Comparison and Analysis of Smart Grid Policies and Roadmaps in Europe and USA

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1. Introduction

Electricity – a foundation for a modern society

Since its inception more than a century ago, the electric system has evolved in industrialized countries to become a generally recognized public utility available for all users. The system, comprising in simplified terms of a range of generation assets along with higher voltage transmission grid and lower voltage distribution grid, is not only a masterpiece of technical achievement (Wolf 2000) but also represents an immense financial investment. The individual components of this system, be they generation assets or sections of transmission or distribution networks, require careful, coordinated and time consuming planning process, significant financial investments to build and are typically designed for life times of several decades. The fundamental design approach for the electric system we today have is based on building a one-way power flow system, where generation capacity and electricity network outreach are built out to meet a weakly controllable and stochastic consumption of widely dispersed end-users (EEGI - European Electricity Grid Initiative 2013). In order to ensure adequate resources for building out and extending the electric system, the industry was typically organized in vertically integrated monopolies, which were given a task and mandate to provide the electric service in a given region by governments and local authorities, who in turn saw the universal access to electric power as a key enabler for economic growth and prosperity of communities.

The role of electric power as a core foundation and key enabler of modern societies has consistently grown over time, and has arguably reached a point where it is very difficult to imagine a well functioning and orderly society without universal and unhindered access to electric power. Many, if not indeed most, activities and processes conducted in a modern society are dependent on the uninterrupted availability of electric power – communication, information management, transportation, health care, nutrition, education, security and entertainment to name a few that have emerged since the first applications of electric power in illumination and lighting. It can well be argued that the electric power system, including the centralized and distributed generation resources together with the high voltage transmission networks and lower voltage local distribution networks are part of a critical infrastructure in the developed countries and increasingly so also in the developing regions of the world.

The high degree of dependence of modern societies to electric power becomes evident when the access to the power is suddenly and unexpectedly interrupted, as recently was experienced e.g. in North-Eastern USA following the superstorm Sandy in October 2012[1], in California as a result of human error in September 2011[2] or in Southern Finland after the so called Tapani storm in December 2011, or. In these instances large numbers of people and businesses were left without

[1] Superstorm Sandy resulted in the largest storm-related outage in U.S. history, affecting some 8.5 million customers in 21 states.
[2] An error made by a technician in Arizona cascaded to become the largest blackout in California history.

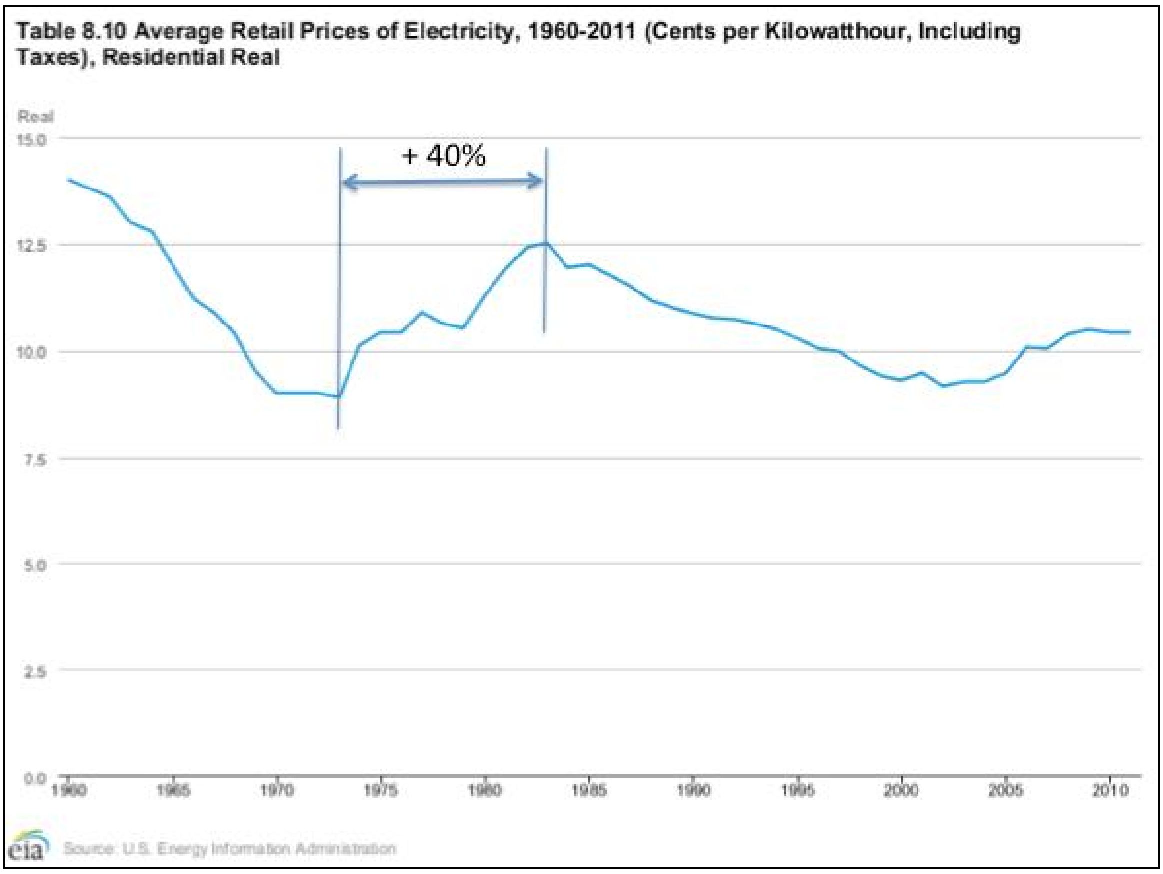
access to electric power, some for days and in worst cases even weeks, causing a wide range of problems, inconveniences, financial losses and even life-threatening emergencies for individual people, communities and businesses. These incidents also provide concrete evidence to the fact that there currently exist no generally available and practical substitutions for electric power in a large scale.

Governments, regulators and policy makers remain as core stakeholders in electric power industry. The policies and guidelines issued by authorities set the fundamental platforms and frameworks for the industry stakeholders to address the various challenges that the power industry is facing. The aim of this paper is to compare the U.S. and EU policy targets and tools to support and encourage the adoption of new technologies – Smart Grid – as vehicle to achieve their prioritized objectives. The “federal” level policy comparison is complemented with a local Smart Grid implementation comparison and analysis between New York and Finland. The objective of the study is to identify key similarities and differences in the overarching policy setting between the U.S. and EU, as well as to describe how these overarching frameworks are translated into concrete Smart Grid implementation roadmaps in one jurisdiction area in both market areas (State of New York, and Finland).

Electricity market structure

Through the past decades the electric network both in the USA and Europe has been methodically and successfully extended to provide access to electricity for all consumers. This undertaking would not have been possible without a profound support and prioritization of governments and regulators – providing universal access to electric power has been a long-standing key policy for governments throughout the past decades. In order to facilitate the progress in building out the power grid, along with the generation capacity needed to meet the growing demand, the governments both in the USA and across Europe steered the industry structure towards vertically integrated monopolies, operating power generation, transmission and distribution in their dedicated geographical areas. In return for providing these monopoly franchises to operate, the governments typically set requirements for the monopolies to provide full services to the captive customers, subjected the capacity and infrastructure investments under regulatory approvals, and exercised control and regulation over the rates charged by the monopoly utilities from the final consumers. (Hogan 2008)

This fundamental market structure started to change during the late 1980s, when the governments embarked into unbundling and deregulation of the electric power industry. (Joskow 2012) This transformation started in the heels of the energy crises, which had led to increasing electricity prices (e.g. the U.S. residential electricity prices increased 40% during 1973 – 1983 as shown in picture 1) and was following the experiences from other industries. (Hogan 2008)



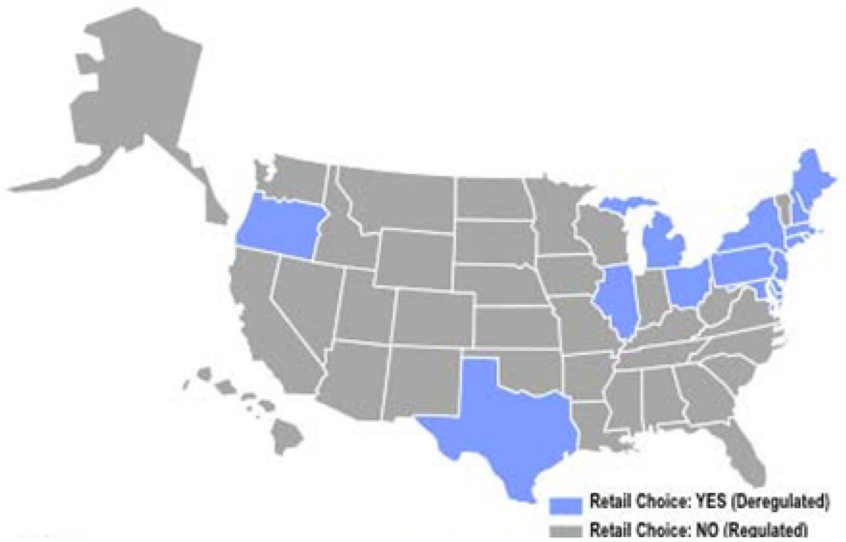
Picture 1: Price history of average U.S. residential electricity prices (real). (U.S. Energy Information Administration 2012)

The core idea was to introduce competition in electricity generation and retail, while keeping the natural monopoly operations of transmission and distribution as regulated operations. To make the competition possible for generation and retail, it was necessary to unbundle the vertically operated monopoly utilities. In the first phase of the unbundling, typically the high voltage transmission network operations were separated from the generation operations, and to facilitate competition between generators, regulation was created to provide open and non-discriminatory access to the transmission network for all generators. In some jurisdictions, such as e.g. the Nordic countries, the governments required the unbundling to extend also to retail operations, which calls for similar separation of retail sales from the monopoly distribution operations along with open and non-discriminatory access to the distribution network for all retailers.

The U.S. market today

The electric power system in continental U.S. consists of three independently synchronized and only weakly interconnected grids – the Eastern Interconnection, the Western Interconnection and Electric Reliability Council of Texas (ERCOT), accounting for 73%, 19% and 9% respectively of electricity sales in the U.S. – which are divided into 107 zones having their own balancing authorities. The U.S. electric power aggregate demand derives from the needs of some 126 million residential, 17.6 million commercial and 728,000 industrial customers, building to a total of some 3,750 TWh annual end user consumption, with a peak demand (summer) of 782 GW according to the Energy Information Agency's (EIA) statistics from 2011. Residential customers stand for some 38% of the total demand, while the share of commercial customers is 35% and the share of industrial customers respectively is 26%. (EIA - U.S. Energy Information Agency 2013) The electric power to meet this demand was generated in some 6,500 power plants, where the electric utilities' share of generated energy was 60%, while the independent power producers stood for 36% and industrial sector for some 3%, according to the EIA statistics from 2011. The electric power is delivered from the generating units to the end users by more than 3,100 electric utilities through some 170,000 miles of high-voltage transmission lines (>200kV) and nearly 6 million miles of lower voltage distribution lines. (Heidel;Kassakian ja Schemalensee 2012) In the U.S. there are 213 investor owned utilities (IOUs) that serve the bulk, some 73%, of the end customers. In addition, there are some 2,000 utilities run by state and local governments (municipal utilities) who serve 15% of customers and some 930 electric cooperatives serving remaining 12% of customers. (ASCE - American Society of Civil Engineers 2009)

The internationally held discussion on the needs and benefits of deregulating and unbundling the electric power industry during late 1980s intensified also in the U.S. and led in to passing of the Energy Policy Act of 1992, which paved the way for unbundling of generation and transmission and thus enabled creation of competitive wholesale markets. (MIT - Massachusetts Institute of Technology 2011) While the market reform progressed quickly throughout the nation from its commencement until late 1990s, the progress slowed significantly following the California electricity crisis of 2000 - 2001 (Joskow 2012). The political consequences of the California crisis were severe and, supported by the opposition of the municipal and cooperative utilities, led to widespread withdrawal of political support for the market reform. The diminished political support for market reform has had concrete implications – no new independent system operators (ISOs alternatively RTOs) have been established since this crisis and the initiatives for introducing retail competition have been halted in seven states (MIT - Massachusetts Institute of Technology 2011). The uneven start to move towards the market deregulation and unbundling together with the abrupt and unexpected suspension of the reform process has left the different parts of the nation in quite different stages of unbundling and deregulation. Today unbundled transmission operations, with independent system operators and organized, competitive wholesale markets, cover some two thirds of the nation, while traditional vertically integrated monopolies serve the remaining third of the customers. Competitive retail markets where customers have a possibility to choose their electricity provider are even more rare, with no more than 15 states and District of Columbia having introduced competitive retail markets, as illustrated in the picture 2 below. Further, only in Texas have more than 15% of customers switched to a competitive supplier. (MIT - Massachusetts Institute of Technology 2011)



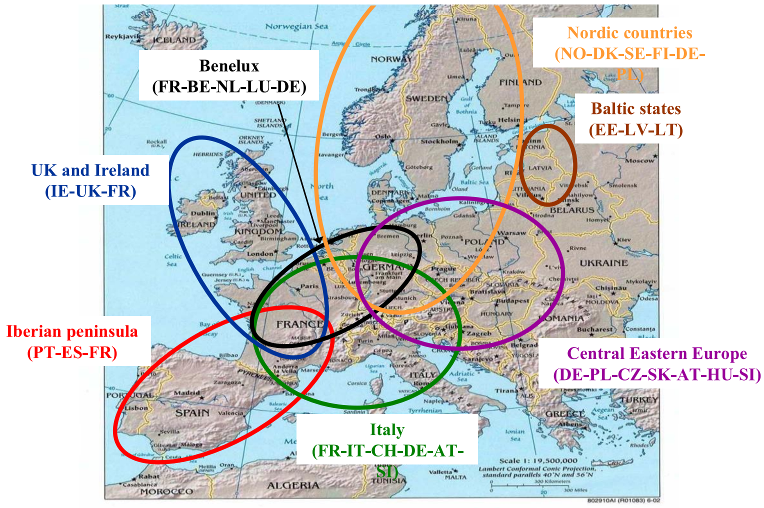
Picture 2: Map of States with retail choice. (EIA - U.S. Energy Information Administration 2010)

Government and legislators play an important role in the electric power industry and its markets. The jurisdiction in electric power related matters in the U.S. is divided between the federal government and state governments, where in broad terms the federal government has mandate over national energy policy, national electric power adequacy and security of supply, along with regulation of wholesale markets and interstate transmission operations, while the state governments hold mandate over energy policies and guidelines, along with regulation of the electric power operations and stakeholders in their respective states. The key organizations mandated to implement the national energy policies, set by the federal government, are Federal Energy Regulatory Commission (FERC – overseeing the interstate transmission and competitive wholesale markets), North American Reliability Corporation (NERC – acting on mandate provided by FERC and overseeing the transmission grid reliability, capacity adequacy and security of supply) and National Institution of Standards and Technology (NIST – overseeing the standard and interoperability creation). The national energy policies act as guidelines for individual states for creation of their own respective state specific energy policies. The state governments transform the aligned state policies, with local prioritizations, into local legislation, regulations and operational frameworks, and typically mandate the state Public Utilities Commissions to supervise the implementation. Following the high degree of autonomy of the states, the evolution of electric power policy and regulatory structures and frameworks has not been a harmonized process, but an evolutionary journey, which has produced complex framework structures that currently govern the stakeholders operating in the electric power industry. Further, the operators in one given state can be subject to different regulatory procedures and frameworks. An example of applicability of different frameworks can be found e.g. in the end consumer electricity rate regulation, which is widely used in the nation. Depending on the ownership structure of the utility, the procedures for acquiring an approval to charge a certain rate from the end customer differs – an investor owned utility (IOU) must acquire the rate approval from the state public utility commission, while municipally owned utilities receive the approval from city councils or independent boards, and finally the (customer owned, typically rural) cooperative utilities turn to committees or boards comprised of their member for the rate case approvals (MIT - Massachusetts Institute of Technology 2011).

The EU market today

The European power system is based and built on national systems, having their individual historical backgrounds and evolution paths. According to International Energy Agency statistics, in an aggregate level, the electricity consumption in European Union (EU27) in 2009 reached 2,720 TWh, from which industry share was 36%, residential consumption stood for 31% and commercial and public services share was 28%. (International Energy Agency 2013)

Given the vital and strategic role of electric power, each country typically have strived for a solution where security of supply is guaranteed and under the country's own control at all times and situations. While this strategy allowed each country to optimize its own electric systems, it did not create an optimal solution from a larger, European perspective, but rather resulted in more than necessary generation capacity and less than optimal cross border transmission capacity. Depending on the geography, there is varying degrees of cross-border interconnections that link the national systems together. One of the central themes of European Union is to promote competition in the internal markets for all products and services, including electric power. In context of electric systems, this includes ambition to create a harmonized and competitive European electricity market that will bring a range of benefits to the European citizens. One key enabler for the creation of a European electricity market is strong enough interconnected transmission grid structure, which will efficiently support competition in generation and supply. In order to accelerate the development of cross border interconnections and market based congestion management solutions, the European Electricity Regulatory Forum (so called Florence Forum) decided to establish seven geographically based "mini-foras" (as shown in picture 3) in 2004 to propose solutions.



Picture 3: Seven mini-foras to develop market-based congestion management mechanisms. (everis and Mercados Energy Markets International 2010)

In addition to the work to improve cross border electricity operations, the European Union is taking actions to harmonize the national regulation (which from historical reasons is heterogeneous) and to promote free competition in the power market. To that end, and as described in more detail later in this paper, the European Commission has issued regulation on universal unbundling of transmission system operations and required issuance of transparent and non-discriminatory third party access rules. Further, the European Commission extends the competition to the retail markets, and has issued regulation to ensure possibility for each consumer to choose his/her electricity supplier.

2. “Federal” government energy policy objectives

Although the U.S. and EU policy and regulatory constellation and set-ups are in many respects quite different they also hold a number of similarities. Both have a centralized body (Federal Government vs. European Commission) that sets the high-level visions, policies, targets and to some degree regulatory and incentive frameworks. These high-level guidelines are passed to local governments (State Governments in the U.S. vs. National Governments in EU countries) for incorporation and implementation in the respective local jurisdictions. Further, both in the U.S. and in EU, the local governments have a degree of autonomy to exercise their own priorities in implementation.

In a high, aggregate level the objectives of the government policies relating to electric power industry can be collected under three main categories:

1. Security, Safety and Quality of Supply, where the high level objectives include securing the energy independence with secured access to primary fuels, and the uninterrupted availability of safe and high quality electric power delivery from generation to consumption;

2. Economic Performance, where the high level objectives include both securing the economic competitiveness of businesses and organizations and affordability and non-discriminatory universal access to electric power for consumers and businesses;

3. Environmental Sustainability, where the high level objectives include mitigation of adverse environmental impacts from power generation, transmission and distribution along with increase of energy efficiency throughout the electric power industry, from generation to transmission to distribution to consumption.

Although these high level objectives can be seen as fundamentally stable, the concrete policies and derived regulation can depend on the prevailing overall economic, societal and political situations and future outlooks. Each government is evaluating the prevailing, and projected, macro environment and based on their assessments and priorities will establish new policies and pass new regulation aiming toward the high level objectives. Consequently, and emphasized by electric power being a strategic resource for any and all governments, the faster the pace of change in the macro environment, the more frequent revisions on electric power related policies and regulation can be expected.

The U.S. policy path

The U.S. federal government first established a role in the electric power industry in the U.S. in 1906 with passing of legislation on surplus power sales from federal irrigation projects. The federal government worked towards objectives of expanding the availability of electric power both by investing in power generation (peaking in 1950s, when federal generation stood for over 12% of total U.S. generation), issuing Rural Electrification Act (1936), driving the interconnections of electric grids and by imposing regulation on the transmission and wholesale of electric power. (MIT - Massachusetts Institute of Technology 2011)

In 1965 a major incident occurred, where a human error in settings of a protective relay ended up causing a major blackout in the North Eastern U.S. and parts of Canada. This incident triggered the formation of North American Electric Reliability Council, NERC (later renamed as North American Electric Reliability Corporation) along with regional reliability councils. The objective of this, primarily industry driven response, was aimed to improving the security of supply and uninterrupted availability of electric power, by taking measures to prevent similar cascading blackouts in the future.

The Arab oil embargo in 1973 was the next major unforeseen external event having an impact on electric power industry. The unforeseen shortage of oil and associated steep price increase, which was further escalated by the 2nd oil crises of 1978, prompted the federal government to draw policies aiming to reduce the U.S. dependency in foreign oil and thus to improve the security of supply as well as to reduce the pressure for increasing electricity prices. (Hogan 2008) To drive these objectives, the Federal Power Commission (FPC) was restructured to Federal Energy Regulatory Commission (FERC) to regulate the intrastate energy transactions and transmission. The federal government also passed the National Energy Act of 1978 aiming to reduce energy consumption and thus to contribute to the security of supply. (Godoy Simoes, ym. 2012) Additionally the Public Utilities Regulatory Policies Act (PURPA) was passed, with an aim to encourage building of smaller scale, independent renewable and cogeneration plants to both diversify the overall generation portfolio and to increase the competition in the power generation. The objectives were to improve the security of supply and to reduce the electricity cost to end consumer – to secure affordability of electric power. Most recently the proliferation of shale gas has provided a significant support both to the security of supply of primary energy fuels in the U.S. and to reduction of carbon emissions, as coal is being replaced by gas in power generation. Moreover, the shale gas production has contributed to the significant reduction of market price of gas, and consequently has eased the pressures for price increases of electricity.

The dominant model of electric power industry, with vertically integrated utilities and high degree of monopoly operations, was increasingly challenged during the 1980s. Building on experiences from other industries an unbundling model, where transmission and distribution, which were to remain as regulated natural monopolies, were to be separated from generation and sales, which would be subjected to deregulation and free competition, received increased popularity. (Hogan 2008) For governments and policymakers the new model promised new possibilities to move toward the high level objectives. Deregulation and increased competition would help in more efficient use of existing generation capacity and encourage building of new capacity, leading to improved availability and security of supply as well as to lower prices for end consumers. The federal government passed Energy Policy Act of 1992 where, among other things, FERC was given additional authorities. Drawing on the mandate given in this legislation FERC issued order 888 in 1996, which required the investor owned utilities to unbundle the generation, transmission, distribution and marketing services, which subsequently led to creation if independent transmission system operators. It further required the transmission system owners to provide open, non-discriminatory access for both utility and non-utility generators to their grid, paving the way for wholesale competition. (MIT - Massachusetts Institute of Technology 2011)

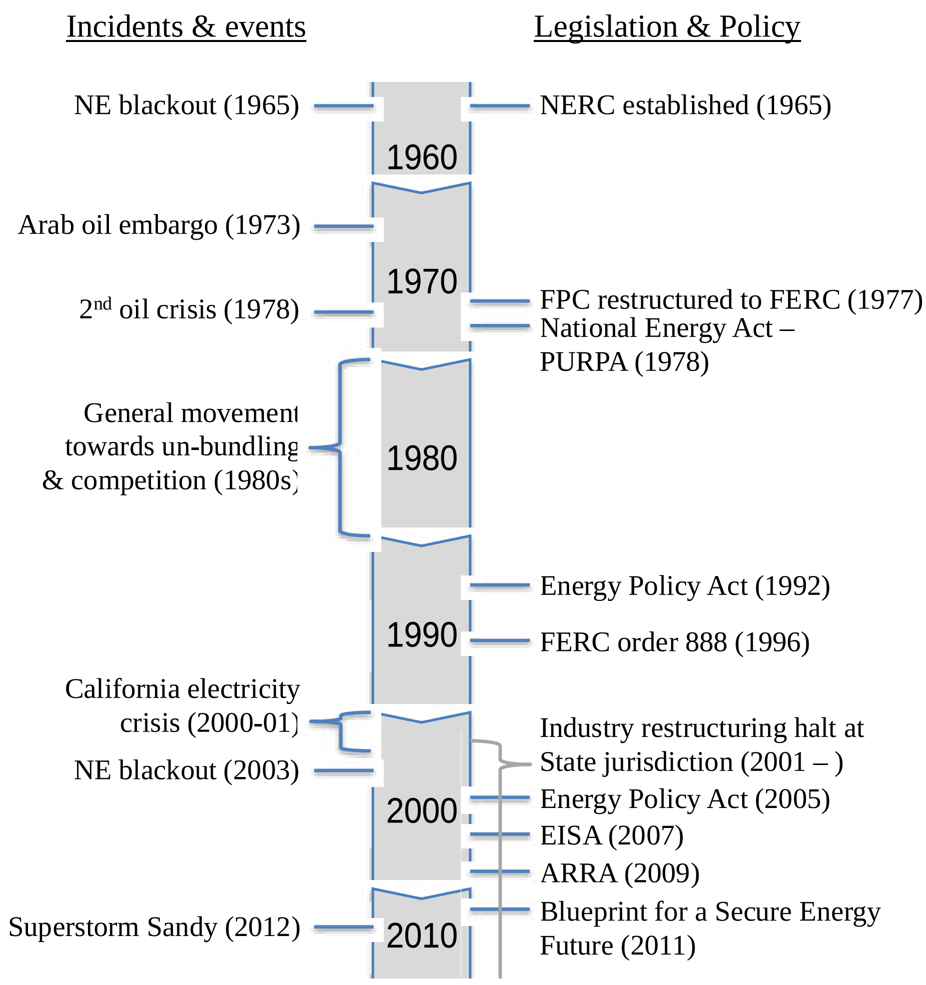
The movement towards an unbundled operating model, with independent system operators and competitive wholesale markets, proceeded during the late 1990s at various paces in different parts of the U.S. California, which was one of the national forerunners, experienced sky rocketing wholesale electricity prices along and blackouts in 2000-01, caused by, among several other reasons, market design flaws (MIT - Massachusetts Institute of Technology 2011). This incident led many States to question the viability of the unbundled and deregulated model and, supported by the opposition of municipal and cooperative utilities, the market reform process was by and large halted in the U.S.

In August 2003 eight North Eastern U.S. states and the Canadian province of Ontario experienced a massive blackout, affecting approximately 55 million people. The causes leading to this blackout were determined to derive from deficiencies in corporate policies and lack of adherence to industry policies of specific organizations, and inadequate management of reactive power and voltage (U.S.-Canada Power System Outage Task Force 2004). Drawing partly on these findings FERC was mandated by the Energy Policy Act of 2005 with new authorities, such as making mandatory compliance with reliability rules that earlier had been voluntary (Hogan 2008).

The current high level U.S. energy policy objectives and visions are defined in the Energy Independence and Security Act of 2007 (EISA), which was passed into law on December 19, 2007. This Act, consisting of 16 Titles (sections), aims “To move the United States toward greater energy independence and security, to increase the production of clean renewable fuels, to protect consumers, to increase the efficiency of products, buildings, and vehicles, to promote research on and deploy greenhouse gas capture and storage options, and to improve the energy performance of the Federal Government, and for other purposes.” (U.S. Congress 2007) EISA introduces Smart Grid in legislative context, where the Title XIII – Smart Grid outlines the policy for modernizing the U.S. electricity grid. In addition to setting the federal policy for Smart Grid, section 1307 of the Title XIII also sets certain requirements for state level Smart Grid considerations by amending the Public Utility Regulatory Policies Act of 1978. The urgency and financial resources to implement the legislation outlined in EISA Title XIII was provided in the American Recovery and Reinvestment Act of 2009 (ARRA), which included federal funding for $4 billion for immediate Smart Grid technology and demonstration deployments. This federal funding was available for projects where private investment accounted for at least 50% of total project costs, resulting in total Smart Grid investments in excess of $8 billion. (Lightner ja Widergren 2010)

Building on EISA, the Obama administration published a three-part strategy, titled Blueprint for a Secure Energy Future, to drive the high priority policies in 2011, promoting i) development and securing of domestic primary energy sources and supplies to reduce dependence of foreign energy sources, ii) providing consumers with choices to reduce energy costs and save energy to ensure that families have access to affordable energy along with creation of new employment opportunities in the nation, and iii) research and innovation in clean technologies to identify a way to clean energy future. (White House 2011)

Some key events in the U.S. are described in picture 4.



Picture 4: Timeline of selected key incidents & events vs. legislative & policy packages.

The EU policy path

The foundation for European energy policy was set in European treaties, agreed between sovereign states. The Treaty of Rome in 1957 led to establishment of European Economic Community (EEC) and European Atomic Energy Community (EURATOM) among the members at that stage. The goals of the treaties included integration of European countries to become ever more tightly interconnected and laid the cornerstone for the objective of free movement of people, goods and capital among the member states. (Meeus;Purchala ja Belmans 2005) The Treaty of Maastricht in 1993 took a further step in the European integration by creation of European

Communities (EC) through introduction of the pillar system and common foreign policy. The Treaty of Lisbon in 2009 finally formalized the European Union (EU) and introduced EU as a legal entity. The Lisbon Treaty also recognized energy as a shared responsibility and thus gave EU a legal jurisdiction in energy issues and paved the way for formation of a common EU energy policy. (da Graca Carvalho 2012)

The roots of European energy policy stem from heterogeneous national energy policies. The aims of the European energy market reform include harmonization of the energy policies across the member countries into a common, European policy. (Coll-Mayor;Paget ja Lightner 2007) The harmonization proceed through European Community (EC), and later European Union (EU), Directives, which each member state is required to implement into their national legislations. The first electricity market directive (96/92/EC) (European Commission (EC) 1996) established electricity generation and supply as a good that falls under the internal market and competition regulation, while concluding that transmission and distribution operations are regulated monopoly operations. (Meeus;Purchala ja Belmans 2005) The directive abolished the principle of vertically integrated monopoly electricity providers and introduced competition into generation and a concept of eligible customers, who were able to choose their electricity supplier. Further, the directive requires unbundling of transmission operations and introduced three alternative models for third party access (TPA) to transmission networks. (Jamasb ja Pollitt March 2005) The second electricity market directive (2003/54/EC) (European Commission (EC) 2003) together with complementing regulation (1228/2003) (European Commission (EC) 2003) provided a timeline for full market opening (all consumer customers eligible by July 1, 2007), extended the unbundling requirement to also distribution system operators, required the TPA to networks to be arranged with regulated-TPA model, defined rules for cross border transmission and congestion management and strengthened the role of the regulator. (Jamasb ja Pollitt March 2005) The third electricity market directive (2009/72/EC) (European Commission (EC) 2009), part of so called Third Energy Package, sets standards for public service obligations, states that consumers have a range of energy related rights (such as choice of supplier and fair prices) (Godoy Simoes, ym. 2012), emphasizes the ownership unbundling of transmission system operators (TSO), increases the independence and powers of the national regulators (by e.g. mandating the national regulators to impose penalties in case of non-compliance), introduces new tools for harmonizing market and network operation rules at pan-European level and establishes new institutional framework for regulator and TSO co-operation. Further, the directive explicitly requires (Annex I.2 of 2009/72/EC) the member states to conduct an economic assessment of intelligent metering systems, and when positive to roll-out the intelligent metering system to at minimum 80% of consumers.

The formulation of European energy policy only became relevant upon formation of European Communities and by the mandates given to it. Thus, the history of common European energy policy is quite short. One of the founding policies in the evolution of European co-operation is to promote the concept of European internal markets, where competition is endorsed. The principle of competition was ruled by The European Court of Justice to apply also in electricity supply and thereby in effect banned the supply model of protected monopolies in defined geographical territories. (Meeus;Purchala ja Belmans 2005) Common objectives in the EU energy policy have included the ensuring of uninterrupted physical availability of energy products and services, securing an affordable price for all consumers, and contribution to the EU's wider social and climate goals. (EC - European Commission 2010)

Parallel to the legislative efforts in form of Directives, the Commission also prepared the European energy policy, which was published in 2007. (Commission of the European Communities 2007) The key objectives of the European Energy Policy are to i) combat the climate change, ii) limit EU's external vulnerability to imported hydrocarbons, and iii) promote growth and jobs, thereby providing secure and affordable energy to consumers. The Energy Policy also suggests a 10 point action plan on how to move forward to reach the defined key objectives:

1. further development and implementation of the Internal Energy Market;
2. solidarity between Member States and security of supply for oil, gas and electricity;
3. long-term commitment to greenhouse gases reduction and the EU Emissions Trading System;
4. ambitious program of energy efficiency measures at Community, national, local and international level;
5. longer term target for renewable energy;
6. European Strategic Energy Technology Plan;
7. move towards a low CO_2 fossil fuel future;
8. future of nuclear power in Europe;
9. drive for international energy policy that actively pursues Europe's interests;
10. secure effective monitoring and reporting. (Commission of the European Communities 2007)

The European Commission concluded in 2010 that the speed and efficiency in implementing the defined policies across member states was not satisfactory. The Commission proposes a new energy strategy, focusing on five priorities:

1. achieving an energy efficient Europe;
2. building a truly pan-European integrated energy market;
3. empowering consumers and achieving the highest level of safety and security;
4. extending Europe's leadership in energy technology and innovation;
5. strengthening the external dimension of the EU energy market. (European Commission (EC) 2010)

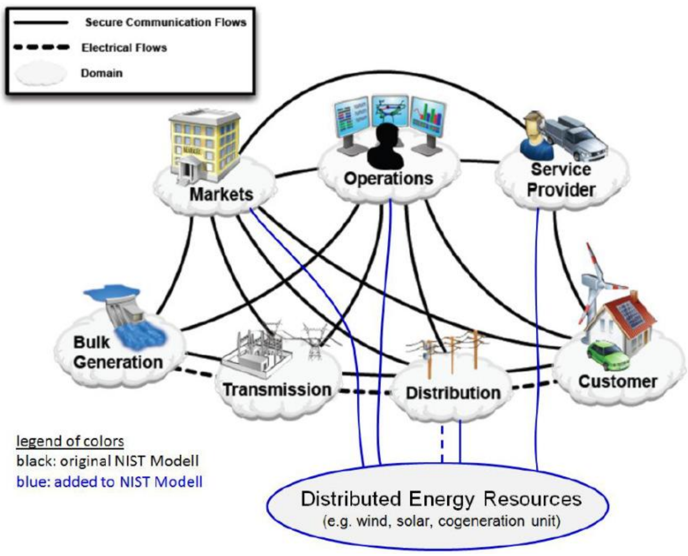
3. Smart Grid technologies as vehicles for policy enactment

Smart Grid does not have a universally accepted, unequivocal definition, but depending on the perspective and context of discussion, the term Smart Grid can be defined in a variety of ways, e.g. by its technologies or functionalities or by its benefits. Both European Commission and the U.S. Department of Energy have articulated their own definitions for Smart Grid, as shown in table 1 below.

<u>EU definition of Smart Grid:</u>	***<u>U.S. definition of Smart Grid:</u>***
A SmartGrid is an electricity network that can intelligently integrate the actions of all users connected to it - generators, consumers and those that do both – in order to efficiently deliver sustainable, economic and secure electricity supplies. (European Commission (EC) April 2010)	A Smart Grid uses digital technology to improve reliability, security, and efficiency (both economic and energy) of the electric system from large generation, through the delivery systems to electricity consumers and a growing number of distributed-generation and storage resources. (Giordano and Bossart 2012)

Table 1: EU and US definitions of Smart Grid

The U.S. National Institute of Standards and Technology (NIST) has proposed a conceptual model that illustrates the components and interrelations of an end-to-end Smart Grid system. This model is complemented by European Commission Smart Grid Task Force to include also distributed energy resources, as shown in picture 5 below.



Picture 5: Original NIST Smart Grid conceptual model and adaptation to the EU context (in blue) (Giordano and Bossart 2012)

Smart Grid policy and objectives in the U.S.

The Federal level Smart Grid policies and objectives in the U.S. are laid out in EISA, where a specific section, Title XIII is dedicated to Smart Grid. In this Title, Smart Grid is seen as the umbrella solution for modernizing the U.S. electric transmission and distribution systems, which is necessary for maintaining the reliable and secure infrastructure that is able to meet future growth demands. To meet the modernization demand, the Smart Grid will be characterized by:

1. increased use of digital information and controls;
2. dynamic optimization of grid operations and resources, including cyber security;
3. deployment and integration of distributed resources and generation, including renewable resources;
4. incorporation of demand response, demand side resources and energy-efficiency resources;
5. deployment of “smart” technologies for metering, grid communications and distribution automation;
6. integration of “smart” appliances and consumer devices;
7. deployment and integration of electricity storage and peak-shaving technologies, including plug-in EVs and thermal-storage AC;
8. provision of timely information and control options for consumers;
9. development of standards for communication and interoperability of devices connected to the grid;
10. identification and lowering of barriers to adoption of Smart Grid technologies, practices and services. (U.S. Congress 2007)

Drawing on the EISA 2007, a vision statement for the Smart Grid concluded six key areas where Smart Grid is expected to achieve value; i) improving grid reliability, ii) improving grid security, iii) making the grid more economical, iv) making the grid more efficient, v) making the grid more environmentally friendly and vi) making the grid safer. Further, it was concluded that Smart Grid is not a “thing” but rather a “vision” indicating the aspect of continuous improvement and a plethora of perspectives. Seven key functionalities were considered as crucial for the value delivery and thus defining for Smart Grid; i) ability to enable active participation by consumers, ii) ability to accommodate all generation and storage options, iii) ability to enable new products, services and markets, iv) ability to provide power quality for the digital economy, v) support of optimization of asset utilization and efficient operations, vi) anticipation and responding to system disturbances (self-healing), and vii) operations resiliency against attack and natural disasters. (DOE - NETL 2009)

Building on the above policy direction defined in EISA, the Federal government established a policy framework in 2011 to outline the prioritized path forward for a smarter grid. The objective of the framework is to enable the U.S. to seize the opportunities to take steps towards a smarter grid, rather than prescribe specific technologies, deployment schedules or uniform policy strategies. The core aim of this policy framework, which has its focus on the distribution network, is to deliver benefits in three cross-cutting categories:

1. facilitating and enabling a clean energy economy with significant use of renewable energy, distributed energy resources, EVs and electric storage;
2. creating an electricity infrastructure that saves consumers money through greater energy efficiency as well as supporting the more reliable electricity delivery;
3. enabling technological innovation that creates jobs of the future and empowers consumers to reduce their energy bills by using energy more wisely (Executive Office of the President of the United States 2011).

The primary enablers for achieving the above benefits are expected to lie principally in technology and infrastructure development. The policy framework highlights three technology categories as of key importance in delivering the benefits; i) advanced information, communications and grid automation technologies, ii) advanced metering solutions, and iii) technologies, devices and services that access and leverage energy usage information. Implementation the policy framework and the path towards a smarter grid builds on four pillars:

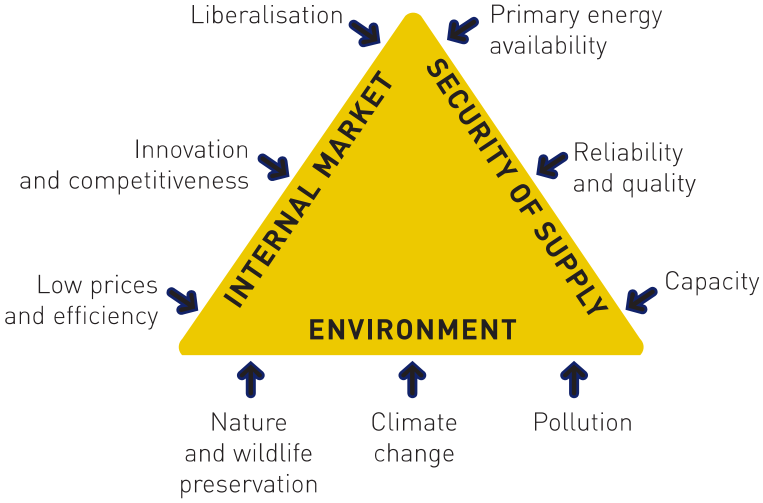
1. enabling cost-effective smart grid investments by i) State and Federal regulators' continued alignment of market and utility incentives with the provision of cost-efficient investments for improving energy efficiency, ii) continued Federal government investments in smart grid research, development and demonstration projects, and iii) continued Federal government support to information sharing from smart grid deployments to promote use of best practices;
2. unlocking the potential of innovation in the electricity sector by i) continued Federal government role to catalyze the development and adoption of open standards, ii) Federal, State and local officials striving to reduce the generation costs associated with providing power during peak demand and encouraging participation in demand management programs, and iii) continued Federal and State monitoring of smart grid and smart energy initiatives to protect consumer options and prevent anticompetitive practices;
3. empowering consumers and enabling informed decision making by i) State and Federal policymakers and regulators evaluating the best means of ensuring that consumers receive meaningful information and education about smart grid technologies and options, ii) continued State policymaker and regulator

consideration on further development of policies and strategies to ensure consumers receive timely access to, and have control over, machine readable information of their energy consumption in a standard format, iii) where a utility deploys relevant infrastructure, State and Federal regulators to consider means of ensuring that consumer-facing devices and applications make it easier for users to manage consumption, iv) State and Federal regulators to ensure that consumers' detailed energy usage data are appropriately protected, and v) State and Federal policymakers and regulators to appropriately update and enhance consumer protections for smart grid technologies;

4. securing the grid by i) continued Federal government facilitation of the development of rigorous, open standards and guidelines for cybersecurity, and ii) Federal government promotion of rigorous, performance-based cybersecurity culture (Executive Office of the President of the United States 2011).

Smart Grid policy and objectives in the EU

European Technology Platform SmartGrids was established in 2005 to create a vision for the future electric grid in Europe, aligned with the overarching energy policies. The Commission recognizes that Smart Grids can make a significant contribution to Europe's smart, sustainable and inclusive growth in addition to the Europe's energy and climate goals. (European Commission (EC) 2011) The European Technology Platform SmartGrids, having representation from industry, transmission and distribution system operators, research bodies and regulators, identified objectives and proposed strategies for moving towards the created vision. The key drivers influencing the creation of the Smart Grid vision included (as illustrated in picture 6 below) advancing the operations and efficiency of the European internal energy markets, maintaining and, if possible, improving the security and quality of supply, and contributing to combatting the climate change and adhering to the Kyoto Protocol and other commitments.



Picture 6: Driving factors in the move towards Smart Grids (European Commission (EC) 2006)

The key components of the European Smart Grids Vision, i) flexibility, ii) accessibility, iii) reliability, and iv) economics, were first published in 2006 (European Commission (EC) 2006), and amended in 2010 (European Commission (EC) April 2010) to define the Smart Grid vision through the below 10 objectives:

1. Provide a user centric approach and allow new services to enter into the market;
2. Establish innovation as an economical driver for the electricity network renewal;
3. Maintain security of supply, ensure integration and interoperability;
4. Provide accessibility to a liberalized market and foster competition;
5. Enable distributed generation and utilization of renewable energy sources;
6. Ensure best use of central generation;
7. Consider appropriately the impact of environmental limitations;
8. Enable demand side participation;
9. Inform the political and regulatory aspects;
10. Consider the societal aspects.

4. Smart Grid roadmaps – from overarching vision to local execution

While the Federal Government in the US and the European Commission in the EU set the overarching policy frameworks and to varying degree can issue binding or non-binding regulatory guidelines, the local states/countries are responsible for implementation in their respective jurisdictions. When planning and conducting the implementation, the local states/countries have a certain degree of autonomy as to decide over priorities and various other matters.

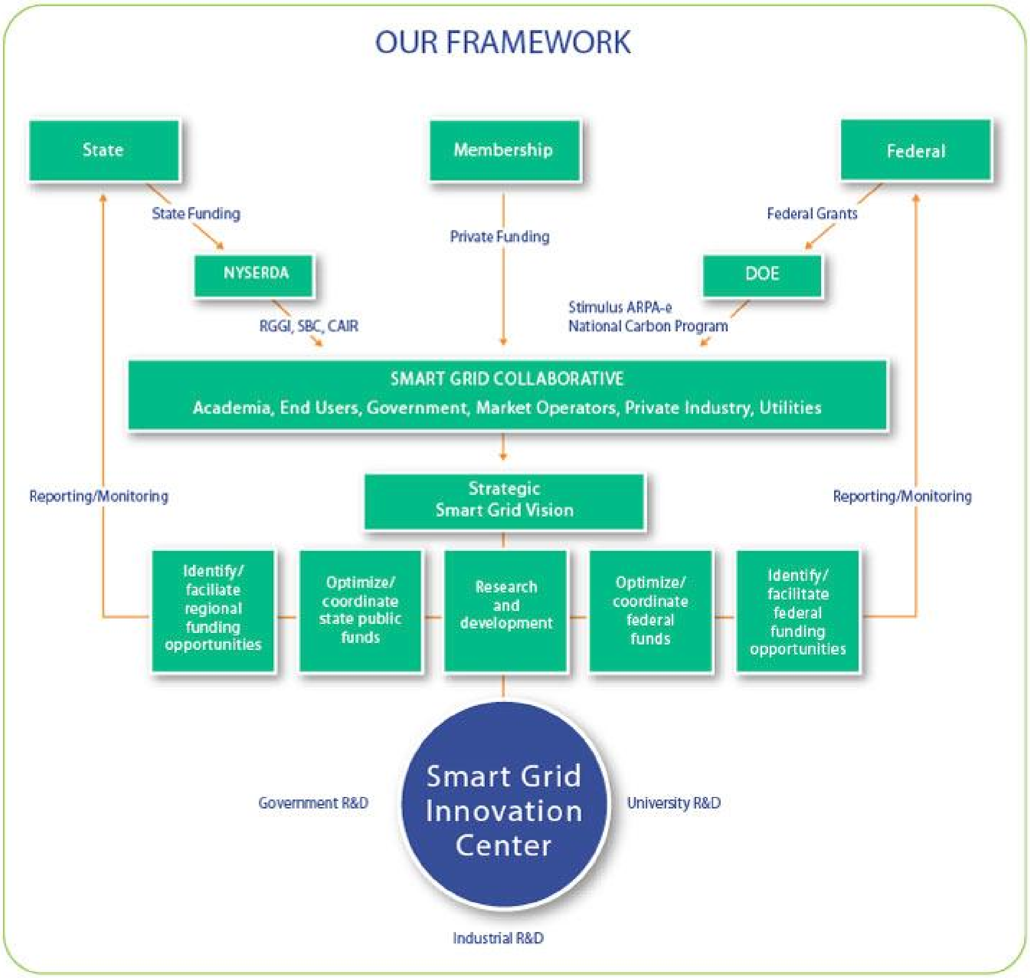
Smart Grid vision and roadmap in the New York State

Building on the Federal Smart Grid policies set, among others, in EISA 2007, the New York State issued the state specific Smart Grid Policy Statement in 2011. (New York State Public Service Commission August 2011) The potential Smart Grid benefits are concluded to be significant, extending from improved reliability and power quality to improved efficiency and power conservation and further to combatting climate change by allowing increasing amount of renewable power into the system. Moreover, Smart Grid is seen as a major economic development catalyst by creating employment opportunities in technology innovation and infrastructure renewal and by allowing new market actors enter to the growing market of providing energy services.

In its Policy Statement, the New York State concludes that Smart Grid should be seen as a continuous evolution for developing solutions to variety of needs and interests rather than as a final product or end-state. The overarching vision for the electric system focuses on the system's ability, at the lowest possible cost, to provide energy services meeting the State's policy objectives, reliability standards and environmental standards. Deriving from this vision, the key goals set for Smart Grid include enhancing system reliability, controlling capital and operational costs, reducing environmental impacts, empowering customers to better manage their energy costs, enabling greater use of demand response and accommodating the incorporation of new electric technologies, such as distributed generation, energy storage and electric vehicles. On the initiative of Governor Cuomo, as a continuation to the issued policies, a task force led by the State Agencies created and issued New York Energy Highway Blueprint, which contains a concrete action plan to move forward with improvements of the State's energy infrastructure. The Blueprint contains 13 prioritized actions that are collected under 4 categories; i) Expanding and Strengthening the Energy Highway, ii) Accelerating Construction and Repair, iii) Supporting Clean Energy and iv) Driving Technology Innovation. (New York Energy Highway Task Force 2012)

Based on the Smart Grid Policy of New York, the Public Service Commission (PSC), which represents the top regulatory body in the State and is part of the State government, emphasizes the protection of customers (ratepayers) from being imposed on any unnecessary or risky costs in its guidance to Smart Grid implementation and roadmap planning. The PSC guides the utilities to emphasize grid modernization efforts that in the short term minimize ratepayer impact and can be shown to be cost effective. More concretely, the PSC prioritizes grid reliability and resilience improvements through grid monitoring and distribution automation technologies, which are deemed to be relatively easy to implement and integrate into existing systems. Conversely, the PSC down-prioritizes smart metering implementations by concluding that customer (ratepayer) benefits from smart meters can not be shown to exceed the required costs, and further, the realization of the benefits are deemed to require significant customer (ratepayer) behavioral changes and thus are uncertain. Additionally, the PSC is concerned that deploying smart meters to mass market customers would raise rate design issues. (New York State Public Service Commission August 2011)

New York State Smart Grid Consortium, a public-private partnership to promote the grid renewal and Smart Grid implementation in the New York State, was established in 2008. This not-for-profit organization collects all major contributors across the entire energy value chain, including utilities, market operators, private industry, academia, government, and end-users to collaborate on the development and renewal of the power grid. The framework of New York State Smart Grid Consortium is illustrated in the picture 7 below.



Picture 7: Framework of New York State Smart Grid Consortium (New York State Smart Grid Consortium 2013)

In January 2013, the New York State Smart Grid Consortium issued a report on the challenges and opportunities in modernization of New York State electric grid, including summaries of the major on-going activities and key areas for research and development and recommending greater sharing of experiences and expertise across utilities and tighter collaboration between utilities and research organizations on setting the research and development priorities. (New York State Smart Grid Consortium January 2013)

In line with the overarching principles, the State and local authorities hold a great deal of autonomy in deciding the implementation of Smart Grid solutions in their respective States. The New York State policy makers and regulators must balance between the high-level Smart Grid objectives and policies set by the Federal Government and the local State specific objectives and challenges, at the same time maintaining the focus for protecting the consumers from excessive power of the utilities and other energy service providers. While the Federal Government does not have authority to mandate any State to implement preferred Smart Grid technologies or solutions, the Federal Government can use incentives to encourage the States and utilities granted the license to operate in the respective States to move forward in utilizing the Smart Grid technologies. The American Recovery and Reinvestment Act of 2009 (ARRA) is a prime example of Federal Government legislation, which provides partial funding and other type of financial support for, among other things, Smart Grid investments and deployments. (U.S. Congress 2009) The New York State has a possibility to benefit from the Federal resources by encouraging the utilities that New York State has granted operation licenses to establish projects that can be eligible for the Federal funding. Moreover, the State PSC can steer the utilities to prioritize such Smart Grid undertakings that are in line with the State's own Smart Grid strategies, as discussed above.

Smart Grid vision and roadmap in Finland

Finland has not developed a specific and dedicated Smart Grid vision, but includes Smart Grids as a component in overarching energy and climate policies, which draw on and are aligned with the EU policies. The key EU level policies include climate change mitigation by reducing the CO_2 emissions, increasing the share of energy generation from renewable resources and improving the energy efficiency in consumption. In addition to these common EU policies, the Finnish energy policy emphasizes securing the national adequacy in electricity generation. Moreover, the government of Finland states that the energy policy objectives include support to economic growth in Finland, maintaining competitiveness towards the key competitor countries, safeguarding both the continuous uninterrupted delivery and longer term security of supply, and providing national job opportunities in energy sector along with new export possibilities for energy technologies. (Työ- ja elinkeinoministeriö March 2013)

As mandated by the EU Third Legislative Package (European Commission (EC) 2009), Finland conducted a national assessment on the economic feasibility of intelligent metering systems and, after concluding a positive result, implemented national legislation requiring distribution system operators (DSO) to roll-out the new, intelligent meter systems at minimum to 80% of end consumers (by end of 2013). Additionally, the DSOs and retailers are required to provide timely consumption information to end consumers to enable informed decision making in energy consumption behavior. The requirements include billing to be based on actual consumption information rather than estimated consumption, and providing access to hourly consumption information for all consumers. Further, the intelligent metering system is required to include functionalities to support demand response capabilities.

The Finnish electricity market environment is characterized by unbundled operations, extending to DSOs, and full retail competition. Additionally, the distribution market is quite fragmented, with a large number of DSOs (85 in 2011) with a wide range in the company sizes and resources. Building on, among others, these facts, the regulatory model in Finland is based on DSO revenue cap approach, where the national market regulator sets the accepted revenue cap for a defined, forward looking time frame, publishes the general structure and rules for the revenue calculation and supervises the adherence of the DSOs to the set frames. (Energiamarkkinavirasto 2011) Based on its neutral role, the regulator does not directly approve/disapprove or favor/down-prioritize individual Smart Grid projects, but evaluation of the feasibility of Smart Grid investments and projects are done within the DSOs independently.

While the DSO’s make their Smart Grid investment and deployment decisions independently, the regulator has an indirect influence to the decision-making. On one hand the regulator defines the rules and criteria for DSO investments that are allowed to be included in the DSO’s balance sheet, and further to the replacement value of the grid against which the revenue cap is calculated. This means that the DSO does not have “free hands” to include unlimited amount of Smart Grid investments (or any other investments, for that matter) into their balance sheet and expect to get all investments included in the regulator approved replacement value of the grid. Further, the regulator has the mandate to set caps for maximum allowed investment into defined solutions. This was the case, among others, in the Smart Meter System roll-out, where the regulator defined a maximum cost per metering point that the utilities are allowed to include in their grid replacement value. Through this “cost cap” the regulator ensured that DSOs had an incentive to implement cost effective solutions to meet the functionality requirements, and as a result to mitigate the pressure of the distribution cost increases towards the end customers.

Furthermore, the regulator exercises indirect influence to DSOs grid operations and investments, including Smart Grid investments, by setting various distribution performance criteria, along with penalties if DSO performance fails to meet those criteria.

In the absence of government or regulator provided Smart Grid roadmap and implementation guidelines, the energy industry and other stakeholders have established a joint collaborative company, Cleen Ltd. to facilitate innovation and long-term co-operation between companies and academia (Chiavari ja Tam 2011). Cleen has launched a number of research programs funded by industry and academia in equal shares. One of the most prominent Cleen programs is Smart Grids and Energy Markets (SGEM), which was launched in 2009 as a five year research program with initial funding of EUR 36 million and original participation from six energy companies, six technology suppliers, seven ICT and telecom companies and eight research institutes.

5. Discussion / Conclusions

Federal overarching perspective

When looking back at the evolution of the electric power system in the USA and in Europe, it can be noted that in the USA an overarching federal perspective on guiding the electric system development has been present in the US market place from early on, which is quite different from the European situation, where the power system was built from the perspective of sovereign national states. While it is clear that the States in the US have much independent local decision power on policies and regulation as well as development, implementation and industry operator mandates, the US have long had also a federal perspective to oversee the national perspective on power adequacy and transmission infrastructure. In Europe, similar federal perspective to electric power domain is fairly new, introduced first along the deepening co-operation as European Union proceeded. It is noteworthy, however, that upon creation of the European Union, the EU was given wider legislative mandates on electric power domain than what the federal mandate is in the USA. Thus, the EU legislative bodies currently have stronger means to steer and control the market evolution across individual member states compared to the situation in the USA. Prime examples of the stronger authority of the EU include e.g. the directive on implementation of intelligent metering systems in all member states as well as unbundling requirement of transmission systems and transmission system operators (European Commission (EC) 2009).

In terms of the high level energy policy objectives, the key issues are very similar and can be collected under three main categories; 1) Security, Safety and Quality of Supply, 2) Economic Performance and 3) Environmental Sustainability. The differences are in the emphasis and wordings of the objectives rather than in the core contents, as shown in the table 2 below.

Category	**US policy objectives (White House 2011)**	**EU policy objectives (Commission of the European Communities 2007)**
Security, Safety and Quality of Supply	Develop and secure domestic primary energy sources and supplies to reduce dependence of foreign energy sources	Limit EU's external vulnerability to imported hydrocarbons
Economic Performance	Provide consumers with choices to reduce energy costs and … create new employment opportunities	Promote growth and jobs, thereby providing secure and affordable energy to consumers

	in the nation	
Environmental Sustainability	Research and innovate in clean technologies to identify a way to clean energy future	Combat climate change

Table 2: Comparison of the US and EU energy policy objectives

In addition to the overall energy policy objectives, both the US and EU have also published objectives on the smart grid. While the overall energy policy objectives are well aligned, the Smart Grid objectives reveal some differences in the emphasis and expectations of areas for value creation. The key Smart Grid objectives, regrouped to follow the energy policy objective categories as shown above, are shown in the table 3 below.

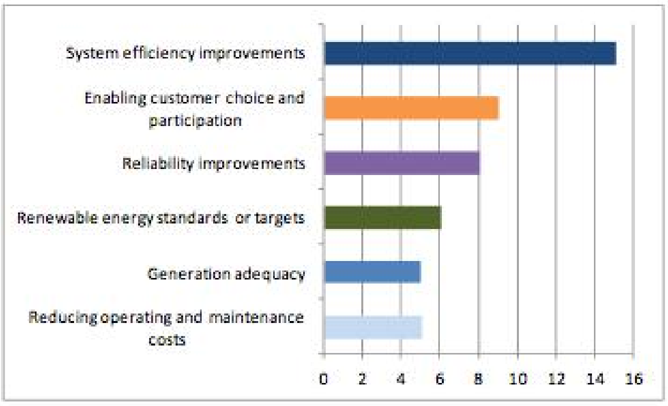
Policy category	The defining objectives of the Smart Grid in the USA (DOE - NETL 2009)	The Smart Grid objectives in the EU (European Commission (EC) April 2010)
Security, Safety and Quality of Supply	Provide power quality for the digital economy	Maintain security of supply, ensure integration and interoperability
	Provide operations resiliency against attack and natural disasters	
	Anticipate and respond to system disturbances (self-healing)	
Economic Performance	Enable new products, services and markets	Provide accessibility to a liberalized market and foster competition
	Support optimization of asset utilization and efficient operations	Provide a user centric approach and allow new services to enter into the market
		Establish innovation as an economical driver for the electricity network renewal
		Ensure best use of central generation
Environmental Sustainability	Accommodate all generation and storage options	Enable distributed generation and utilization of renewable energy sources
	Enable active participation by consumers	Consider appropriately the impact of environmental limitations
		Enable demand side participation
Other		Inform the political and regulatory aspects
		Consider the societal aspects

Table 3: Comparison of the US and EU Smart Grid objectives

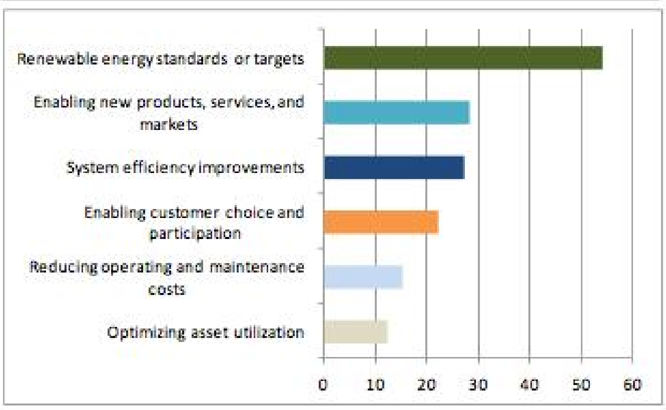
The most notable differences in the federal level Smart Grid objectives lie in EU's higher emphasis on advancing competition in the market, while the US emphasizes more disturbance management and grid resiliency. This is explained by the general perspective to electric power as a product/service as well as by prevailing market and regulatory structures and operating environments. There is a fundamental difference in how the policy makers and regulators view electricity between the US and EU. While there are some State-by-State differences, the dominant perspective to electric power in the US is that it is a public utility and the role of the policy makers and regulators is to protect consumers from the high supplier power of electricity providers, who often are in a monopoly (or monopoly-like) position. The regulators exercise customer protection e.g. by controlling and mandating the sales price of electricity that utilities are allowed to charge from their customers. This is in clear contrast to the EU perspective, which requires unbundling of distribution (natural monopoly) and retail operations, and strongly promotes active competition among electric power suppliers (retailers) and wants to ensure that customers have unrestricted possibility to switch electric power supplier to that of their choice. In the view of the EU, the open market principle and active competition ensures right prices for consumers and thus national regulators are not pre-approving the prices of the energy component retailers are offering to customers. Further, the EU has taken an active role in mitigating the climate change and as part of that has issued regulation and objectives to minimize the climate impact also from the electric power sector. Consequently the environmental aspects are emphasized more in the EU objectives. On the other hand, the US has experienced multiple mass-outages affecting millions of people, along with relatively high number of smaller outages and other disturbances in the grid. These challenges are reflected in the US emphasis on improving the grid resilience, disturbance management and power quality.

This is also supported by a recent ISGAN[3] study on Smart Grid drivers and technologies, where the governments and/or regulators of participating countries were asked to score and prioritize, among others, the most important motivational drivers for implementing Smart Grid (ISGAN Octber 2012). The study concludes that in North America (comprising of the USA, Canada and Mexico) the system and operational efficiency along with reliability improvements addressing the cost to consumer and grid vulnerability to outages are among the top-3 motivating drivers, while in Europe (11 countries[4]) the mitigation of climate change through renewable generation along with promoting competition through introduction of new products and services make up the top-2 motivating drivers. The top-6 motivating criteria for Smart Grid in North America and Europe as concluded by ISGAN report are presented in pictures 8 and 9 below.

[3] ISGAN (International Smart Grid Action Network) is a multilateral government-to-government collaboration organization to advance the development and deployment of smarter electric grid technologies, practices, and systems.
[4] Validated results from Austria, Belgium, Finland, France, Ireland, Italy, The Netherlands, Russia, Spain, Sweden and Switzerland.



Picture 8: Top-6 motivating criteria in North America (ISGAN Octber 2012)



Picture 9: Top-6 motivating criteria in Europe (ISGAN Octber 2012)

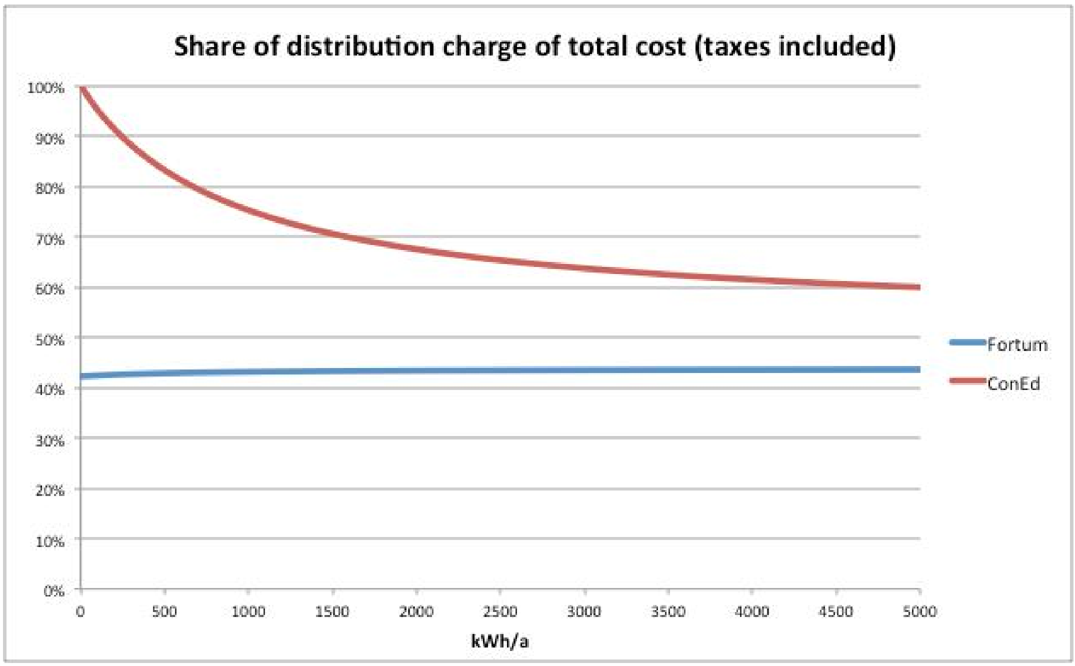
National perspective

There are clear differences in the operating principles of electric power industry between New York State and Finland. While a (limited) customer choice is implemented in New York State, the operating principle of the retail electricity market is close to a monopoly-like regulated operation, as opposed to free and encouraged competition in electricity retail implemented in Finland. Following the choices of these overarching operating models, the role and mandate of the regulators are different. In New York State the State PSC, for example, approves ex ante, the utility rates (including both energy and distribution components) that investor owned utilities (IOUs) are allowed to charge their various customer segments, while in Finland the utilities are free to set their retail energy rates and the regulator analyses the financial performance and reasonability of the distribution charges of the DSO operations, ex post. Although a comprehensive consumer price comparison between New York State and Finland is out of the scope of this paper, a quick comparison between the prices for residential customers consuming 3000 kWh per year of incumbent Investor Owned Utilities (Consolidated Edison in New York, Basic Customer Rate (State of New York, Department of Public Service 2013) and Fortum in Finland, energy rate with Kesto service and delivery rate with Fortum Espoo Distribution Yleissiirto (Fortum 2013)) reveal differences both in absolute price levels and in pricing structures (ConEd prices converted from US dollars to Euros by using Bank of Finland published USD exchange rate for October 2013 (Bank of Finland 2013)). As shown in table 4 below, the total customer electricity charge for a 3000 kWh per year consuming customer in New York City is over 50% more expensive than in Finland, where the energy charge is roughly one quarter more expensive but as noteworthy, the distribution charge is more than four times higher than in Finland. Some endcustomer cost balancing comes in form of tax collection, which in New York is little more than one tenth of what is collected in Finland.

	Price level		*Deviation, €*	*Component share of total cost*	
	Fortum	ConEd	ConEd to Fortum	Fortum	ConEd
3000 kWh/a	€ / a	€ / a	%	%	%
Energy	177.34	222.93	26%	43%	34%
Delivery	88.69	402.64	354%	21%	62%
Taxes	147.36	20.68	-86%	36%	3%
Total	*413.39*	*646.25*	*56%*		

Table 4: Comparison of annual electricity charges of residential customers using 3000 kWh / a

When looking at the relative shares of energy and delivery components of the total customer charge, it can be noted that in Fortum's case the distribution charges makes up a consistent 44% of the total customer charge (all relevant taxes (VAT, electricity tax) are computed in the distribution charge) regardless of the annual consumption of the customer, while with ConEd the share of the distribution charge differs based on consumption volume, being the predominant component with low annual consumptions, and remaining at well above 50% share even with high consumption cases. Picture 10 shows the share of distribution charge at annual consumption volumes from 0 to 5000 kWh for Fortum's combination of Fortum Espoo Distribution general distribution product (Yleissiirto) and general tariff sales product (Kesto), and for ConEd's general rate.



Picture 10: Relative share of distribution charge

Furthermore, in New York State, the State PSC, i.e. the regulator, operates in very close cooperation and control of the state government and legislators, and thus can be seen as an extended arm of the State government. In Finland on the other hand, the regulator is a more independent operator, with an arms length from the politically elected government.

Following the chosen operating models, the development and implementation of Smart Grid technologies and solutions in New York takes place in close co-operation with the State PSC and the utilities. The State government approves prioritized Smart Grid policies and targets and builds a roadmap for the future. Following these guidelines the utilities operating in the State prepare proposals for prioritized Smart Grid investments and deployments, including an evaluation of the investment/project to the prevailing utility rates. The State PSC then evaluates the cost-benefit ratio of the utility proposals, case-by-case, and decides upon their approval. If approved, the utility can adjust the rate or rates to impacted customer segments in order to collect the required investment costs. Thus, with some simplification, it can be said that the State PSC is deeply involved in individual Smart Grid projects and technologies along with giving the ex ante mandate for utilities to revise their rates in order to finance the required investments. In Finland, on the other hand, the regulator is not involved in individual DSO investment decisions, on Smart Grid or any other investments for that matter. The operating mode of the regulator is to define and publish guidelines and rules that are transparent and applicable to all DSOs and the regulator strives for equal treatment of all DSOs. The regulator also sets and monitors achievement of various performance targets on DSO operations, and by adjusting these targets, the regulator can steer the utilities into developing and implementing various Smart Grid solutions. The regulator is technology agnostic and does not take a stand in how or by using what technology the DSOs aim to meet the performance criteria.

As above discussed, the policy makers and regulators in New York State have much closer control and more active steering role on concrete Smart Grid technology implementation and roll out compared to their Finnish counterparts, who operate through setting generic and transparent performance, functional and economical targets for DSOs and supervise the achievement of these targets. Building on their stronger role, the New York State holds a key role in setting the Smart Grid implementation prioritization – both through their role as member of the New York State Smart Grid Consortium and by being the approval body for utility rate cases. In terms of the concrete Smart Grid technology prioritization and implementation, the New York State Smart Grid Consortium publishes the key focus areas (New York State Smart Grid Consorium 2013), which are regrouped to match the previously used Policy Category and the U.S. Smart Grid objective classifications and presented in the table 5 below. These key focus areas are further elaborated in the New York State Smart Grid Consortium's web site (New York State Smart Grid Consorium 2013) along with a list of concrete Smart Grid activities and projects that are on-going in New York State (New York State Smart Grid Consortium 2013)

As earlier discussed, Finland has not published a national Smart Grid strategy, nor a prioritized Smart Grid focus areas, apart from the EU mandated smart metering roll-out. The DSOs are expected to independently evaluate the suitability and feasibility of Smart Grid implementations, within the performance and economical framework defined and revised by the regulator.

Policy category	The defining objectives of the Smart Grid in the USA (DOE - NETL 2009)	Grid Modernization focus areas in New York (New York State Smart Grid Consorium 2013)
Security, Safety and Quality of Supply	Provide power quality for the digital economy	
	Provide operations resiliency against attack and natural disasters	
	Anticipate and respond to system disturbances (self-healing)	Enhancing the situational awareness of the grid, i.e., the ability to know what is happening on the grid and to anticipate future problems in order to take effective actions
		Improving the grid's "self healing" capability, i.e., automatically detecting, isolating, and responding to power system disturbances, enabling improved reliability and resiliency
Economic Performance	Enable new products, services and markets	Providing more information and tools that help consumers better manage their electricity usage, i.e., providing more detailed usage information through two way usage information and control technologies that will help consumers conserve energy and save money
	Support optimization of asset utilization and efficient operations	Enhancing the control of the grid, i.e., advanced controls and automated response strategies that will increase system performance and efficiency
Environmental Sustainability	Accommodate all generation and storage options	
	Enable active participation by consumers	
Other		Pushing research and development, i.e, effectively harnessing and focusing all of New York State's research talent and resources
		Helping to Define Policy, i.e., updates on key standards to achieve interoperability and functionality of smart grid systems and devices underway at both the federal and state levels

Table 5: New York State Smart Grid focus areas matched to the Federal objectives

Summary

While the policy and regulatory decision set-up has similarities in its composition between the USA and EU, i.e. a supranational/federal level (US Federal Government vs. the EU Commission), state/national level (US State vs. EU countries) and local level (city/municipal), the mandates, compositions and dynamics of these levels vary significantly across the Atlantic. And not only do the decision making process differ, but there is a fundamental difference to the perspective on electric power. The dominant view in the USA is that electric power is a public utility and the role of the government (consisting of policy-makers/legislators and regulators) is to protect the rights of the consumer against excessive market power of often monopoly or monopoly-like utilities. In the EU, the dominant view on the other hand is that electric power is a commodity service that must be subject to competition across the EU internal market, similar to any other product or service. Further, the non-competitive, natural monopoly operations of transmission and distribution of electricity (and gas) must be unbundled from the competitive operations (generation and retail) and independent regulators must ensure a non-discriminatory access and services to all participants in the competitive operations. The high-level summary of the US and EU set-up regarding Smart Grid policy and implementation decision making roles is presented in table 6 below.

Level	*USA*	*EU*
Federal / Supranational	• High-level objectives and policies • Provide access to federal funding for approved projects and initiatives (=”carrot”)	• High-level objectives and policies • Issue legislation requiring implementation actions (=”stick”)
State / National	• Dominantly vertically integrated monopolies • Regulators part of State government • Consumer rates (both energy and distribution) approved by regulator, ex-ante • Individual Smart Grid project approval process run by State government	• Un-bundled operations with competitive retail and regulated distribution • Regulators at arms length from elected government • Competitive/free retail energy pricing with ex-post DSO financial regulation on distribution component • National government and regulator issue performance and economic criteria for DSOs, who then independently evaluate utilization of Smart Grid technologies

Table 6: High-level comparison of the US and EU set-up of Smart Grid related decision making

It can be concluded that the US model emphasizes the State authority to decide and steer the implementation of Smart Grid technologies. The Federal policies and objectives, along with the possibility to tap into Federal funding, provide guidance for the State officials for their prioritizations and decision making. Further, the State government, often the Public Services Commission (or similar), is in close dialogue with utilities having a mandate to operate within the State on the Smart Grid implementation projects. The utilities must seek an approval for implementing Smart Grid solutions if they conclude that a rate increase is necessary to fund the investment.

EU, on the other hand, emphasizes the market mechanism and transparent performance criteria. The promotion of retail competition and customers’ right to switch suppliers is expected to ensure competitive energy pricing for all customers, while financial regulation of DSOs is expected to keep the costs of the distribution component at reasonable levels. As an enabler for the competitive market place, the EU requires unbundling of natural monopoly operations from the vertically integrated utilities, along with a requirement of open and non-discriminatory access for all players to the monopoly infrastructure. Additionally, the EU has legislative mandate, which its American counterpart does not have, to issue Smart Grid implementation requirements, such as e.g. the Smart Metering Infrastructure roll-out.

It can be argued that the higher legislative power of the EU has a potential to steer the market area towards better coherence in terms of implemented Smart Grid solutions and their implementation schedules. On the other hand, the higher autonomy of the U.S. states may better support the most effective prioritization of Smart Grid technologies to be implemented in their individual situations. The Smart Grid policies are not “stand-alone” but are interlinked to e.g. energy and economic policies as well as on the pace of technology development. Implementation of the Smart Grid technologies in production scale is typically a long term, capital intensive and non-trivial exercise. As the immediate history has shown, the pace of change in surrounding circumstances can change quite fast when compared to Smart Grid deployment time schedules. The economic recession, sudden change in attitude and prospects of nuclear power, growth rate in renewable power and in particular in distributed solar PV, introduction of electric vehicles, growing frequency in weather related disasters, proliferation of shale gas and stagnating growth rates and prospects for traditional utilities are all examples of relatively recent developments which should be considered in setting of Smart Grid policies and regulation. Traditionally the regulatory process has been quite slow and inflexible, but as the examples above illustrate, further research should be conducted on ways to develop the policy making and regulatory processes more dynamic.

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