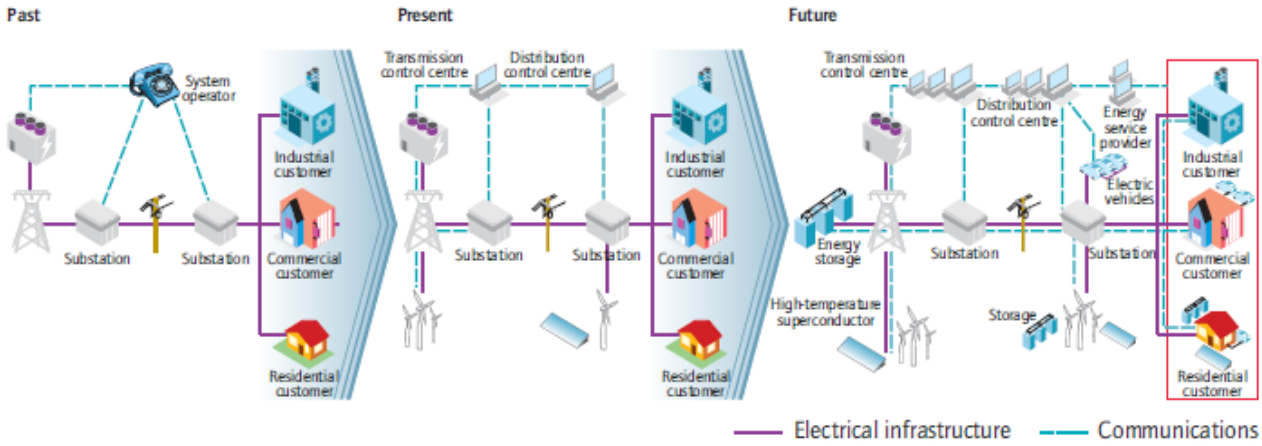


Figure 1: Evolution of electricity systems (IEA, 2011)

Smart grids are defined in many different ways. Therefore, to study about the implementation of smart grids and related policies, a standard definition with relation to the thesis focus must be defined. To do so, several definitions for smart grids were considered.

As the realm of the study also considers the case studies of India and the Netherlands, it is important to understand how they define smart grids. The Indian government defines it as:

"A Smart Grid employs innovative products and services together with intelligent monitoring, control, communication, and self-healing technologies to:

- better facilitate the connection and operation of generators of all sizes and technologies;
- allow consumers to play a part in optimizing the operation of the system;
- provide consumers with greater information and choice of supply;
- significantly reduce the environmental impact of the whole electricity supply system;
- Deliver enhanced levels of reliability and security of supply."

On the other hand, the European Commission defines it as:

"A smart grid is an upgraded electricity network to which two-way digital communication between suppliers and consumers and intelligent metering and monitoring systems have been added. It ensures an economically efficient and sustainable power system with low losses and high levels of quality, secure and safe power." (EU Commission, 2017)

Smart grid implementation policies are often defined by the national governments as the main stakeholders of most of the smart grid projects today. Policies spanning a wide-ranging realm, such as funding and investments, regulations, security and privacy, market integration and consumer awareness and incentives need to be developed and then implemented in an effective manner to encourage the growth of smart grids. Implementing these policies is often hindered, especially as it a relatively young concept. Therefore studies and reports on the policy implementation challenges in smart grids are not abundant although much insight could be gained from the challenges experienced by projects that have already been conducted.

III. Research Questions

This research aims to answer the question **"What are the barriers of effective implementation of smart grid policies in developing and developed countries?**" To fill this research gap, other questions must also be looked upon and these are:

[1] Which socio-cultural, political & governance and economic factors affect the successful implementation of smart grid policies as can be seen in literature?
[2] What is the smart grid policy framework for India and the Netherlands? How far has it already been implemented?
[3] What can be learned from the smart grid implementation policies in the Netherlands and in India that could be useful for other developing and developed countries?

Goal: To build recommendations, based upon the barriers hindering successful implementation of smart grid policies, which suggest ways to overcome these barriers so as to aid other developing and developed countries from experiencing similar challenges.

The goal of the research is to identify the barriers in smart grid policies implementation in countries of varying economic circumstances. Literature on smart grid policies provides insight into the challenges that are facing such projects today and have faced in the past. By identifying these challenges and how they are different or similar in developing and developed countries, possible suggestions to circumnavigate or avoid these barriers can be realized. Furthermore, using case studies, the challenges faced by the two specific countries will be analyzed and compared to find similarities and differences, which will help understand what India could learn from the Netherlands and vice versa.

IV. Research Design

This research will be conducted with the goal of understanding the barriers in smart grid policy implementation in developing and developed countries. For the purpose of research, case studies of India and the Netherlands will be chosen. India, as a developing nation is tackling many challenges in its energy sector, such as poor energy security, energy independency, and energy efficiency which can all be alleviated if not solved through successful and widespread implementation of smart grids. Moreover, the Government of India as well electricity utility companies in India have established policies on implementing smart grids which could be studied to give an understanding of the challenging they are facing during the implementation phase. Many of India's fallbacks in the energy sector can also be seen in other developing nations, therefore by looking at India's smart grid implementation policies much insight can be gained by others trying to implement smart grids in similar situations.

Similarly, the Netherlands, as a developed country in Europe faces some similar and some different challenges and obstacles that hinder the successful implementation of smart grids which can be useful to other developed countries trying to take the same path. Especially, as a European Union country, there are many other countries that will follow in the path of Netherlands in the smart grid scheme or collaborate in international projects, therefore gaining an understanding of the difficulties the Netherlands is facing will be useful to many others.

1) Research Nature

The research will take a diagnostic approach as the goal is to identify the barriers in smart grid policy implementation. Therefore, by looking at different smart grid implementation policies in literature and in particular cases studies, this thesis will aim to recognize the different types of challenges in different backgrounds. Once the main barriers that are present in policies in the developing or developed world or both are identified then they can be further analyzed to point out any similarities or differences. As the range of barriers can be spread out over a wide scope, the research will be demarcated to study only three kinds of barriers and these are: socio-cultural, political and governance and economic.

2) Research strategies

A qualitative study will be conducted to understand the state of art of the current smart grid policy implementation process in the Netherlands and India. This will be done through desktop research and secondary analyses of reports and scientific papers focusing on smart

grid developments in the respective countries. The energy situation of the Netherlands and India also a play a role in defining the role of smart grids projects, and will hence build an understanding of the prime national energy priorities. This will also help to understand how the existing smart grid policies developed by the governments are stimulating the development and implementation of smart grids in the respective countries.

The first part of the research would comprise a study in literature to identify barriers in smart grid policy implementation. This will be done by looking at reports and studies that have already been conducted on this topic. As the interest in smart grids has increased rapidly over the last decade, so has the research and documentation regarding their implementation. Scientific papers as well as project reports can give insight into the existing challenges that have been identified while in building smart grid policies. Furthermore, as this research also aims to understand how the barriers are similar or different in the developing and developed world, the initial part of this research will be dedicated to identifying barriers in countries with respect to their state of development. Once a list of barriers has been identified and categorized into sociocultural, political & governance and economic groups, the research will then move forward by studying the case studies of India and the Netherlands.

In India as well as in the Netherlands, the government plays a key role in promoting smart grids implementation; therefore, data from them can be used to understand the current progress in this field as well as the future plans. Regarding formulating a structured approach to answer what are the main challenges these countries are facing in smart grid implementation, one can look into current smart grid policies in the two countries to understand the missing gaps that need to be filled. The government policies of both the nations will stand the key smart grid policy structures and these will be further looked upon to identify fallbacks that were already identified during the literature review as well as specific drawbacks on the country's policies.

Both the Netherlands and Indian governments have put in a lot of effort into developing policies that help develop and implementing smart grids in these countries, which is why a case study on these countries could serve to provide a good understanding of policy implementation challenges in developing and developed countries. By focusing on the countries in general, and not on specific projects, a much more widespread range of barriers can be analyzed which will be beneficial to smart grid project implementers in other parts of the world. Especially, since smart grid projects are in a budding stage in both the Netherlands and in India, looking at the challenges in policies in the countries as a whole will paint a more complete picture. Whereas, focusing on particular projects could result in only presenting a narrow and case-specific range of problems which may not be as beneficial to implementers looking for potential challenges they could be facing in other parts of the world.

3) Case studies: India and Netherlands

When discussing smart grids, it is also important to look at why the development of smart grid systems in countries like India and the Netherlands is crucial to the successful growth of the country in many aspects. Economic growth, energy security and independency are goals that every country in the world is aiming for.

Energy challenges for India are quite abundant. As the country's primary energy sources are fossil fuels, a fast and thorough change in the overall energy portfolio of the nation is needed to tackle the problems that arise from the use of such fuels. The first concern for the country is energy dependency, as the urban population and industrial growth continues to rise, India must look at alternative ways to satisfy its potential demand.

The Netherlands, which is a much more economically stable and more technologically developed country, faces more than a few similar obstacles. As the European Union pushes for sustainable growth and a switch to renewable energy production, Netherlands, as an EU member state must upgrade its current energy portfolio to follow the strict standards.

By looking into the challenges these two countries are facing during their smart grid implementation, it is possible to categorize these barriers into different sections of:

[1] Sociocultural
[2] Policy and governance
[3] Economic

Such a categorization will create an understanding of where the difficulties in smart grid implementation in developed and developing countries fall into. Furthermore, insight into these difficulties can lead to more pin-pointed recommendations which could suggest ways of implementation that avoid such challenges in the future.

4) Research Framework

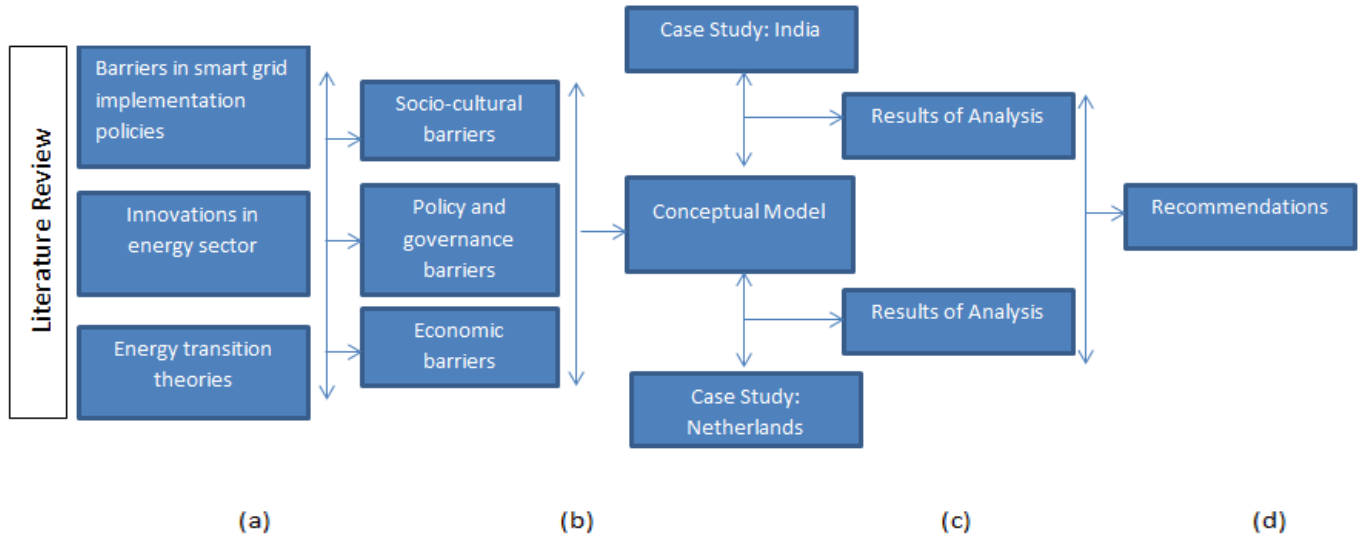


Figure 2: Research Framework - Schematic Diagram

The framework above is formulated as follows:

a) Understand the theories about the characteristics that define a smart grid, about the need for smart grids in countries of different backgrounds as can be seen from literature on existing research and current smart grid implementation policies.
b) Once the barriers are identified and categorized, the case studies of India and the Netherlands will serve to provide a practical example of barriers in specific barriers and perhaps give more insight into case-specific challenges.
c) The barriers are analyzed to determine the root -cause factors, and identify any similarities and differences in barriers in developing and developed countries.
d) Recommendations on how to overcome these barriers are suggested to be of use to other ongoing or future smart grid implementation aspects in developing and developed countries.

5) Conceptual Model

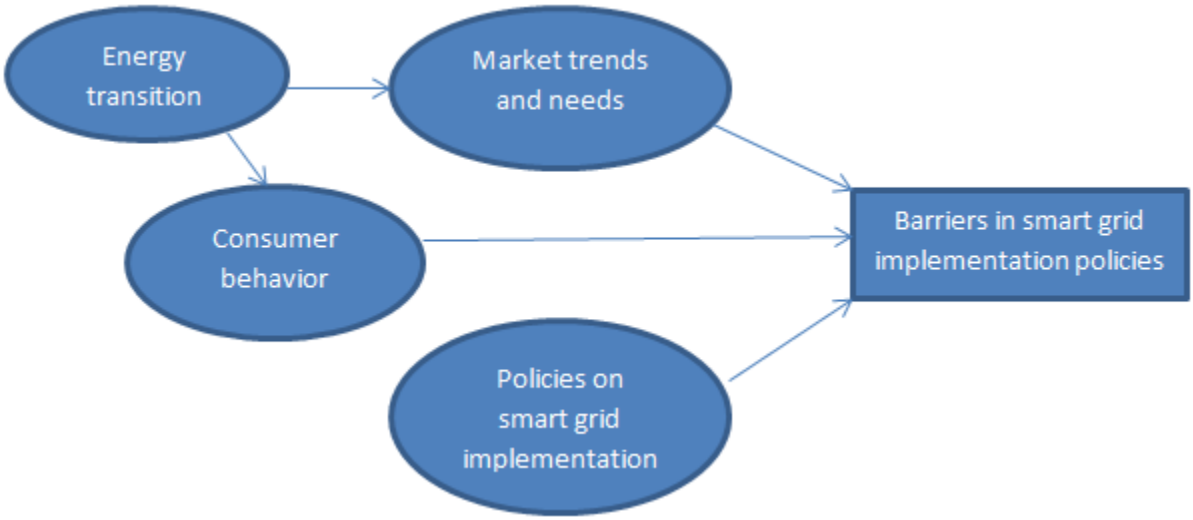


Figure 3: Conceptual Model: Schematic Diagram

The conceptual model above will serve as the framework to identify the barriers using the key objects and variables of the research as a whole. The model will guide the search in existing literature to look for different challenges that have been identified in smart grid implementation policies under various circumstances. The literature review will aim to look to into ongoing research into the field of smart grid implementation that document the barriers experienced during the policy implementation stage. Literature on energy transition will serve as a backbone which would lead into other literature on strategic niche management, implementation, demand side management, consumer behavior patterns etc. which will all comprise as the basis in identifying the barriers in smart grid implementation. General policy implementation barriers, like funding and capacity, stakeholder engagement that are experienced in different projects will also be looked upon as they will also be an issue for smart grid projects.

6) Research boundaries

As India and Netherlands are different in so many aspects, such as geography, population, GDP, it is important to demarcate how a comparison between the two countries will be made. But this is a challenging task, as the number of choices of areas where smart grids are being planned in are very limited. Therefore, the research will aim to look at barriers in

smart implementation policies all over the country, in both India as well as the Netherlands.

The range of barriers in smart grid implementation policies will be demarcated into three categories:

[1] Sociocultural
[2] Political & governance
[3] Economic

Therefore, the literature review which will be conducted as part of the thesis to identify barriers will be limited to the above three categories and others such as technical challenges will not be considered as part of the research.

Chapter 2 - Barriers in Smart Grid Policy Implementation

The thesis focuses on understanding the barriers of effective implementation of smart grids in developing and developed countries. This chapter aims to answer the final research question by answering the first sub-question: *Which socio-cultural, political & governance and economic factors affect the successful implementation of smart grid policies as can be seen in literature?*

The literature review comprises of looking through different types of sources including scientific articles and journals, world energy agency reports etc. with the goal of collecting information on the challenges in policy implementation.

Among the many stages of a policy cycle, which include: agenda-setting, policy formulation, decision making, implementation, and evaluation (Fischer et al., 2006), policy implementation as can be seen in one of the final steps. Policy implementation is defined as "what develops between the establishment of an apparent intention on the part of government to do something, or to stop doing something, and the ultimate impact in the world of action" (O'Toole, 2000). Ideally, policy implementation might include the following core elements:

1. "Specification of program details – how and by which agencies/organizations should the program be executed? How should the law/program be interpreted?
2. Allocation of resources – how are the budgets distributed? Which units/organizations will be in charge for the execution?
3. Decisions - how will decisions of single cases be carried out?" (Fischer et al., 2006)

As can be seen from the core points above, there are many ways that policy implementation can fall back in achieving what was intended. Policy implementation faces many obstacles, regardless of the area of implementation, hence it is important to look at the general policy implementation challenges. By looking through the general barriers, one can form a basic idea of the common obstacles faced in any policy implementation and will help in moving on to looking into specific smart grid policy implementation challenges. Furthermore, a look at the current energy transition worldwide will set a tone to the priorities in policy development and implementation worldwide. This chapter will then conclude with a short summary and a figuring depicting the prime smart grid policy implementation challenges identified in the following sections.

I. General Policy Implementation Challenges

1) Motivation and Funding

Policy implementation requires funding from varied sources is required to enable a balanced collaboration between the many stakeholders involved. Different actors must know the final goal of the policy as well as the individual unit goals (Dinica et Bressers, 2003). It is also important when raising the funds needed for the policy implementation to ensure that the economic risks are evenly distributed among the different stakeholders of the project (Fischer et al., 2006). The lack of equal risks often becomes a challenge in the implementation stage, as stakeholder become demotivated to come forth.

Secondly, when many stakeholders come together it is only natural that they have their individual goals and targets that they expect to achieve from the project. This is a huge challenge for the success of the implementation scheme, as goals may differ and even counteract one another. To enable policy implementation, efforts must be put into addressing the different motivations such that they come together to build the goal of the overall project (Fischer et al., 2006).

2) Capacity and Information

Policy implementation is a resource rich process which requires adequate funding and facilities to be effective (Bressers, 2004). Since today policy implementation is a circular process, resources need to be available readily to enable any modifications to the current policies at any given point during the different stages of any project. Both information and manpower are crucial to the success of any policy implementation (Bressers, 2004), therefore strong efforts should be put into these aspects for the policy implementation to be considered successful.

3) Stakeholder Engagement and Balance of Power

In any policy implementation process multiple stakeholders and actors are required. Therefore an effective policy implementation requires cooperation and collaboration between the many institutional actors (O'Toole, 2006). Each may have different roles and set of goals which will contribute to the final goal of the project, but often prioritizing is needed in such situations. This is often a point of conflict during the implementation stage, as each stakeholder holds their challenges and difficulties at utmost priority making it difficult to put a start to addressing these problems. Therefore "a balance of power" (Dinica

et Bressers, 2003) must be established. This is also visible in many cases where societal actors are not able to play a significant role in the negotiation process where public and other authorities are considered to the primary stakeholder despite the fact that the society is the final recipient or consumer of the benefits and disadvantages of a policy (Fischer et al., 2006).

The general policy implementation challenges mentioned above are usually encountered regardless of the type or area of policy. These challenges may be encountered depending on many different background factors of the project. However, these are not specific to the problem of smart grid policy implementation which is being looked up in this thesis. While these general barriers are important to keep in mind, it is also crucial to look through the literature on smart grids to understand project related barriers. As this thesis focuses on the challenges in smart grid policy implementation barriers it is important to look at the obstacles that are faced specifically during smart grid policy implementation which will done in the following sections.

II. Smart Grid Policy Implementation Challenges

1) Socio-cultural and financial barriers for smart consumers

Smart consumers need to entail two qualities to be good users of smart grids, these are awareness and motive. Therefore, to raise smart consumers, work needs to be put in building on these two characteristics. Consumer willingness is crucial to the success of smart grids as well as smart grid policies as they are the end-users of the product. "The implementation of energy-efficiency programs, demand response, and outage-management applications will be effectively achieved through active customer participation in the system" (Gungor et al., 2012). Therefore, their collaboration can bring forth several changes that can enable the success of smart grids and related projects.

The socio-cultural barriers focus mainly on the difficulties of consumers, one such important barrier that exists today is the lack of awareness about the function and extent of benefits as well as fallbacks of smart grids. Information about energy consumption and pricing should be readily available to the users. Consumers must also be informed about the cost benefits that could be gained from the use of dynamic pricing mechanisms enabled by the use of smart grids in addition to the societal and environmental benefits (Gungor et al., 2012). "In areas where costs (of energy) are low and specialized rates to this point non-existent, there is little interest or economic incentive on the part of the consumer to modify usage of even think about energy having an hourly cost" (US department of energy, 2017). As this quote suggests, consumer awareness and participation is crucial to the success of

energy and electricity projects. Therefore, it is crucial to incorporate all aspects of end-users as an active stakeholder in the policy implementation process so that any concerns can be addressed and new ideas can be taken into consideration in the early stages of the project itself.

Lack of incentives for consumers

The second challenge is the lack of incentive among consumers to switch to smart grid systems. To encourage this transition, it is crucial to provide awareness about the "what, why and how's" of smart grids but furthermore consumer incentives must be introduced as part of the governmental and regulatory schemes. "While consumers in places such as Ontario are highly positive, some smart grids developments provoked public outcries, project delays and even withdrawal of policy support" (Mah, et al., 2012). This shows that consumer involvement plays a huge role in the success of policy implementation; therefore policies must ensure incentives, motivation and awareness about smart grids, their use and benefits, to enable increased consumer participation.

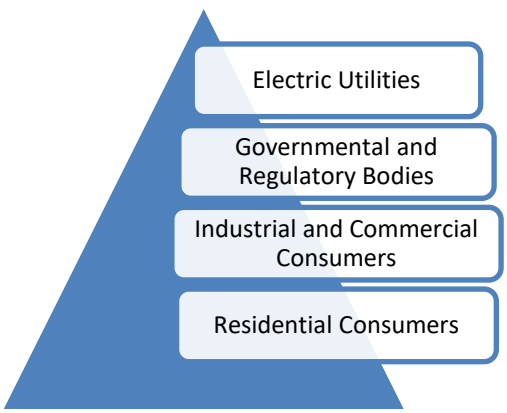
2) Stakeholder Collaboration and Fair Task/Risk division

As there are many entities that are involved in a smart grid policy development project, the key players must be identified and have designated sectors to operate on to improve the internal relationships within the team.

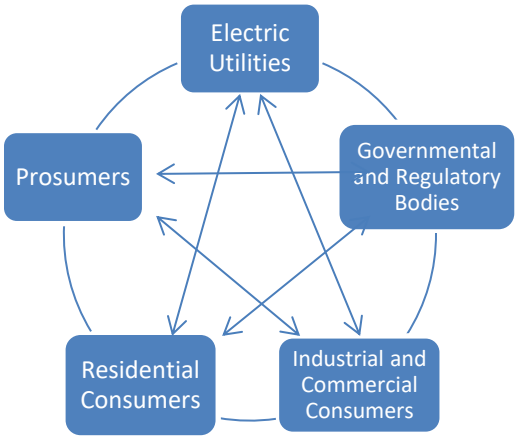
The primary focus, in the smart grid field, has so far has been on technological challenges, but funding and research is slowly but surely bridging the gap between the theories and real and successful smart grid projects. Even though the technological challenges have drastically improved in over the years, more than a few smart grid project pilots, e.g. 2 BESCOM projects in India, XcelEnergy in Colorado, continue to fail (Moudgal, 2015) (Jaffe, 2016). To address this, one must look into the policies that enable the growth of smart grids in the market, among end-users and other energy products. As smart grids bring together several sectors in the electricity sector and otherwise, it is important to consider all the different stakeholders during the policy development and implementation stages as well. To enable the interdependent nature of smart grids in a successful manner it is crucial to enable cooperation between the various stakeholders during the early stages (Fischer et al., 2006).

Yet another problem that will arise in policy development for smart grids is that change in relationship between the stakeholders. Both the emergence of new actors, as well as the need for new relationships between the existing and new actors is a topic of issue. As of today, most of the electricity network systems have a linear approach in their relationships, but to allow for successful smart grid projects it is important to change this rigid structure

(Fischer et al., 2006). For smart grids to thrive, a more interconnected and non-linear network is needed to interlink different aspects of society. For example, with smart grid deployment "prosumerism" will become more popular, i.e. more and more consumers will be selling self-generated energy back into the grid. New relationships like this will need a more open relationship layout (Rodríguez-Molina et al., 2014), for example a structure similar to the one shown in the figure below. To encourage such changes that will benefit the development of smart grids, policy development and implementation structure must also strive to include the many stakeholders within close connect such that a multi-way communication network is also established during the early stages of the project. A change in the structural layout of smart grid stakeholder could also lead to positive developments in improving the task and risk division which is often an issue in the smart grid policy implementation stage.



Linear relationship among Electricity network stakeholders



Interconnected relationship among electricity network stakeholders.

Figure 4: Structural layout for the existing electricity sector vs. layout for an interconnected smart grid network

The transition in the structural changes in the electricity sector is also crucial for welcoming new electricity and energy products. This is also stated in the white paper by KEMA on innovation in competitive electricity markets as "Market reforms can foster energy innovation through introducing structural changes that are associated with accessibility, market rules and incentive systems" (citation in Mah et al., 2014) (KEMA, 2011).

3) Need for Regulatory Frameworks and Interoperability Standards

But as of today, public engagement in the field of raising awareness about smart grids or in research and development for smart grids is relatively low. Without incentives or regulatory schemes, even public authorities prioritize the matter of smart grid development very low. This can affect an implementation scheme even if much funding and research has been put in to the other related aspects. Furthermore to these challenges it is also necessary to look at policies that push the growth of smart grids directly and indirectly, as further enhancement of such project requires direct measures and policies to be established to support as well as guide all who are involved in building smart grids.

a. Privacy Protection Policies

Cyber security is a very alarming issue when it comes to the topic of smart grid systems. End-users, regulatory authorities and utilities are all threatened by the possible attacks that could be launched in a completely digitalized system such as a smart grid network. To motivate the implementation of cyber-security and related policies, incentives are necessary. "Any legislation dealing with Smart Grid, cybersecurity, and energy policy needs to include incentives for utilities and manufacturers in such areas as adoption of best practices and implementation of security measures" (NEMA, 2011)

Safety is also a huge concern for consumers, as hackers can get information by getting access of the energy consumption and behavior of a household to know whether residents are alone at home, or the houses are unoccupied. (Bari et al., 2014) Access of such information could be a severe threat for all smart grid users. Households are not the only possible victims of such attacks, countries are also vulnerable to data leaks about the energy statistics as well as hacking of national electricity grids that could lead to severe energy access and security problems for a country.

Regulatory bodies and concerned ministries should create policies that ensure technology providers of smart grid goods and services such as smart meters for example, to place security measures to prevent any leak of private information such as the consumer's activities and occupancy patterns (Mah et al., 2014). Furthermore, effort must also be put into creating a team to monitor the security of regional smart grid systems throughout the use of such a system.

b. Demand-side Management Policies

The establishment of demand-side management policies can bring forth a significant improvement in the interest for building smart grids. "Demand-side management is a set of interconnected and flexible programs which allow customers a greater role in shifting their own demand for electricity during peak periods, and reducing their energy consumption overall. DSM programs comprise two principal activities, demand response programs or 'load-shifting' on the one hand, and energy efficiency and conservation programs on the other" (Davito et al., 2010). Demand –side management requires the intensive support that a smart grid can provide through its robust and "live" communication networks to make use of load-shifting and energy efficiency improvements (Sharifi et al., 2017). As DSM brings many benefits locally as well nationally, through improved energy security and efficiency, the government must take an initiative in promoting DSM. Even though the DSM concept has been around for years and is implemented in one way or other especially in developed countries, DSM when combined with smart grid will result in severe improvements in the energy sector. The growth in the policy and structure regarding DSM will simultaneously push the growth of smart grids in developing as well as developed countries.

Smart grids and demand side management policies are in a way see-sawing off of each other (Sharifi et al., 2017), as both the concepts depend on each other for their own growth. Improvement in DSM policies will mean, improved energy consumption and management methods and standards which will lead to smart grid policy developments as smart grids offer energy management features. And vice versa, improvements in smart grid policies will lead to DSM policy development.

c. Monitoring and Maintenance Policies

A smart grid system requires maintenance throughout the time of operation, i.e. from the moment of installation till a part of the system or the whole system needs to be replaced requires careful monitoring and upkeep. As smart grid networks carry a lot of data through and from end-users, utilities and others, the intense data flow requires top-notch hardware and software facilities. Such a data rich network requires immense amount of maintenance throughout the life-time of a smart grid (Lee, 2009). Therefore policies must push stakeholders of all aspects to routinely maintain and monitor the system. For example, policies for utilities must require thorough maintenance of the network software and hardware, policies for end-users must require maintenance and monitoring of metering equipment etc. (Lee, 2009).

Furthermore, as policy implementation today is a circular process that requires continuous modifications, resources and facilities must also be mandated to support these alterations (Fischer et al., 2006).

a. LACK OF AN INTEGRATED SYSTEM

A smart grid is an integrated system that interlinks many aspects of an electrical grid system that currently exists as individual or private entities. Therefore to create one, connected network, the role of an integrator must be taken upon by a fitting entity. The debate is often about who should take this role, but this can only be decided depending on the specific characteristics of the smart grid system that is planned to be implemented. The location, funds, and type of stakeholders all play in role in determining the key role that the integrator must play in the project.

Today there is a considerable amount of interest and dedication in carrying out small scale smart grid projects (Giordano et al., 2011). But as more and more of these pilots turn out to be successful, more effort should be put into large-scale smart grid networks.

A smart grid system requires numerous products as well as services that differ in size, composition, function etc. which therefore need to be manufacture by different manufacturers. This leads to a problem that will be faced by smart grids worldwide and this is the lack of interconnectivity. As the standards for smart grid goods and services are currently undefined, smart grid implementers will face challenges when building a whole system. “The failure of inter- operability is the most reported incompatibility among the different IT protocols and their components, in addition to the lack of a communication standard for EVs and the different communication standards for SG devices” (Giordano et al., 2011). Furthermore, in regions like the European Union where an international smart grid network is proposed to setup, several challenges lie ahead in ensuring that the standards within the linked nations is synonymous.

b. STAKEHOLDER COORDINATION

There are many different stakeholders that are involved in a smart grid project. These include actors from different sectors such as the ministries, regulatory boards, utilities, technology providers, academicians and research institutes, business and private entities, end-users etc. A successful smart grid projects needs to enable collaboration and discuss among all these different players to account for needs and growth of a smart grid network.

But the challenge lies in the fact that all the stakeholders (a) responsible for different parts of a network and that part only (b) have different interests in implementing smart grid systems. These differences translate to difficulties in consumer perception of the project as well and this can be damaging to the growth of such projects and the end-user participation is crucial for the success of smart grid networks. The utilities are interested in their personal benefits like, improved energy efficiency and easier management of the system while the end-users are interested in careful management of their energy consumption and

energy use patterns and national authorities are interested in improved energy efficiency and energy access for the public.

4) Need for Governmental (and other) Incentives

Smart grid policy implementation faces a lot of unpredictability as it is a relatively new concept and consumer trends are difficult to predict. This kind of unpredictability demotivates other stakeholders like the electric utilities, regulators and private investors from funding projects that study the consumer behavior in the areas of implementation.

a. Regulators and electric utilities:

Regulators need to ensure that investments in smart grid projects are reliable but this is often difficult as stated by Bryan Olnick, a senior director at the major utility Florida Power and Light that "improved efficiency and reliability can't easily be quantified" (Bullis, 2009). Regulators need to be convinced about the creating a balance between electricity pricing and the long term societal benefits which could result from the use of smart grids as compared to cheaper electricity without such benefits.

Electric utilities are often not motivated in investing grid expansion or improvement to allow for smart grid development as this could result in overall reduced electricity consumption as a result of less line losses and increased efficiency. Furthermore, it is important to consider that the "The set-up of the smart electricity system is expected to yield benefits all along the value chain of electricity sector, from generation to consumption; however, the bulk of investment will be required at the distribution level" (Cambini et al., 2016). As they are the prime stakeholders, in the financial sense and as they must face the highest risks in a smart grid implementation project, it is important to include incentives for electric utilities that encourage them to enable smart grid development. Moreover, the initial investments for such projects are also high and require additional support from private or public entities to cooperate in a joined economic plan to work towards smart grid development (Bullis, 2009).

While there need to be a change in policies that will encourage smart grid development directly, there are also possible changes to secondary policies that could be made to promote the growth and development of smart grids indirectly.

a. Promote renewable energy

By promoting renewable energy, a stronger need for smart grids can be realized. This is because of the variable nature of renewable energy sources which will require careful energy management measures which can be achieved through the multi-way

communication networks that a smart grid entails. Moreover, promotion of renewable energy sources will also require increased "prosumer" roles which would also be easier to incorporate in a smart grid system. The EU for example, has set a goal of reaching 20% renewable energy production as part of its 2020 energy directive (European Commission, 2017). This goal has also indirectly lead to the growth of smart grid development with the EU nations as smart grids will be crucial in switching to increased consumption of variable energy sources as compared to constant supplies of fossil fuels.

b. Increase energy security and independency

As countries begin to become more developed and industrialized the energy consumption increases drastically. Moreover as the urban population increases as high rates, the energy consumption per capita or per household also increases. These and many such factors put stress on the energy supplies of the country which eventually lead to energy security and energy independency issues. This is why many countries, like China and India have increased the focus on energy independency targets so as to improve the supply and demand ratio as well to alleviate the financial and political burden of energy import (Nayani, 2016). As a part of the energy security measures, energy management is severally stressed upon which can be achieved through the implementation of smart grids.

c. Increase energy efficiency measures

Energy efficiency is also a hot topic in developing as well as developed countries as line losses are responsible for low efficiency rates in many countries. Due to low efficiencies, a larger supply is required to account for the losses that will take places during the generation to distribution to transmission lines. Energy efficiency improvement is also an aspect that can severely benefit from the use of smart grids. As smart grid networks have many measuring points that are digitally monitored through different areas of a distribution and transmission network, it enables systems to detect any line losses.

5) Market Development

a. Need for open markets and new market protocols

Although markets have become more open since the 80's electricity market liberation of different forms, as the needs of the market are changing continuously further improvement is needed in this aspect. As a relatively new energy product, smart grids need a more open market than is present currently to enable new market players and competition to emerge.

This is based on the white paper from KEMA on innovation in competitive electricity markets which states that "liberalized markets tend to improve market accessibility through lowering the barriers for new entrants" (Mah et al., 2014).

"Setting up an SG platform requires integration the physical and market layers" (IqtiyaniIlham et al., 2017) where the physical layer refers to the technical infrastructure needed for smart grids and the market layer refers to "an efficient mechanism capable of coordinating transactions among operators, prosumers, and aggregators" (IqtiyaniIlham et al., 2017). Smart grids require involvement of new stakeholders as well as new relationships between these stakeholders therefore the market needs to be robust enough to incorporate these changes. Moreover, the aim of a smart grid is to create a network that is linked in many ways, which means as the connections increase the dependency between the markets may also increase. This is predicted to occur in an international smart grid network in a region such as the European Union, where member states of different electricity supply, demand and rates will be interlinked. Such a system will mean an increased dependency of electricity markets among the member states. While this dependency could be beneficial to the overall growth of the electricity market of the region, it could also lead to collective failures caused by the domino effect within the market. Therefore, new protocols need to put in place to account for such scenarios such that the interdependency between the markets is used for the benefits while maintaining and potential risks that are attached.

b. Business Models

As smart grids are a relatively new energy product, a study about introducing them to the market is required to develop and implement relevant market based policies that will encourage the growth and use of smart grids. Furthermore, with smart grid development new related businesses are also likely to pop up. Such things need to be predicted so as implement policies and frameworks to enable the growth and development in the future (Rodríguez-Molina et al, 2014). To understand what and how these policies need to be implemented, business models that simulate the use of smart grids in the current and future markets is essential. "The effectiveness of new business models and regulatory frameworks to combine the Smart Grid pieces together in a coherent system will significantly define the effectiveness of a market driven modernization of the power sector" (Giordano & Fulli, 2012.) Moreover, an in-depth analysis of the energy market in the area of smart grid implementation is crucial to guarantee the success of the project. For requirements like these and others it is important to engage in collaboration between the government and the private or business sector. With the use of such models and analyses, policies can be modified and restructured to fit a mold that new energy products like smart grids require, risks could be predicted and eliminated, and many such advantages can be reaped (Giordano & Fulli, 2012).

c. Electricity Pricing

As mentioned earlier consumer awareness and incentives are crucial for the success of smart grids as it is the end-users that can, in an open market with competition, choose their own suppliers and type of pricing (Faruqui et al., 2010).

In addition to incentives that promote the use of smart grids, governments could also establish measures to tax emissions and polluting sources of electricity. This will not only disincentivize the consumers from but will also encourage utilities to keep up with the current standards and continue to improve the service being provided. Secondly, dynamic pricing must be established to promote increased customer participation. Some countries have already established one of the many types of dynamic pricing, which has led to many benefits including careful management of energy consumption (on a micro and macro scale) and decreased strain on power supplies (Mah et al., 2014).

There are several different types of dynamic pricing which include: (Faruqui et al., 2010)

1. Real-time Pricing (RTP)
2. Critical-Peak Pricing (CPP)
3. Time-of-use Pricing (TOU) – not dynamic as the price does not depend on actual market prices.

The different types of dynamic pricing hold different benefits for consumers, but choosing an appropriate should be based upon the electricity consumption patterns, total supply and demand, reliability of supply and many such factors that are specific to the location of the project. Therefore implementing dynamic pricing policies requires looking into these and other specific characteristics of a smart grid project.

The smart grid policy implementation challenges identified above cover many realms and involve cooperation between multiple stakeholder areas. A brief look into the ongoing energy transition could provide insight into prioritization of these challenges although this may differ as energy transition takes many different forms in different countries. The following section looks at the global energy transition perspectives which may serve in understanding energy scenarios of different countries, and national energy priorities which will be discussed in the next chapter as part of the case studies.

III. Energy Transition Theories

Energy transition can be defined as a shift in the ways of energy generation, consumption and other related aspects that lead to environmental benefits as well as better energy management (Morris &Pehnt, 2012) (IEA, 2017). This is not a universal transition but one

that shapes its changes according to the specific requirements and goals of individual countries. One particular change that is being encouraged and worked upon worldwide is the transition to renewable energy generation. As global warming and other environmental issues continue to increase in severity many regulatory bodies across the globe have begun working on integrating renewable energies into the national energy mixes as well as some countries who are working on eliminating fossil fuels completely (Morris & Pehnt, 2012). Both these goals require drastic changes that need to be made in terms of policies, incentives, organization and structural changes, market development among many other such requirements.

Energy transition plays a huge role in the development of smart grids. The primary reason for can be viewed as the need to switch to renewable energies. As many of the popular and viable renewable energies are variable and lack the consistency of fossil fuels in nature, new measures need to be implemented ensure their successful integration into the energy mix.

The Energy Trilemma Index, a tool developed by the World Energy Council, is one way of understanding how energy transition is coming forth in different countries on the basis three main dimensions (World Energy Council, 2016):

1. Energy security
2. Energy equity (accessibility and affordability)
3. Environmental sustainability

Energy transition is bringing about many changes to the current energy mix, energy consumers, how energy is being consumed among several other changes. Many of these changes that need to be brought about need a drastic change relating to questions such as, how energy is produced, how energy is transmitted, who is generating or consuming energy etc. That is, as the energy transition pushes renewable energies, load management and "prosumer-ism" forward, a new and more efficient form of data collection and communication is crucial. This is why many countries are working on smart grid development as part of the national energy directives, because a large number of the innovations (technologies and concepts) require the functions and features that a smart grid network provides.

Drivers of the energy transition include not only climate change, energy efficiency and security, innovative markets but also consumers. Energy transition can also be seen within the electricity load characteristics. "As electricity becomes more widely available, electricity loads become more varied (plug-in hybrid electric vehicles, etc.)" (Rodríguez-Molina et al, 2014).

IV. Conclusion

As seen by the literature review, smart grid policy implementation is currently facing many challenges that are hindering the success of smart grid projects worldwide. The barriers are not concentrated in one realm but dispersed among many fields. General policy implementation barriers like lack of motivation, information and stakeholder engagement affect smart grid policy implementation just as it does for other policy implementation projects. But there are also many derivatives of these main challenges that are specific to smart grid policy implementation that must be considered during this stage. These include barriers such as raising consumer awareness about smart grids to incorporate valuable input and feedback from the primary users of the product. Stakeholder engagement must also be emphasized in a smart grid policy project as a smart grid is a sort of umbrella concept or product which includes many distinct sectors such the utilities, regulatory boards and end-users. Cooperation and collaboration becomes increasingly difficult as the number of participants increase, therefore smart grid project face great difficulty in this aspect. As a relatively new concept, the need for regulatory frameworks is crucial to not only enable successful integration into the electricity market but also to allow for interoperability among different grid networks and markets. These are the primary challenges that have been identified through the study of smart grid reports and current smart grid policy schemes worldwide, and have been summarized in the figure below.

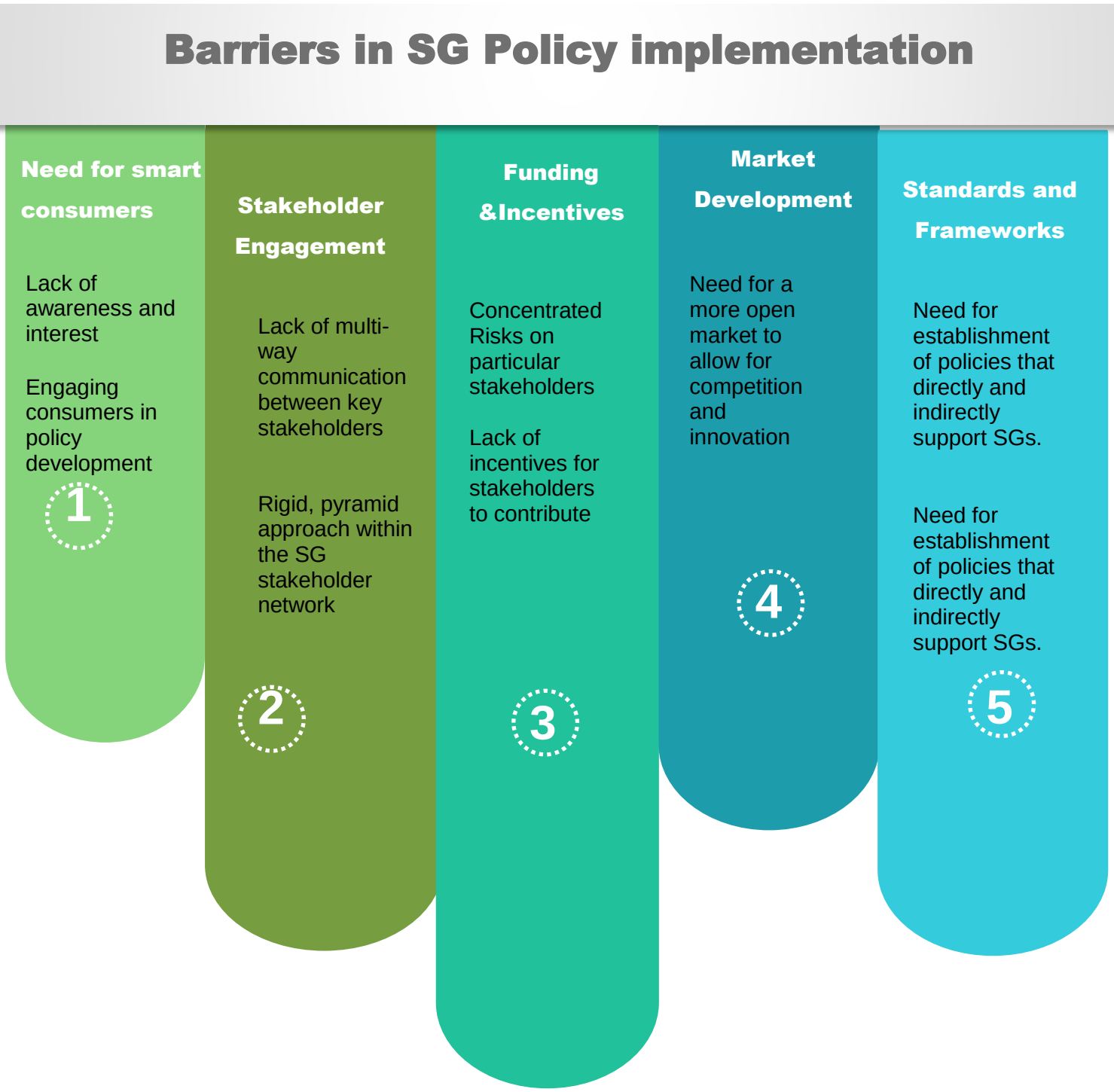


Figure 5: Key barriers in smart grid policy implementation as seen in literature

Chapter 3: Case Study Introduction

Energy Scenario, Need for Smart Grids & Smart Grid Policies in India and the Netherlands

Introduction

This chapter will aim to answer the second sub-question: *What is the smart grid policy framework for India and the Netherlands? How far has it already been implemented?*

By looking into the current energy situation and smart grid policies in the Netherlands and in India this chapter aims to set a foundation for the analysis of the smart grid policy implementation barriers in the chosen countries in the following chapter.

India and Netherlands were chosen as the case studies for several reasons. The first and foremost is that both the countries have initiated the smart grid project plans over the past few years. There are more than a handful ongoing collaboration in the Netherlands between research institution and the public and private sector that are working on smart grid pilots (Covrig et al., 2014). Smart grid products like smart meters have been also been promoted by the Dutch Government as part of the EU Smart Grid Task Force. India is also working vigorously on its smart grid prospects. The Government of India has established a India Smart Grid Task Force Smart Grid Vision for the country that aims to tackle national problems such as low electricity access, reliability and quality of supply as well as incorporating renewable energies into the energy mix (Ministry of Power, 2013).

I. India

1. Energy Situation

India is a country that is heavily dependent on fossil fuels, as can be seen in the diagram below showing the primary energy demand in the nation by fuel.

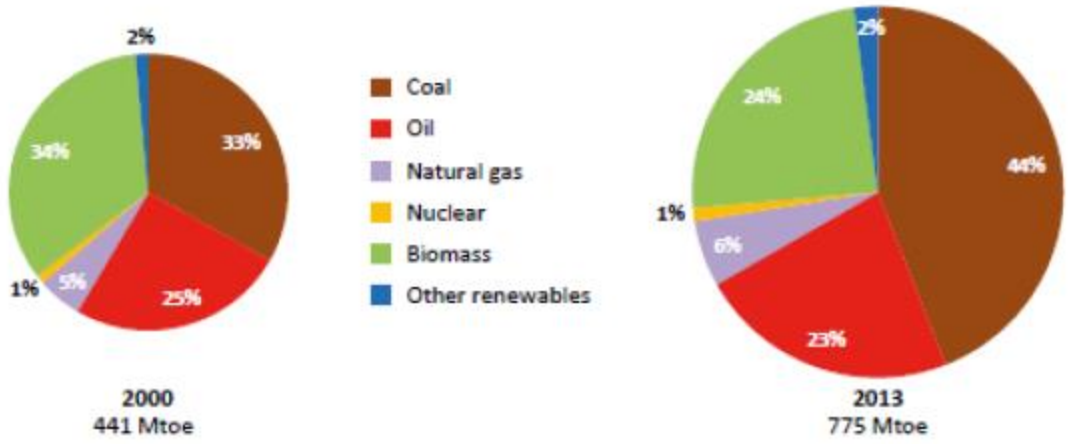


Figure 6: Primary energy demand in India by fuel
Source: India Energy Outlook 2013

Coal and oil constitute more than 50% of the country's energy demand. As this is raising many challenges in terms of energy security, independency and economic growth of the nation, the government of India is putting strong emphasis on the development and use of renewable energy technologies. Although India is abundant in renewable resources like solar, wind and hydroelectric the transformation to a greener energy use within the country is a slow and taxing process.

While India continues to transform its energy sector into a greener, sustainable one, the demand will continue to rise as a result of a rapidly growing urban and industrial sector. To reduce the resulting pressure on the energy sector, smart grids could be the first stepping stone. India could work on increasing its energy efficiency through the implementation of smart grids, as the country's transmission and distribution are at a shocking 22.7%. (PR Newswire, 2017)

2. Need for Smart Grids in India

The reason behind the need for smart grids varies significantly with regard to whether one is talking about developed or developing countries. The IEA has studied these factors by creating a technical roadmap to smart grids for both these regions. While as emerging economies, developing countries face some additional challenges that developed countries do not. Nevertheless, such countries also have the opportunity to 'leapfrog' into the smart grid technology by learning from the experiences of developed countries. The most important factors are described below in detail.

a) Growth in energy demand

Energy demand in India as well as many other developing countries like China and Brazil is growing at an alarmingly fast rate. Many reasons such as economic, population or industrial growth are known to be causing this increase.

Electricity consumption, in particular, is increasing rapidly in India and the developing world in general. The figure below shows the electricity consumption growth between the period of 2007 and 2050. And as can be clearly seen from the figure, developing countries such as India and China are at the forefront of highest increase in electricity consumption by a large lead, as compared to other OECD countries or even the global average.

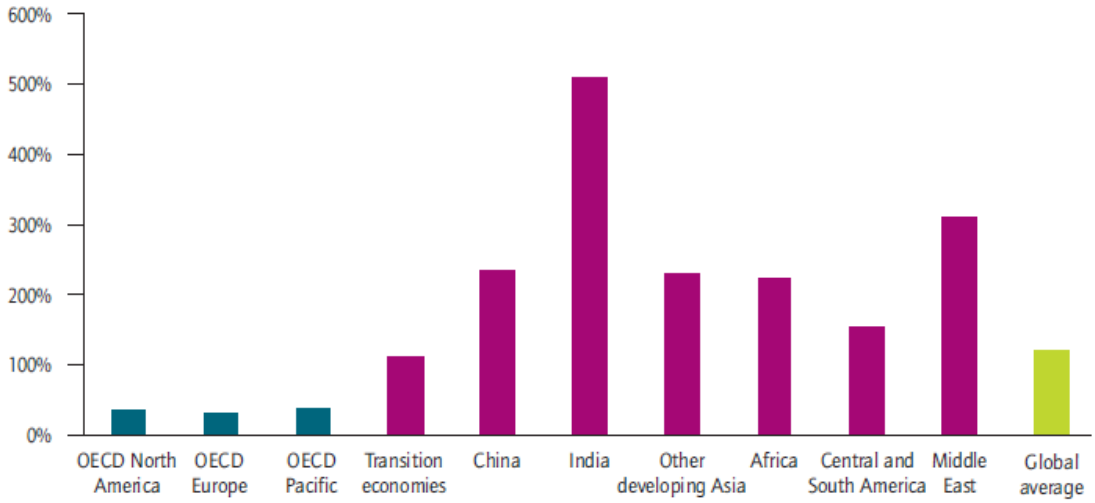


Figure 6: Electricity consumption growth 2007-2050 (Blue Map Scenario)
Source: IEA 2010

India and China in particular, also have a booming population along with a large fraction of people moving to urban cities. This internal transition of the population from rural to urban setups is also a key player behind the growth in energy demand.

Smart grid technologies can enable increase in the efficiency of the supply system as well as the efficiency of the energy management system by understanding and predicting the consumer demand which could help alleviate the stress placed on the supply system.

b) Energy theft

Energy theft is a problem that is prominent in many developing nations, but particularly so in India. This not only leads to several issues for the consumers but also affects the supply system in a harsh way. Energy theft can be done in many ways and the methods change to adapt to the utility system. This makes identifying where, when and how much of energy was stolen very difficult to determine. Most of the thefts in India use modifications of similar ideas, such as bypassing the meter, slowing down the meter and inverting the meter

(Purvis, 2015). This leads to severe losses and problems for the utilities, such as lower reliability as the utility may continue to dispatch energy from the substations but due to theft in between the substations and consumers, consumers may be receiving an unreliable supply if not a complete loss of supply. Many utilities, especially in the developing countries, take the possibility of energy theft into account and distribute more energy than needed by the intended consumers so that the end-user is guaranteed a reliable supply. But this means a higher need for generation and transmission that not only affect the cost of the electricity being transmitted (Ahn & Graczyk, 2012) but also more significant impact on the environment leading from increased energy generation. This affects the Indian electricity authorities severely, especially due to the financial burden of transmitting additional electricity and the energy theft.

All these methods involve fiddling with the meters, which then affect the reading or prevent the meter from registering any use. By using one of the most important aspects of smart grid technology, distribution system meters, together with smart meters, utilities are able to know how much energy is being consumed at a given point within a grid and compare it with the energy distributed from the substations. The use of such meters along with other smart grid features can help utilities in increasing their operational efficiency which was previously being compromised due to the lack of appropriate measuring, detecting and monitoring equipment.

c) Incorporation of renewable energies into the grid

The production of renewable energies has become one of the top priorities for nearly all countries in the world, i.e. for both the developing and the developed world. India has also signed agreements like the Paris Climate Change agreement that urges the nation to act in reducing CO_2 emissions by switching to renewable energies as much as possible. Although most countries have the resources, such a copious amount of solar radiation, wind or hydroelectric potential, reliability is the most troubling problem with the use of such energies. As the resources are not guaranteed at all times, utilities must remodel the grid system to adapt to needs such as these. The figure below illustrates the expected increase of India as well as different prominent regions in the use of renewable energies into their electricity systems. Such a severe increase would require electricity systems to be capable of managing the sources to moderate the reliability and flexibility of the system.

Smart grids can improve the flexibility of an electricity system with the use of real-time system information that would allow utility operators to “manage generation, demand and power quality, thus increasing system flexibility and maintaining stability and balance”. (IEA, 2011)

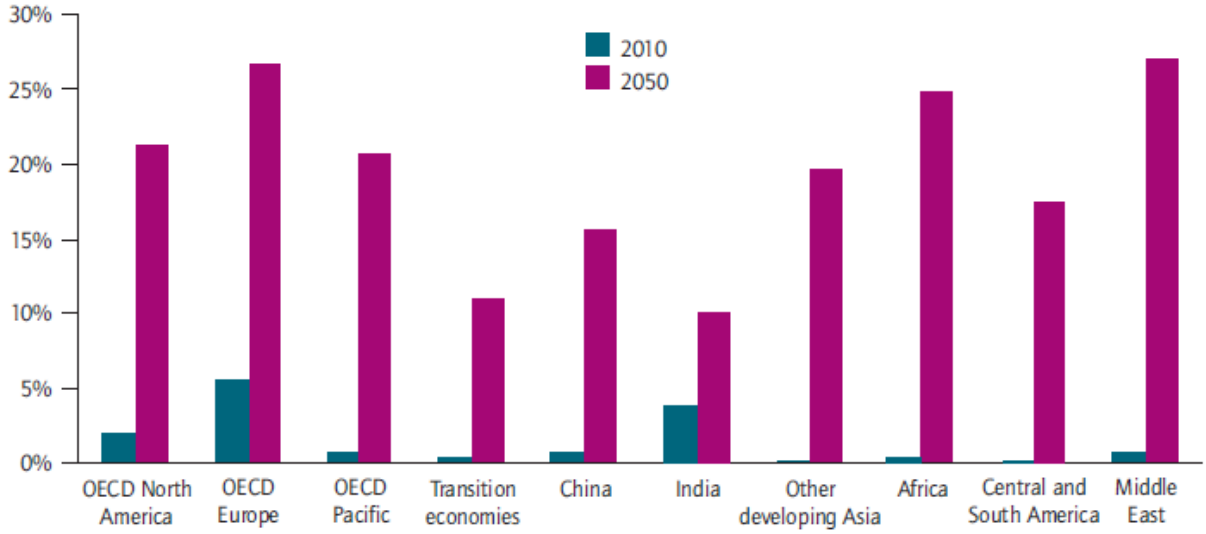


Figure 7: Portion of variable generation of electricity by region (BLUE Map Scenario)
Source: IEA 2010

3. Electricity sector - India

India's electricity sector is relatively complex owing to the large area and high population. "The country is electrically demarcated into five regions namely, Northern, Western, Southern, Eastern and North Eastern Region." (Government of India, 2017) As the electricity sector holds most of the key players that are needed to implement a smart grid system, it is vital to look into the entities within this realm. As of today there are more than a handful of entities that govern the electricity supply, distribution and transmission and regulatory boards based on the IEA Partner Country Series Report on the Energy Challenges in India (Ahn & Graczyk, 2012):

[1] **Central Electricity Authority (CEA)**: gives advice on future plans related to the development of electricity system and National Electricity Policy to the government.
[2] **Central Electricity Regulatory Commission (CERC) and State Regulatory commissions (SERCs):** responsible for "regulate tariff, formulate policies regarding subsidies and promote efficient and environmental benign policies at central and state levels, respectively" (Ahn & Graczyk, 2012).
[3] **Central Transmission Utility (CTU) and State Transmission Utility (STU):** ensures development of an efficient, coordinated and economical system of interstate and intra state transmission systems respectively.
[4] **Powergrid Corporation of India LTd (POWERGRID):** responsible for national and regional power transmission planning, while the state sectors have separate state transmission utilities.

[5] **National Load Despatch Center:** responsible for optimum scheduling and despatch of electricity among the regions.

[6] **Power System Operation Corporation Limited (POSOCO):** responsible for real time operation of the grid and dispatch of electricity within the region through secure and economic operation of the regional grid.

As can be seen from the list above the electricity sector in India is crowded with many entities that govern different crucial areas. This could pose a challenge in implementing smart grids in the country as all these different entities need to be brought together, and the higher the number the more obstacles to face.

The energy situation and the need for smart grids in India in one way or the other shape many of the energy, electricity and climate policies of India. The structure and key actors in the electricity sector of India play an important role in the future of new project and policy developments in India. To understand the current smart grid policies for India and to later on look into the challenges in smart grid policy implementation in India, such background factors like current energy scenarios, electricity sector layout, prime stakeholders are crucial. A basic understanding of the following areas will aid in grasping the following the section about the current policies and policy challenges in India.

4. Smarts Grids Roadmap for India

The Smart Grid Vision for India is declared as "*Transform the Indian power sector into a secure, adaptive, sustainable and digitally enabled ecosystem that provides reliable and quality energy for all with active participation of stakeholders*".

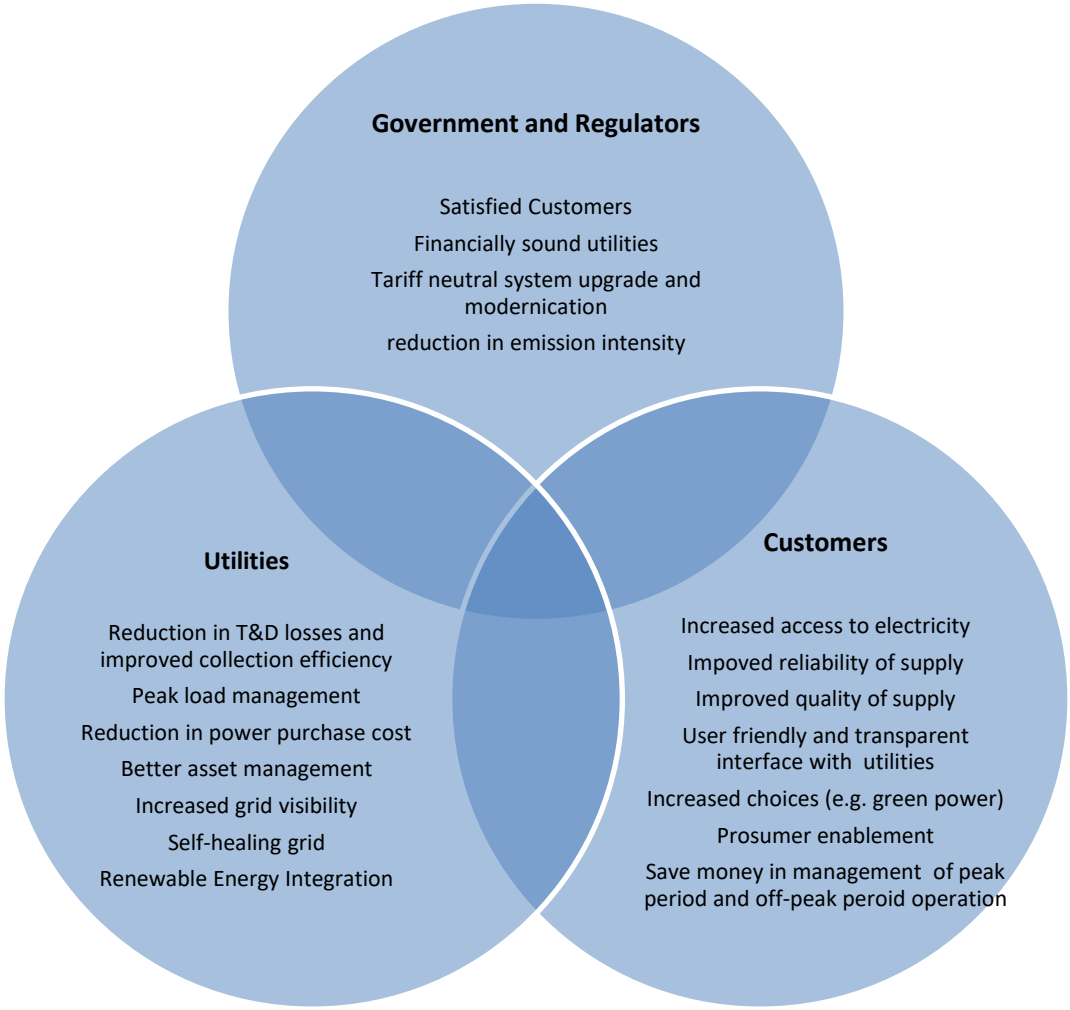


Figure 7: Smart Grid Benefits for the three main stakeholders of a smart grid system.
Source: Smart Grid Vision and Roadmap for India as given by the Government of India (2017)

The current policies, standards and regulations that fall under the policy objective of Access, Availability and Affordability of Power for All:

1. "Formulation of effective customer outreach and communication programs for active involvement of consumers in the smart grid implementation.
2. Development of state/utility specific strategic roadmap(s) for implementation of smart grid technologies across the state/utility by 2014. Required business process reengineering, change management and capacity building programs to be initiated by 2014. State Regulators and utilities may take the lead here.

3. Finalization of frameworks for cyber security assessment, audit and certification of power utilities by end of 2013.
4. Policies for grid-interconnection of captive/consumer generation facilities (including renewables) where ever technically feasible; policies for roof-top solar, net-metering/feed-in tariff; and policies for peaking power stations by 2014.
5. Policies supporting improved tariffs such as dynamic tariffs, variable tariffs, etc., including mandatory demand response (DR) programs, starting with bulk consumers by 2014, and extending to all 3-phase (or otherwise defined consumers) by 2017.
6. Policies for energy efficiency in public infrastructure including EV charging facilities by 2015 and for demand response ready appliances by 2017. Relevant policies in this regard to be finalized by 2014.
7. Development/adoption of appropriate standards for smart grid development in India–first set of standards by 2014; continuous engagement in evolution of applicable standards relevant to the Indian context. Active involvement of Indian experts in international bodies engaged in smart grid standards development.
8. Study the results of the first set of smart grid pilot projects and recommend appropriate changes conducive to smart grid development in the Indian Electricity Act / National Power Policy by end of 2015.
9. Development of business models to create alternate revenue streams by leveraging the smart grid infrastructure to offer other services (security solutions, water metering, traffic solutions etc.) to municipalities, state governments and other agencies.
10. Development of Skill Development Centers for smart grid." (Ministry of Power, 2013)

5. Policy Implementation Status – India 2017

Today in 2017, four years have passed since the Ministry of Power established the smart grid roadmap for India with the goals mentioned above. But the progress that has been during this time regarding the actual implementation of these policies is not as well documented as one would expect. There have been 12 pilot projects that were sanctioned by the Ministry of Power in 2012 and three large scale projects which were sanctioned in 2016 (Government of India, 2017). Some examples like a pilot project in the state of Assam, within a period of about two years (March 2015 – June 2017) the only progress has been in installing smart meters while other relatively early stage aspects like smart grid control center setup and security measures are still only in progress (Government of India, 2017). While other projects, like a pilot in Punjab which also started in March 2015 has only been able to get documents for smart meters approved by POWERGRID while still only

drafting the regulations and consumer awareness plans (Government of India, 2017). The current status of the ambitious vision of the Government of India shows the surprisingly slow rate at the progress of smart grid pilots in India. If this continues, more largescale projects that are planned to be implemented are likely to suffer severely. Private projects like the two that were initiated as a part of BESCOM's pilot projects also failed due to reasons including the lack of appropriate planning in the process among the many national and international stakeholders (Moudgal, 2015).

The previous sections on the current policies regarding smart grids in India show that the India has a very ambitious plan to move forward with the development and implementation of smart grids in urban and rural areas of India. The policies aim to target multiple problems with the implementation of smart grids including, efficient energy management, improving power access and increasing national energy security among others. These problems are putting a pressure on building smart grids urgently, but much work needs to be completed to be able to achieve success to any extent in any of these aspects. The Smart Grid Roadmap for India addresses several policy implementation targets such as developing consumer outreach programs and introducing market measures to encourage smart grid development. This vision also states the year by which many of the targets aim to be achieved, and this shows the tight schedule in which the roadmap aims to achieve these targets. The roadmap which was developed and published in 2013 by the Ministry of Power sets forth many targets within a short duration of one or two years. But after four years of developing this vision, the Ministry of Power has not released any further information regarding the progress of the targets stated in the vision. However, the status of the smart grid pilot projects in different cities of India is briefly stated on the National Smart Grid Mission Webpage (National Smart Grid Mission, 2017). From the short project reports it can be understood that there have been a couple successful projects that have been completed for example in Ajmer and IIT Kanpur (National Smart Grid Mission, 2017) although the complete details of the achievements are not provided, while there are more than a few projects that are still lagging due to failures and repeated attempts in issues like installing smart meters. Furthermore, the updates in the project status descriptions shows that many processes needed to be sanctioned by concerned authorities of the different pilot projects, which suggest that complex bureaucratic and administrative systems may have added to the delay in the progress of the smart grid pilots.

II. Netherlands

Netherlands was chosen as one of the case studies for this project for several reasons. The first reason is that the country is tackling many energy issues as are many countries in the world, and one way Netherlands is combating these issues is through the introduction of

smart grids to improve energy efficiency. This leads to a discussion and developments of smart grid related policies with many different stakeholders within and outside the country. As a European Union state, Netherlands serves as a unique example as compared to prior discussed nation of India as in many ways Netherlands is obliged to external rules as directed by the European Commission and related authorities. Furthermore, the Netherlands serves as interesting comparison to India as they differ quite drastically in their state of development as countries. As will be seen from the following sections, this shapes the policy implementation challenges of these two countries quite significantly.

1. Energy Situation

The Netherlands is obliged as per EU regulations to mitigate its carbon footprint and increase its use of renewable energies. This requires stricter energy management systems within the country to monitor and control the energy demand. However, incorporating renewable energies into smart grid systems needs further advancements in terms of technology and finance.

A common issue that the Netherlands and India are both trying to tackle is an energy mix that is dominated by fossil fuels. Natural gas and Oil constitute about 80% of the energy mix of the country. This is a strikingly high share of fossil fuels, especially for an EU member state as EU is strongly pushing production and the use of renewable energies. The Netherlands is committed to sustainable and renewable energy goals internally as well as to external goals mandated by the EU for 2020, 2030 and 2050 (Energy Report, 2016). The Dutch cabinet's energy policies aim to work on three main principles which are:

1. Focus on CO_2 reduction
2. Make the most of the economic opportunities that the energy transition offers
3. Integrate energy in spatial planning policy. (Energy Report, 2016)

As a European Union country, many but not all smart grid projects are funded to a large extent by European Union. And the European Union aims to create an interconnected smart grid network among the European Union different concerns must be addressed as the priorities and challenges in the member countries may be different hence requiring different focus areas during the planning and implementation stages.

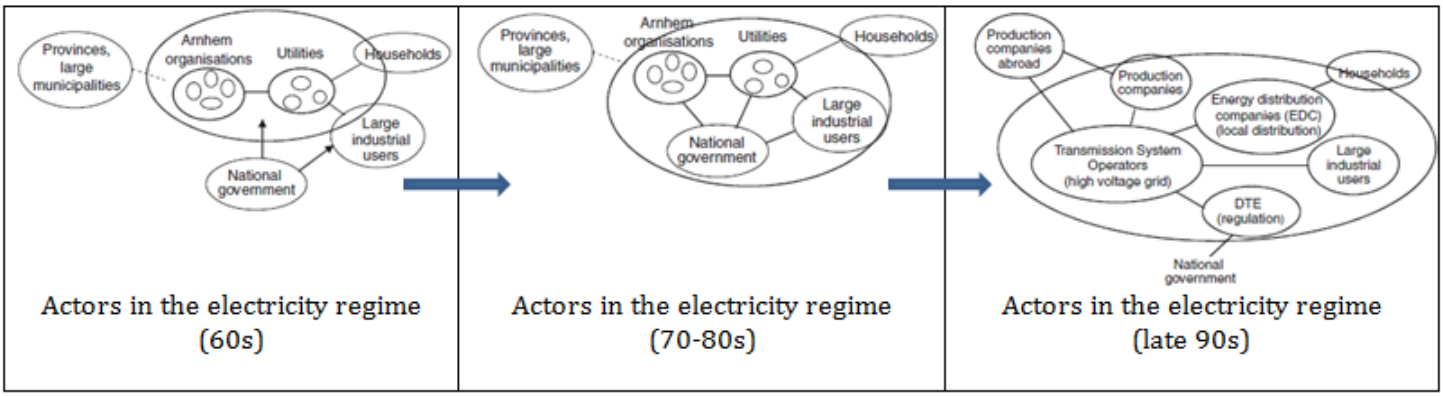


Figure 8: Actors in the electricity regime in the Netherlands through the decades.
Source: Verbong & Geels (2007)

As can be seen from the diagram above the landscape of actors in the electricity regime within the Netherlands has changed very much over the years. In the 60's the key players with the most influence of the market was limited to the Arnhem organization and the utilities. This evolved in the 70s and 80s to include the national government and industrial consumers, thus expanding the range of influential stakeholders. It expanded further in the late 90s to include production companies, transmission operators, regulatory boards and energy distribution companies. This gradual expansion of the reigning stakeholders within the Dutch electricity market shows that further expansion and development of the market is possible if needed and is handled with care. Smart grid policies and the respective stakeholders that need to make their own space within the electricity market can surely do so with time and motive. But to make this transition quicker as is the current need of the energy transition worldwide, regulatory boards specifically must step forward in expanding the market authority needed stakeholders of smart grids such as residential consumers and the private sector.

The energy situation of the Netherlands shapes many of the policies and market sector of the country. While many countries are currently working on smart grid developments, the reasons are often different and these reasons are more and less shaped by the energy issues of the country. The energy sector and the issues and gaps within it, do influence the growth and need for smart grids in the Netherlands which are described below.

2. Need for smart grids in the Netherlands

Developed countries, like the Netherlands, are also facing its own set of challenges in the energy and electricity sector. New policies and governments are urging nations to take severe measures to cut down CO2 and other greenhouse gases that result of energy

production. In this regard, both emerging economies and developed nations are almost in the same situation, as renewable energy production and the measures needed to facilitate a flexible supply with varying resources are the same for both groups. Although, it is important to recognize that developed countries can be said to be at the forefront of pushing for a transition to a digitalized grid. This means that unlike developing countries, OECD countries do not have a functional operating model to look up to and must be the initiators and pioneers in this field. Many of the issues in the electricity sector in developing countries described above are also key issues in the developed world, but there are some challenges that they face differently which are described below.

a) Ageing infrastructure

Since electrification of developed countries took place a long while ago, the current infrastructure of electricity sector is not entirely suitable to support growth or changes in demand. As goals such as European's 2020 targets urge nations to cut down on their use of fossil fuels, many measures have been taken to not only change the energy production style and pattern but also the consumer demands.

b) Growth in demand (Electric transport)

Growth and changes in demand must be predicted and acted upon so as to prevent unprecedented shock to the electricity system .One such demand, which is now growing in developed countries, is the use of electric transport. A growing population is now transitioning to electric vehicles from fossil-fuel powered cars not only because of the environmental benefits but sometimes also to gain the "green-image" tag that is gaining popularity rapidly. Trends such as these demand a change in grid infrastructure. Smart grids

c) Reducing Peak Demand

As electricity systems are designed to meet the highest level of demand, the system operates at the highest level at all times. Therefore during the non-peak hours the system is dealing with, i.e. generating and distributing more energy than is used by the end users. This leads to a low operational efficiency of the network, but it can easily be improved with the integration of smart grid technologies into the grids. By providing information about peak hours as well as incentives as lower rates during non-peak hours, consumers can be motivated to shift their consumption to lower demand periods. This is known as the demand response in the electricity system, where "end-users (at the industrial service or residential service level) alter consumption in response to price or other signals – can both

reduce peak demand but also provide system flexibility enabling the deployment of variable generation technologies" (IEA, 2011).

These needs of ageing infrastructure, growth in demand and reducing peak demand are some among the many reasons of why research and investment in smart grid development projects as well as other energy projects is increasing (National Energy Outlook, 2015). These reasons along with the guidance and directives from the European Commission play a role in developing the current national policies that encourages the growth of smart grids in the country as will be seen in the following section.

3. Netherlands' Smart Grid Policies

Political and governance barriers arise mainly from the lack of incentives from the government and other regulatory bodies that encourage and support the development and implementation of smart grids in developing and developed countries. While these two parts of the world are putting in work to encourage the use of renewable energies and focusing on energy supply and security issues that in turn support the growth of smart grids which alleviates these problems to some or a large extent, much work still needs to be put in to allow a full dispersion of smart grids around the world.

Within Europe the policy drivers are the "climate and energy goals, energy policy goals and the third energy package". These policy drivers serve as a motivation for private as well as government smart grid development programs, but these goals are not simply enough. Incentives, in the form of subsidies or other benefits must be provided for all relevant parties that are involved in a smart grid network, i.e. the producers, consumers and utilities.

The development of policies can help create a basic framework serve as a guideline for the implementing smart grids. As many different aspects of a smart grid need to be considered such as generation, transmission, substation, distribution, consumption etc. policies regarding on these component topics needs to be formed or specialized within reference to their role within a smart grid network. [Zhang et al 2017]

Policies of different sorts have been adopted by different parts of the world that directly or indirectly promote and support of the development of smart grids. The EU supports smart grids as part of its low-carbon programs, Japan to increase its energy security and China to improve its energy savings. Although the main motivation behind these policies may vary, as the world moves towards a global transition in the way energy is produced, transmitted and consumed, the sub-motives of the policies lead to more and more stakeholders investing in the development of smart grids.

Current smart grid related policies in the EU

1. Smart Grids Task Force – a collection of common standards and technical requirements for smart grids. One of the primary goals of the Smart Grids Task Force is to "replace at least 80% of electricity meters with smart meters by 2020 wherever it is cost-effective to do so". (European Commission, 2017)
2. Connecting Europe Facility
3. 2009 Electricity Directive – rollout of smart metering systems (but without a deadline binding the member states to comply)
4. Cyber Security in the Energy Sector EECSP – Expert Group

To understand the energy policies of Netherlands specifically, one must first look into the key energy regulatory bodies in the country, and these are "

1. **The Ministry of Economic Affairs** – responsible for the overall Dutch energy policy, including policies for renewable energy, energy transition and bio-based economy, and research, development and demonstration (RD&D). Also responsible for large-scale infrastructure projects in the field of energy
2. **The Ministry of Infrastructure and Environment**- responsible for policies on climate, environment, transport, water and public works.
3. **The Ministry of Education and Science** – responsible for fundamental research through publicly funded universities and research institutes" (IEA,2014)

These ministries together have come together in developing several national policies concerning energy and environment issues in the country. Some of the **key energy policy objectives** are mentioned below:

1. "A modern industrial policy to strengthen the competitiveness of the Dutch energy sector through public support to businesses and knowledge institutes to work together in the development of energy technologies (for both green and grey energy) in which the Netherlands excels on the international market. This should make renewable energy cost-effective and bring benefits to the Dutch economy.
2. Expanding the share of renewable energy to reach European targets by stimulating the production of the most efficient renewable energy options through the Sustainable Energy Incentive Scheme (SDE+), efforts to promote offshore wind and the co-firing of biomass in coal-fired power plants within the sustainability criteria.
3. Encouraging energy conservation and decentralized sustainable energy generation by promoting a Green Deal for energy with the society.
4. Providing scope for all energy options for a reliable energy supply to ensure a balanced mix of green and conventional energy, including nuclear energy.
5. Investing in a sound European energy market with a good infrastructure by ensuring careful spatial planning, including the connection of future offshore wind, and

crossborder co-operation of transmission system operators (TSOs)." (Ministry of Economic Affairs, Agriculture and Innovation, 2011)

These policies mentioned above do not influence the development of smart grids in the Netherlands directly, but do play a role in encouraging them indirectly as increasing the share of renewable energy in the energy mix, working on a nurturing energy market do. One of the policies that directly targets the implementation of smart grids is one among the ten pillars of Energy Agreement for Sustainable Growth. This objective is stated as:

"Completing the energy transmission network (smart grids, innovative use of energy infrastructure, including storage and demand-side participation). The investments are to be supported by adequate conditions for infrastructure financing and a strong regional and EU-wide co-operation on the integration of energy networks". (IEA, 2014)

4. Policy Implementation Status – Netherlands 2017

Smart grid policies in the Netherlands as can be seen by the targets mentioned above are derivatives of the European Unions' Directives. The primary focus of the energy sector and stakeholders in the Netherlands has not very specifically focused on the development and implementation of smart grids. Instead by promoting many other external factors, like promoting renewable energy and improving energy efficiency and energy security of the Netherlands smart grids are being encouraged as they play a key role in achieving all of these targets. "The current policy is mainly focused on further setting up the innovation system for smart grids, organizing the players involved, the cooperation with local initiatives, international cooperation, laws and regulations, and the development of (usually international) standards." (NL Agency, 2012) The quote above captures the current policy objectives of the Netherlands regarding smart grid implementation in a thorough manner, as it shows how the external or indirect factors affecting smart grids are stated to be of priority.

Secondly, the smart grid policies of the Netherlands do not seem to be long-term and sustainable. This can be seen in the experimental approach the Dutch stakeholders have adopted in implementing several smart grid pilots in cities across the Netherlands (National Energy Outlook, 2015). The pilots are deployed only for short durations which has given the Dutch smart grid project implementers many vital lessons from the failures and successes but still do not give a full perception of a scenario of a large-scale smart grid system which is what the European Union is aiming to achieve.

The Netherlands has implemented twelve pilot projects as part of the goal of the Smart Grid Innovation Programme (Innovatieprogramma Intelligente Netten - IPIN) (Netherlands Enterprise Agency, 2015a). Netherlands is ahead of India in terms of the progress that has

been made over the past years regarding the implementation of smart grid policies, as the pilot phase was completed in 2015 and some pilots were to be continued. Smart grid pilots in areas like Lochem, a residential area, helped stakeholders identify the prime concerns regarding further development of smart grid policies over the span of three and a half years (Netherlands Enterprise Agency, 2015a). These include implementation of market measures like variable tariffs and demand response during peak hours (Netherlands Enterprise Agency, 2015a). Pilots also show that grid improvements are crucial to the success of smart grids as well for renewable energy integration which is also a key priority for the Netherlands. The chairperson of Zeenergie, Henri van 't Erve, one of the main stakeholders for a smart grid pilot project in Zeewolde evens goes so far as to say that "biggest bottleneck for implementation is that the legislation and regulations do not encourage participation" (Netherlands Enterprise Agency, 2015b). The current pilot projects in the Netherlands have been relatively successful although also highlight many issues that need to be addressed. Furthermore, stakeholders need to move into implementing largescale projects that can help understand new problems or new severities of existing problems that could emerge in largescale projects which may not be experienced in smaller pilot smart grid projects.

One pilot project which gained a lot of attention in the Netherlands is the PowerMatching City pilot in the city of Groningen. This was a multi-stakeholder project which comprised of collaboration from different realms like universities, business and electricity providers. The project proved to be quite successful in technical, economical and sustainable aspects. However, the stakeholders have come up with improvements in the current system which could enable a larger-scale implementation of smart grids. These include improvements in the energy market such that the role of "collecting and distributing flexibility" (Gasunie, 2015) is taken upon by one institution rather than many. Standardization of the smart energy systems is also a primary feature which will enable smoother implementation of successful larg scale projects. An additional benefit of standardization is reduced cost to consumers which is also of importance when aiming to build a successful smart grid system. The recommendations above of standardization and market reform highlight the two main focus areas which need to be improved when considering smart grid projects in the Netherlands.

Netherlands has put a lot of focus in the implementation of smart meters as the first step towards an integrated smart grid network. Smart meter installment was initially planned to be a mandatory process but growing privacy concerns amongst consumers caused severe delays in the process which later on led to an opt-out smart meter rollout program. This allowed consumers to opt out of installing smart meters in their homes (EU Commission, 2017). A study comparing smart grid project in the Netherlands, the PowerMatching City to one in the United States tells that the most of the participants of the

Dutch smart city project which involved smart meters, smart appliances, energy management systems, were mostly highly educated and well paid and some even employees of the main stakeholders of the project (Obinna et al., 2017). This shows that public awareness and involvement in smart grid projects is low in the large- scale perspective and initiatives to better this situation need to be implemented.

III. Conclusion

With an understanding of the topics discussed in the earlier sections which comprise of country energy scenarios, stakeholders in national policy development and the current smart grid related policies in the Netherlands and India, a further look into the challenges in implementing these policies can be conducted. The countries chosen differ in many aspects, such as state of development, priority on energy matters, funding, standards and frameworks development for policy implementation. The current energy policies and directives governing the development of related projects in the respective countries also give an understanding of the current standing of India and the Netherlands in the matter of smart grid development. An understanding of these factors will aid in the comparative analysis of smart grid policy implementation barriers in the following chapter.

Chapter 4 – Case Studies: Analysis

Comparative analysis of smart grid policy implementation barriers in India and the Netherlands

I. Case Studies

The previous chapter on the energy situation and the need for smart grids in India and the Netherlands will set the foundation for the analysis of barriers in policy implementation in this chapter.

This chapter aims to answer the third research question of this thesis: *What can be learned from the smart grid implementation policies in the Netherlands and in India that could be useful for other developing and developed countries?*

The barriers in smart grid policy implementation identified in Chapter 2 will serve as a backbone for the comparative analysis which is to follow. These barriers are briefly described below:

1. Need for consumer awareness and involvement
2. Lack of Stakeholder Engagement
3. Funding & Incentives
4. Market Development
5. Standards and Frameworks

II. India and Netherlands' Smart Grid Implementation Challenges

"There has been little indication of how policies should be prioritized, no plan for funding them, and often a gap between policymaking and implementation" (Madan, 2006). This is what has been state of energy policy making and their implementation in India. As a developing country, India faces many difficulties in effective implementation of its policies such as the lack of effective stakeholder collaboration, lack of consumer awareness about smart grids, lack of incentives for consumers and other prime stakeholders to take initiatives among others. The Netherlands also faces many such challenges in its policy implementation in the field of smart grids even as a developed country. While there are some similar challenges that both the countries face, the extent of the problem of the

challenges is often different and affects the implementation process in different ways. The barriers in smart grid policy implementation as identified from the literature review in Chapter 2 serve as a backbone is building a comparative analysis of the challenges in the case studies of Netherlands and India which could also aid in creating a representation of differences in smart grid policy implementation challenges in developing and developed countries.

1. Need for increased consumer awareness and involvement

Consumer and Smart Grids in India

A very important challenge that is hindering the implementation of smart grid projects in India is the hesitancy of consumers to switch from an analog to a digital system. In India and other developing countries, especially in rural areas, technology is still somewhat of a foreign concept. Therefore, new concepts like that of smart grids are rejected by consumers due to fear or belief that an "ordinary" or normal electricity grids rather be implemented in their areas.

In rural areas, the benefits of smart grids such as incorporating renewable energies or advantages of an interconnected system may not be valued highly by consumers as they are often not aware of these concepts and even more often consider these problems to not affect them directly. While sometimes, awareness raising programs can succeed in getting through, it may not be enough. Therefore, when reaching out to consumers like these it is important to appeal to benefits that they can relate to such as increased energy efficiency which would hence lead to minimized costs etc. The lack of awareness programs and incentives limit consumer involvement in the policy implementation stage, which hinders policy implementation and hence negatively affects the project success as a whole. (Acharjee & Gunda, 2010). "Capital or fund is not the core problem to implement SG. But the great obstacle to apply SG is political issues, mind set of general consumers (common people) in the developing and under-developed countries." (Acharjee, 2013) While funding is a significant challenge to smart grid policy implementation, as this quote states consumer willingness is among the most crucial factors to effective policy implementation.

Consumer and Smart Grids in the Netherlands

Consumer involvement is crucial to the success of smart grids worldwide, hence in the Netherlands as they are the direct end-users of this service. Therefore, consumers must have a fair share in putting forth their opinions and ideas during the implementation of a smart grid system. The lack of consumer involvement could lead to many unexpected problems during the final stages of implementation which would affect the duration, cost, effects and overall success of any smart grid system.

The importance of involving end-users was clearly proved by the smart grid rollout in the Netherlands in 2012 as per the EU 2009 Directive (Hoenkamp et. al, 2011). The rollout which obliged all consumers to install smart meters received severe backlash from the public due to concerns of privacy and security. The public protested against the mandatory rollout of smart meters which eventually led to reforms in the policies that made the smart meter implementation optional. This makes Netherlands the only country in the European Union to currently have a "mandatory with opt-out" smart meter deployment strategy (European Commission, 2017). The experience from this rollout process should be a lesson in further smart grid implementation projects to include the public and consumers of smart grids in the development of strategies and policies.

2. Stakeholder engagement in policy implementation

Stakeholder Engagement in India

As seen in the section describing the electricity sector of India, nearly all of the key energy players are governmental authorities. This affects the stakeholder management and relations in many energy issues, including that of smart grid policy implementation. One of the main challenges that India faces due to the structure of the existing electricity structure is lack of vertical and horizontal collaboration among the stakeholders, especially since India lacks a singular, cross-country authority to govern the energy sector (Ahn & Graczyk, 2012). This poses a very difficult challenge, especially in a federal nation like India where about 30 different state governments have their own agendas which must be made sure to correspond with the central government's policies (Government of India, 2017). Without multi-level discussions, policy implementation in the field of smart grids which in itself is an interconnected web of different sectors like technology providers, regulatory boards, end-users and many others, is likely to suffer severely. As stated in *Strategy and Implementation of Smart Grids in India* by Acharjee, "It means that the standards should be developed and maintained through a collaborative, consensus-driven process that is open for the participation by all relevant and materially affected parties and not dominated by, or under the control of single organization or group of organizations"(Acharjee, 2013).

Secondly, the energy sector, which is the primary stakeholder in smart grid related projects in India, faces immense financial pressure. But it is important to note that "many of India's energy players suffer from financial weakness, with limited financial resources and restricted investment ability" (Ahn & Graczyk, 2012). This adds to the stress on the prime stakeholders, which could demotivate them from taking initiatives and lead to cutbacks which could be critical to the success of a policy implementation. The lack of diversity in stakeholders in the field of smart grids and energy sector as a whole is pulling back from

investment in smart grids while the lack of cooperation among the many stakeholders adds to the time needed for policy implementation (Madan, 2006).

Stakeholder Engagement in the Netherlands

The Netherlands faces similar challenges in engaging effective stakeholder cooperation when it comes to smart grid policy implementation. The need for further involvement of stakeholders in the policy implementation is evident in many aspects such as financial investments, market study, developing frameworks and standardization procedures etc. The Dutch National Energy Outlook summarizes this issue as "Successful market development for innovations requires co-investment by all the societal parties involved. Private investment is lagging behind, not only in the Netherlands but also in the rest of Europe" (National Energy Outlook, 2015). On the other hand a different source states that "Netherlands, Denmark, Belgium and Finland have their largest share of private investment coming from the University/Research centres/Consultancies" (Covrig et al., 2014). It is important to note that both the statements claim contradictory things, however it is important to notice how these sources define "private investment". A closer look at the two statements can show that it is investment from the business sector that is lacking severity and not private investment in total which includes universities, research centers etc.

As mentioned here, smart grid policy implementation as well as policy implementation in other projects in the Dutch energy sector could benefit from private investment. "Compared with other stakeholders, DSOs also play a major part in coordinating SG deployment throughout Europe. The overall investment by DSO was nearly 67% for about 115 projects" [Iqtiyanillham et al., 2017]. Without the private investment required, the financial burden of the implementation falls primarily on the government. This disturbs the "balance of power" (Dinica et Bressers, 2003) in the system.

3. Funding & Incentives

One of the biggest challenges holding back investors from investing in smart grid projects is the risk associated to the implementation. "Policy makers face high capital costs and benefit constraints within the same cost to the consumer as seen by the regulator" (Government of India, 2017).The high capital costs arise from the need not only for the infrastructure development but also effective policy implementation.

The financial burden and risk is often put on one main stakeholder, which is in most cases the utilities. Such an immense amount of pressure on the utilities leads to a lack of interest from their side to invest heavily on smart grid projects. The risk in this case, can be referenced as the time, infrastructure needs, funds, resources such as skilled workforces. These shape the backbone of any smart grid project, which is why concentrating all of these risks onto one stakeholder is not practical.

To overcome this challenge, policy makers and regulators must develop a way to balance the risks across the whole value chain. As the smart grid system will replace the existing pyramid structural system of the electricity sector with an interconnected, circular one, a similar structure must also be adopted in terms of risk division. This can be achieved by establishing a clear area or set of tasks that each group of stakeholder is responsible for. So, the regulatory boards must take efforts to establish the clear role of the different stakeholders involved in a project before they embark on the actual implementation.

Smart Grid and Funding in India

India faces many challenges in financing smart grid projects and policy implementation as the prime stakeholder is an indebted energy sector. This is primarily because "part of the energy sector in India keep end-user prices too low" (Ahn & Graczyk, 2012). Such subsidized prices of electricity, which keep the Indian electricity market separate from the international energy market lead to the great losses with the energy providers. The lack of measures to keep the energy prices in line with the international market prices, puts the Indian energy sector in great losses (Ahn & Graczyk, 2012). Moreover, the over-subsidized electricity prices put the state DSO's into debt making them unable or unwilling to invest into smart grid policy implementation (Ahn & Graczyk, 2012).

Smart Grid and Funding in the Netherlands

The developed world generally faces fewer challenges in term of funding and capital as compared to the developing world. However, developed nations like the Netherlands still face some barriers that are encountered in smart grid policy implementation depending on the location, the scale and many other factors surrounding the implementation procedure. While no barrier can be categorized as a higher or lower priority since each project is unique and will experience different and new difficulties, economic barriers are common in many such implementation projects.

Economic barriers can be alleviated by pushing to increase the number of sources of funding for smart grid development. For example, the EU currently derives its funds for smart grid implementation from five different sources (Covrig et al., 2014):

1. "Private funding – referring to the funding provided by private organizations or individuals.
2. European Commission funding
3. National funding
4. Regulatory funding
5. Unclassified funding"

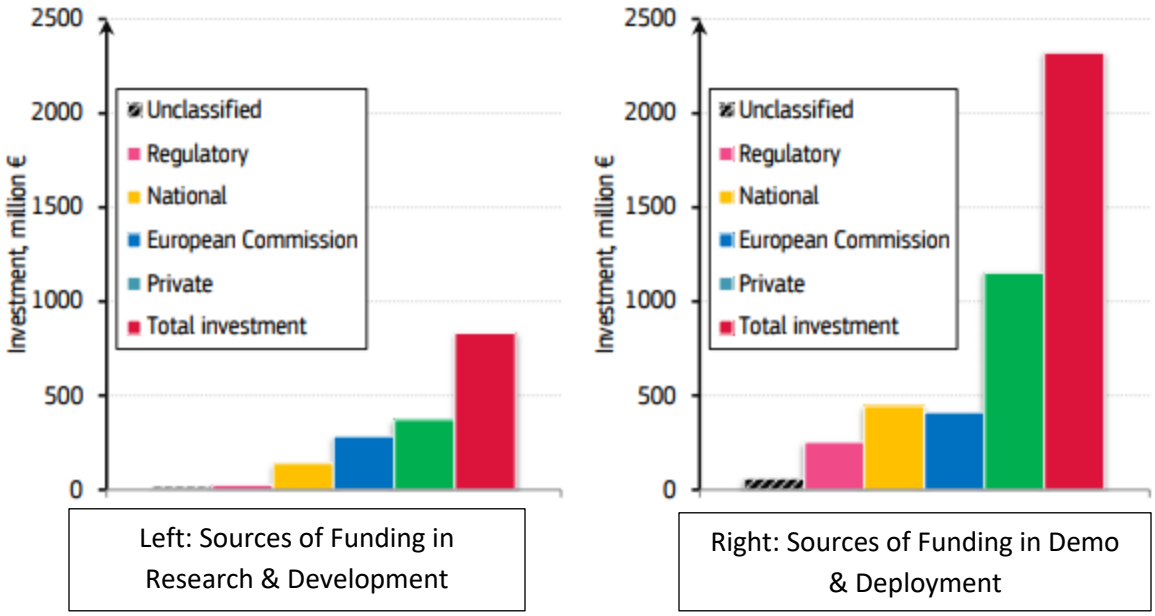


Figure 9: Difference in sources of funding in R&D and D&D in smart grid projects
Source: (Covrig et al., 2014)

The figure above shows the constitution of funding sources in R&D vs. D&D stages. As can be seen from the diagrams, the funding sources in the R&D stage are much more evenly distributed than the funding sources in D&D stage. As mentioned earlier on, a balance of power among the many stakeholders in a project is crucial to the success of policy implementation (Dinica et Bressers, 2013). Funding in the demo and deployment stage is dominated by the private sector which comprises mainly from research institutions and consultancies (Covrig et al., 2014). The lack of increased investment from other sector affects smart grid policy implementation negatively, for example the decreased involvement of the business sector is holding back market studies and analysis that could enable a smooth transition into the use of smart grids.

4. Market Development

Another challenge that affects smart grid policy implementation in both the Netherlands and India is the lack of market development and flexibility. As smart grid policy implementation requires many significant changes in market characteristics, it is critical to allow and encourage for these changes to occur. However, both the countries looked upon in this case study face difficulties in bringing forth these changes.

Smart grid market needs in India

As most of the Indian state utilities are owned by state or national authorities, the current electricity market of the nation as a whole is quite monopolized (Ahn & Graczyk, 2012).

These can cause several challenges in smart grid implementation. One such challenge is the lack of participation of private companies in the research and development of smart grid technologies which can lead to some sort of stagnation in this field. Moreover, as the participation from more and more companies is limited, innovation will also become limited leading to a lack of cost reduction.

Furthermore, as mentioned earlier in the section looking into stakeholder engagement the current electricity market structure of India affects the success of many policies in the energy sector. This is because the market sector is independent of the international energy market which puts immense financial burden on the stakeholders of the Indian energy sector (Ahn & Graczyk, 2012). Smart grid policy implementation will require changes to the pricing mechanism to enable successful growth of such projects. Changes to the pricing mechanism can only be done if the Indian energy market can be made more functional. "India needs a functioning energy market, in other words, a system where national energy demand can be met by timely and adequate investment in a sustainable way and business entities operating in the energy market are commercially viable" (Ahn & Graczyk, 2012).

Many research articles state that smart grids and demand-side management benefit from the development of each other (Sharifi et al., 2017). Demand-side management policies influence consumer behavior and market pricing quite a lot; therefore it could provide a smoother pathway of introduction to smart grids in the current environment. But a disconnected market in India which is not affected by the global market conditions, make it "difficult to use pricing as a policy instrument for demand-side management" (Ahn & Graczyk, 2012).

Smart grid market needs in the Netherlands

On the other hand, Netherlands faces a different challenge that affects smart grid policy implementation. As an EU member state, as well as for other reasons the Netherlands is very much dependent on its neighbors and other EU member states when it comes to the matter of electricity market structure. Not only are most of the national policies and guidelines derivatives of the EU goals and targets, but also the electricity market conditions vary significantly depending on the market conditions of its neighboring countries.

While sometimes a dependent electricity market may be good for the Dutch electricity market, it also makes it more vulnerable to any unexpected changes in the neighboring markets. Therefore measures must be taken to make the Dutch market more resilient to possible fluctuations that could result from this dependency. This can be done by "Maintaining a market-based approach which recognizes future uncertainties and the need for flexibility will also be required" (IEA, 2014).

Market development in the field of smart grids in the Netherlands as well as in all of Europe is needed for the effective policy implementation of smart grids in this region. As an

interconnected network operation is what the European Commission aims to have (Wilson, 2015), it is crucial to have an understanding of the future international electricity trading system. This is especially difficult as smart grids are being deployed at different rates among the many EU member states (Giordano et al., 2011). This "could make trade and cooperation across national borders more difficult and jeopardize the achievement of the EU energy policy goals (Giordano et al., 2011). Therefore it is clear that successful smart grid policy implementation in the Netherlands or any EU member state "requires coupling a policy-led vision with a market-driven deployment, balancing energy policy goals and market profitability (Giordano et al., 2011).

5. Standards and Frameworks

Smart Grid Standards and Frameworks in India

India on the other hand, faces a different challenge with its dealing of long-term policies. Although the Government of India and Ministry of Power have established several long-term policies governing the energy sector, including smart grid development, in the country. However, with India's complex structure of multiple governing authorities like the central government and state governments, these long- term goals are often overlooked in the short-term goals (Ahn & Graczyk, 2012). Secondly, many of the policy implementation attempts in India also fall short of the effects that it aimed to achieve. A report by the IEA analyzing the shortcomings of Indian energy policy implementation claims this "usually occurred when the government attempted to achieve multiple policy objectives with one policy instrument" (Ahn & Graczyk, 2012). As India is only beginning to grow in the field of smart grids, policy implementation must be taken as a step-by-step process in order to achieve overall success. Therefore the main challenges in developing standards and frameworks are: lack of consistency between long-term and short –term policies, lack of organization in the use of policy instruments and their implementation and lack of uniform policies between the state policies and the central government policies (Madan, 2006).

Smart Grid Standards and Frameworks in the Netherlands

As mentioned earlier, since most of the Dutch policies and regulations are derivatives of the EU's policies and action plans (Government of the Netherlands, 2012), they tend to have a short life-span as the focus is on achieving the EU targets rather than on long-term benefits. The primary policies on energy and electricity focus on short-term goals instead on long-term ones which hold back the country from making structural changes to benefit the country for a longer period of time. A lack of long-term policies also makes the focus areas and projects vulnerable to political power changes within the country (National Energy Outlook, 2015).

Without long-term policies, any improvement in the energy and environment sector of the Netherlands, as well energy transition within the country will be extra difficult. "A third

reason is that government policy has not provided long-term guarantees and stability" (Van Rooijen and Van Wees, 2006). Policymakers too rapidly abandon innovations when learning processes are more difficult than expected. Shifts in policy, almost every few years, create uncertainties and hamper investments." (Verbong and Geels, 2007) This is a lesson that needs to be learned from countries such as Germany, where long term policies enable the development and growth of a project by hindering obstacles that result from the changes in the political climate of the country. Netherlands's current energy related goals are very short-term orientated to achieve any significant change in the energy structure of the country. However, due to European Union directives like the Paris Agreement, Netherlands has established a few long-term goals as required. Establishing long term goals can also result in a smoother run through of a project , this is also mentioned in the 2017 Dutch Energy Agenda as "A clear course in this regard will lead to greater investment certainty and consequently a lower financing burden" (Ministry of Economic Affairs, 2017).

While the lack of long-term policies is really pulling back the country from a quick and smooth smart grid implementation, the lack of strong internal energy targets is also a key issue. The effect of the lack of strong internal targets is visible when observing the renewable energy targets and achievements of the Netherlands. Although, the country has agreed to the EU 20-20-20 Climate and Energy package targets which oblige the nation to increase the share of renewables in the energy mix by 2020, in 2016 the Netherlands has only been able to achieve 11.0% and expects to achieve 11.9% by 2020, i.e. falling behind the target of 14%. (Glastra & Twickler, 2017). This shows that having goals set by the EU is simply not enough. For example, countries like Germany and Denmark set more difficult internal energy targets based on the EU targets and have now achieved more than share of renewables as was set by the EU goals.

As can be seen from the challenges described above, there are still a lot of changes that need to be brought to different areas like consumer awareness, stakeholder engagement, funding, market characteristics and standards development to enable successful and effective implementation of smart grid policies. As the case study examples of India and the Netherlands show, while some challenges are quite similar in the general sense, many detailed characteristics within these realms differ leading to different effects on policy implementation. The challenges are also prioritized differently in India and the Netherlands, as many country specific factors like the national energy and environment targets are taken into consideration while addressing the barriers. Nevertheless, the case studies may serve as an example of the types of policy implementation challenges developing and developed nations may face during smart grid policy implementation.

III. Conclusion

The smart grid policy implementation challenges in India and the Netherlands, described throughout this chapter show that as a relatively new concept policy implementation in smart grids faces many obstacles on its way. In India, "considering the present power scenario and social, economic, political circumstances, it can be concluded that the implementation of SG in India is not so easy and it can't be completed within a few years" (Ahn & Graczyk, 2012). The Netherlands, also faces some similar and some different challenges, although the one of the key priorities for the Netherlands is to maintain policy stability over changing government coalitions (IEA, 2014). Both India and Netherlands serve as a challenge case of policy implementation as they are both polycentric entities. In India, with many governing bodies like the state governments and the central governments, policy implementation needs to be a consistent throughout. Similarly, the Netherlands, as a European Union state is obliged to match up its national policies to align the European Commission's Directives. Therefore the challenge of maintaining consistency in all its policies is an issue that both these countries are tackling with regard to smart grid policy implementation. These challenges while having similar roots have many different reasons which cause them and to look into all the reasons is out of the scope of this thesis. However, the comparative study of the two countries gives an insight into the primary challenges of smart grid policy implementation in the Netherlands and India and could serve as an example of policy implementation in the field of smart grids in developing and the developed world.

1. Need for Smart Consumers

- Lack of consumer involvement in stakeholder discussions

- Lack of consumer awareness and involvement in stakeholder discussions

2. Lack of Effective Stakeholder Engagement

- Low involvement of the business sector

- Rigid, hierarchical structure of stakeholder limits multi-way communications

3. Funding & Incentives

- Lack of fair cost division
- Low involvement of business sector

- Lack of fair cost division
- Lack of varied sources – concentrated risk on some stakeholders

4. Market Development

- Challenges of a dependent market within the EU

- Monopolized Utility network
- Lack of an open market can limit competition and innovation

5. Standards and Frameworks

- Lack of long-term policies and more ambitious national targets

- Lack of corresponding long-term and short-term policies

Chapter 5 - Conclusion

As stated in the beginning, the aim of this thesis is to answer the questions:

[1] Which socio-cultural, political & governance and economic factors affect the successful implementation of smart grid policies as can be seen in literature?
[2] What is the smart grid policy framework for India and the Netherlands? How far has it already been implemented?
[3] What can be learned from the smart grid implementation policies in the Netherlands and in India that could be useful for other developing and developed countries?

These questions will serve in achieving the goal of building recommendations, based upon the barriers hindering successful implementation of smart grids policies, which suggest ways to overcome these barriers to aid other developing and developed countries from experiencing similar challenges.

[1] Which socio-cultural, political & governance and economic factors affect the successful implementation of smart grid policies as can be seen in literature?

The barriers in smart grid policy implementation as can seen in literature can be categorized as five main challenges. These were stated in Chapter 2 as: need for consumer involvement, lack of effective stakeholder engagement, funding & incentives, market development and integration and need for proper standards and frameworks. These are obstacles that are hindering smart grid policy implementation in many projects worldwide. However different challenges are prioritized differently according to the key concerns of the area or country of implementation.

Although the challenges facing smart grid policy implementation is different depending on the size, location, funds and stakeholders of the project there are many challenges that keep reoccurring in smart grid projects everywhere. Whether it is a project in the developing world on in the developed world, smart grid policy implementation faces similar challenges but the only difference is that these challenges are often prioritized differently depending on some specific characteristics of the project. Some of the difficulties the developing world faces in implementing smart grids are similar as the surrounding conditions for the project setup may resemble those in countries with a similar background. Therefore, by looking at the key issues hindering smart grid policy

implementation in India may be useful as a reference for projects in the developing world while looking into the Netherlands could give insight for other developed countries.

[2] What is the smart grid policy framework for India and the Netherlands? How far has it already been implemented?

The smart grid policy framework in India addresses several issues and aims to tackle wide-ranging problems through the implementation of smart grids including improving energy access, better energy efficiency through proper energy management systems etc. The Smart Grip Roadmap for India highlights the primary goals the Government of India aims to tackle which include work in building consumer awareness programs, policy work for improving market conditions for smart grids and developing smaller scale (state and utility) specific implementation roadmaps to speed up the implementation of smart grids. But the policies seem to have been overambitious, as even though they were established four years ago, there are no detailed updates on the current standing of the progress of these national smart grid targets.

Smart grid policies in the Netherlands are not specifically targeted towards smart grids developments while the ones that are directly influencing it are derived from EU policies. The lack of standards and frameworks to encourage the growth of smart grid policy implementation is a problem that is strongly hindering the progress rate as well as success rate of smart grids in India and the Netherlands. With adequate policy measures and standards, the key actors can be designated specific goals that they are responsible for while also enabling cooperation between them. Moreover, there is a lack of long term policies, especially in the case of Netherlands, which do not allow for continuous growth of smart grid networks, as smart grids need to be considered as a long-term project not just as pilots to fully deliver the benefits that it promises to deliver. The main challenges of this research has been in acquiring relevant information on the updates of smart grid policies which were established several years ago in both India and the Netherlands. Brief reports by the Government of India on the pilot projects lack in expressing the failures and successes of these projects while information on the status of Dutch smart grid policies were difficult to obtain due to the language barrier.

[3] What can be learned from the smart grid implementation policies in the Netherlands and in India that could be useful for other developing and developed countries?

The case studies of India and the Netherlands were chosen for the thesis as a representation of the developing and the developed world respectively. A comparative analysis of the barriers in smart grid policy implementation show that the barriers identified in Chapter 2 are of concern in both the countries but are caused by different reasons and need different ways of tackling the issue.

Lack of consumer awareness about smart grids is an issue that is highlighted very often in many projects as a crucial challenge to the success of smart grids in developing as developed countries. The case study of Netherlands could be considered to be a step ahead of India, in considering its smart grid consumers among the key stakeholders as the nation has learned from earlier cases of smart meter rollouts that failed without the cooperation of the end-users.

India and the Netherlands are both struggling in the aspect of effective stakeholder collaboration. As the stakeholders for smart grid projects are generally high and includes teams from different realms such as politics, technology, society etc. collaboration as well as task division becomes challenging. Further initiatives from the government and other stakeholders of the project to allow for an integrated approach in policy implementation could aid in addressing this challenge.

Related issue of funding of smart grid policy implementation also plays a major role in delays associated to smart grid projects, as often the responsibility of funding is thrust solely upon already burdened utility companies. Such a situation can be alleviated with the correct policy measures and market analysis that will allow regulatory boards the respective ministries to ensure that the risk, is balanced among all relevant stakeholders of a smart grid project is minimized with the help of in depth studies that predict that return rates of the amount invested after the implementation of the project.

In the case of market development needs, India and the Netherlands are on the opposite ends of the spectrum. India, with an independent electricity market and subsidized electricity rates struggles with the financial burden of implementing smart grid policies. While the Netherlands, is vulnerable to a dependent market within in the EU which could lead to fluctuations in the national market. Both these factors affect smart grid policy implementation in their respective countries and hence need to be taken into consideration whilst planning the market integration of smart grids.

Interoperability standards to be set forth to allow for an integrated smart grid network spanning over many countries as is proposed within the EU member states. To enable a smooth transition into such an interconnected network, the private sector must be incorporated into the project stakeholder mix to create business models and predict market trends for smart grids and smart grid products.

There are also many other challenges that both the developing and the developed world face in terms of establishing a successful smart grid project. These include the lack of standardized policies that allow for renewable energy integration into the smart grids, the lack of frameworks and incentives for encouraging prosumers into the market. While these factors do not affect smart grid policy directly in many cases, further improvement in these areas could encourage and allow for effective smart grid policy implementation indirectly.

Furthermore, long-term goals and frameworks regarding smart grids can really motivate a smooth and sustainable transition into a world of smart grids both in the developing and developed countries.

This thesis aims to use the sub-question discussed above to answer the research question "***What are the barriers of effective implementation of smart grid policies in developing and developed countries?"***

The barriers of effective implementation of smart grid policies can be summarized as five main issues which are: lack of consumer engagement, effective stakeholder collaboration, funding and incentives, market development and need for standards and frameworks. As the case studies of this thesis as well as the literature on smart grid projects show, these problems are likely to occur in smart grid policy implementation in both developing and developed countries.

The need for increased consumer involvement during smart grid policy implementation is crucial to the success of such projects regardless of where the project is being conducted. Increased involvement of end-users during the policy implementation stage will allow for implementers and regulators to receive valuable feedback from the direct users of the product leading an overall successful project. Another issue, stakeholder engagement is particularly critical to an effective smart grid policy implementation as it very often spans over many realms and needs an integrated system as a support. Therefore, to encourage collaboration and involvement of several stakeholders, a fair division of risk is required. This is often linked to another issue which often arises when it comes to smart grid policy implementation which is funding. Utility companies, the government and regulatory boards and the end-users are all hesitant in stepping forward as the risk associated to such projects is often concentrated on one or few of the key stakeholders instead of a balanced risk among all actors of the project. Market development is also crucial to the success of smart grids as the case studies of this thesis, India and the Netherlands show despite of their differing market setups. And lastly, one of the primary issues in smart grid policy implementation, that is of growing concern is the lack of standards and frameworks that allow for smooth operation of smart grids, throughout its life-cycle which includes interoperability standards something that is crucial in today's perception of globalization and interconnectivity.

While these are the main smart grid policy implementation challenges that are looked upon in this thesis there are many other factors that influence effective implementation but that would be outside the scope of this thesis. This thesis identifies the key challenges in policy implementation in the field of smart grids as per a literature review which then serves as a backbone for the comparative analysis of the case study nations. The challenges identified in this thesis look into the developing and the developed world and hence aim to provide

insight into lessons that could be learned from developed countries for smart grid policy implementation in developing countries and vice versa.

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