



**FINPRO**

Smart Grid as an Innovation Enabler  
for  
Scalable Business Model Development

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*"The Smart Grid will mark a total transformation of the industry's operating model – the first major architectural change since alternating current became the dominant system after the Chicago World's Fair in 1893."*

Peter Fox-Penner

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## INTRODUCTION

Smart Grid may be defined based on the point of preference as follows:

**Network focused definition of a Smart Grid:** *“A smart grid is an electricity network that can use information and communications technology to monitor and administer the transportation of electricity from all production sources on a more flexible, efficient basis. These intelligent networks will be able to coordinate the needs and output of all producers, network operators, and end-users. They do this by optimizing the use and operation of the various systems and as a result simultaneously minimizing costs and the effect on the environment, as well as increasing the reliability and stability of the system.”<sup>1</sup>*

**Enduser focused definition of a Smart Grid:** *“Smart Grid combines time-based prices with the technologies that can be set by users to automatically control their use and self-production, lowering their power costs and offering other benefits such as increased reliability to the system as a whole.”<sup>2</sup>*

Smart Grid is going to bring major changes in people's lives. It is also clear that this will happen over many years and may involve:

- ✓ **Technical Architecture** that will allow for time-based prices, bidirectional networks, and electricity storages and ultimately a fully asynchronous Grid.
- ✓ **Business Architecture / Deregulation and standards** to introduce incentives to overcome issues of high investment and reduced receipts related to quality, efficiency and development<sup>3</sup>.
- ✓ **Innovation process** may be amplified by intelligent, balanced deregulation and standards – and by predefined business model roles and responsibilities - in the areas where new value added service development is seen to be inevident. A separate “Service Provider” role might provide the way – very much analogical to the telecommunications networks 20-30 years ago. National level pilots may pave the way for innovation beyond EU-wide incentives like EEGI<sup>4</sup>.

Smart Grid ultimately promises increased energy efficiency, integrating renewable energy resources into the system, and therefore reducing CO<sub>2</sub> emissions.

This paper will highlight some of the issues and enablers on the way to generate an market driven ecosystem where Finnish companies could achieve Smart Grid innovation leadership. The focus is intentionally put on the business rationale of the Smart Grid introduction. Also, some reflective comments from the telecommunications success story will be made. At the end of this paper, South-Korea and Portugal provide excellent examples by highlighting their roles as spearhead countries in smart grid development to lead the way. Both countries have ambiguous visions towards electrification of the transport fleet and energy Smart Grid as a whole.

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<sup>1</sup> Credit Suisse, Economic Research. 2011.

<sup>2</sup> Peter Fox-Penner, Smart Power. 2010.

<sup>3</sup> Energy Market Authority (EMV). Simo Nurmi. 9.2.2011.

<sup>4</sup> The European Electricity Grid Initiative. 2010.

## SMART GRID RATIONALE

Transforming the electricity grid into a Smart (digital) Grid that will integrate power generation and distribution, service providers, enduser appliances, storage, as well as sensors and communications into a new dynamic ecosystem is as such not a new concept nor development. We have seen similar transformation processes take place in other “transportation” industries like telecommunications where deregulation, digitalization and more lately new enduser appliances and content have radically changed the operating models and facilitated innovation and growth at the same time during the last 25-30 years.

Within telecoms, government or community owned telecommunications utilities had provided vertically integrated “plain old telephony services” to their endusers since almost a century - much like the energy companies of today. Those utilities transformed themselves into fixed and mobile network operators (still regulated), with separate service provider units / profit centers for wholesale, data, internet, value added services, and content. Innovation moved towards customers and customer role was strengthened. Also, a multitude of new operators and service providers emerged especially since the 1987 deregulation in Finland that enabled competition and innovation within the value added value chain.

As established in Figure 1, massive investments on electricity networks infrastructure will be required to make Smart Grid happen. A long term business vision and short term actions will be necessary in order to focus on the right investment decisions at the right time, thus avoiding massive risks and giving investment protection. Also, the two disciplines Energy and ICT need to strongly collaborate and innovate for mutual future success.

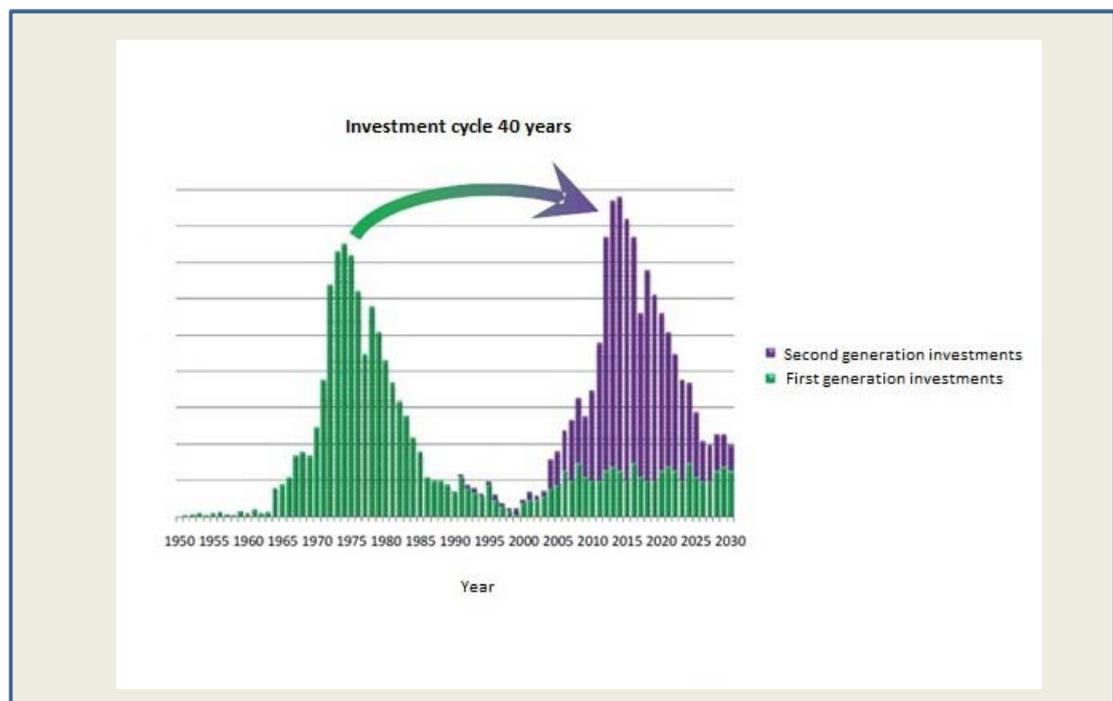


Figure 1: 2<sup>nd</sup> generation electricity network investments in Finland<sup>5</sup>

<sup>5</sup> Älykkäämmät sähköverkot Suomessa. 7.6.2010.

[http://www.energiamarkkinavirasto.fi/files/Matikainen\\_Mita\\_ovat\\_alyverkot.pdf](http://www.energiamarkkinavirasto.fi/files/Matikainen_Mita_ovat_alyverkot.pdf)

## SMART GRID BUSINESS ARCHITECTURE

The single most important aspect of power system architecture (“Old Grid”) has been the requirement for perfect continuous balance between electricity generation and consumption, where consumption is not directly linked to generation characteristics – other than possibly malfunctioning of the Grid. Thus, the business models have been largely vertically integrated from energy generation and trade towards energy transmission, distribution and energy service provisioning to the customer/consumer.

Figure 2 shows, how the energy value chain might change during the next years. The Smart Grid paradigm will have a profound impact downstream towards the customer interface and most of the service innovation will be generated in this part of the ecosystem. Any players within the current value chain as well as new players from energy, ICT and service industries but also equipment suppliers (e.g. electric vehicles, end user appliances, distributed storage, ...) might become new successful challengers. Service Provider(s) may ultimately package a seamless service for a specific customer – much in a way telecom services are ultimately packaged to include, access, voice, data, internet and tv.

*Note. Obviously, innovation will also take part within generation, transmission and distribution but it will be more focused on efficiency and quality and later the integration of network alternatives like distributed generation and storage. Universal Service Obligation will be necessary for the dominant players – similar to the telecommunications ecosystem.*

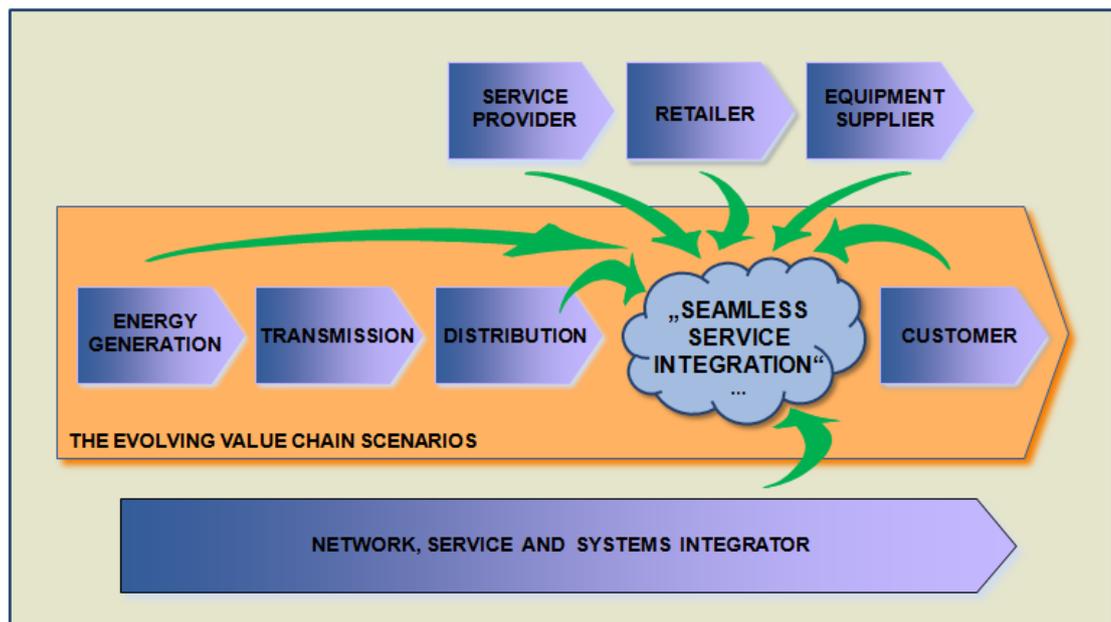


Figure 2: Energy value chain evolvement and players within<sup>6</sup>

Customers will be provided services that enable them to control their power usage and thus costs based on time-based prices. Distributed generation (DG) will force the Grid to become bidirectional. Ultimately, the availability of (cheap) electricity storage will provide a true disruptive technology and will substitute for balancing and thus will enable an asynchronous Smart Grid business (and network) architecture.

<sup>6</sup> Adapted from Olli E. Laaksonlaita. Telecommunications Value Chain. 1995.

Figure 3 illustrates how the energy end-user price may develop to involve the Service Provider share additional to the other existing players' share within an overall service offering, that will substantially grow as a whole.

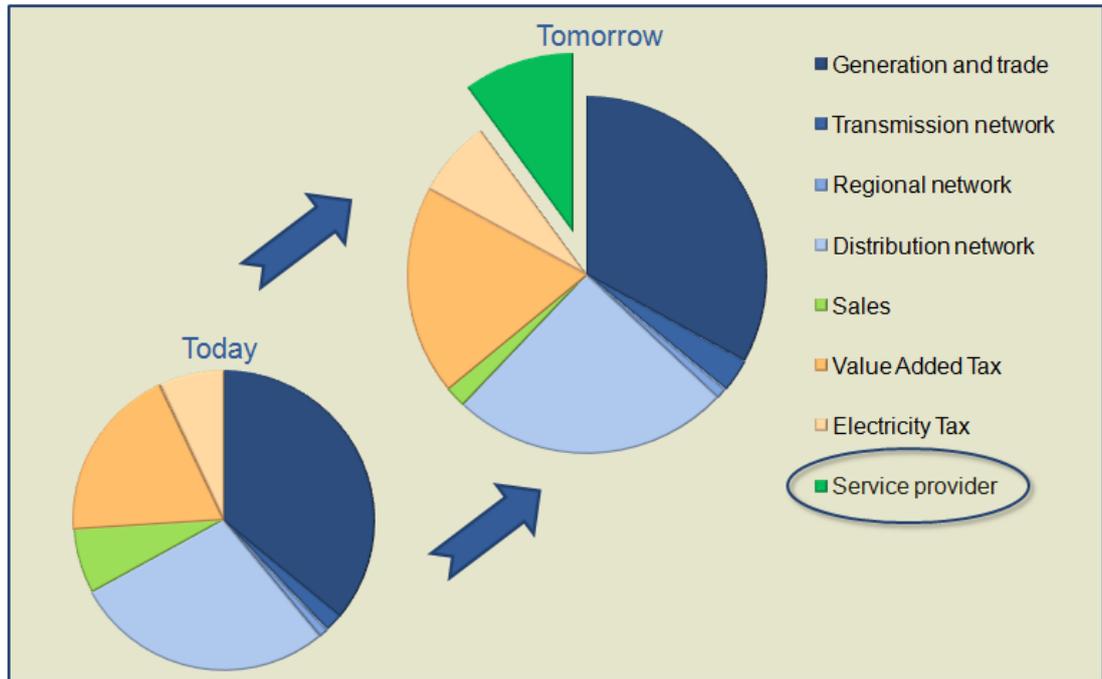


Figure 3: Energy price split between value chain players.<sup>7</sup>

But ,why can't all this be done only within the current, integrated value chain? Please, read further.

<sup>7</sup> Retail consumer electricity price share as of 1.9.2010, Energy Market Authority (EMV), taken as today's basis.

## REGULATORY POLICY AND STANDARDISATION

Vertical, strongly integrated value chains like within the energy industry (like within telecommunications some 30 years ago) work very efficiently when the environment is stable and no major reason for innovation exists. When the environment faces a paradigm change like today's Smart Grid vision, intelligent methods to accelerate innovation need to be introduced into the ecosystem.

Figure 4 shows the innovation process when the environment changes. One major challenge is to further develop a regulatory policy where innovation will initially be enabled by regulation/ deregulation of the integrated value chain and adapted roles/responsibilities within. A market driven innovation will then attract more investments that will further accelerate innovation.

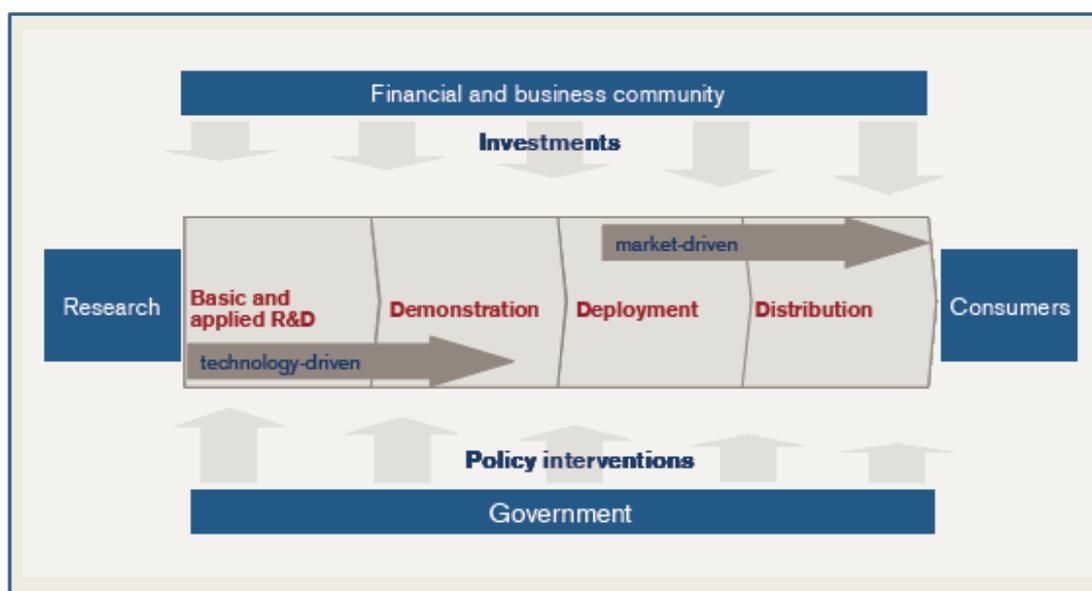


Figure 4: Innovation process<sup>8</sup>

### Incentives

Currently, innovation incentives – additional to quality and efficiency incentives - have been proposed within Finland's energy ecosystem in order to facilitate R&D investment.<sup>9</sup> In the UK, as an example, OFGEM has introduced similar Innovation Funding Incentives (IFI) already some years ago. However, the incentives within the integrated ecosystem might not do it alone. They often focus to the transmission and distribution networks and less on the services provided to the end users.<sup>10</sup>

### Interfaces and standards

Smart Grid service innovation may be facilitated by standardized interfaces and quality standards between the various B2B roles and responsibilities. These measures will allow for free-market-like competition within the value chain. Standards may be based on de jure interfaces. The new end user B2C interfaces may be standardized – at least partly –

<sup>8</sup> CS, Stern Review quoted in CS Monitor Q1 2011.

<sup>9</sup> Energy Market Authority (EMV). Simo Nurmi. 9.2.2011.

<sup>10</sup> OFGEM. Annual IFI Report 2009/2010.

by using de facto standards that will define the way as-you-go. *Note. Electric vehicle charging infrastructure (hardware) interfaces currently already use - largely Japanese - de facto standards.*

### **Scalability**

The one most important element of the new value chain is its scalability. Customers will be able to subscribe services within the whole country or even within foreign countries. Just think about the overall ecosystem inefficiencies and missing scalability if every energy utility in Finland would develop and introduce and sell new energy services on their own within the integrated value chain. Instead, e.g. electric vehicle users will ultimately be able to charge their car batteries using a same solution, same quality and same price structure everywhere they drive. *Note. Within the telecommunications ecosystem, mobile phone users not even notice when they are abroad using underlying foreign networks but getting their own service with their own price structure.*

### **Regional vs Global Scalability, examples**

**Portugal** has created within the MOBILE framework a scalable electric vehicle ecosystem including various roles and responsibilities in order to enable new products and services, to generate new business opportunities and has an ambiguous goal of “A Business Model for The World”. This model might open scenarios for global scalability – at least for some of the ecosystem components. Please, see the case study later in this document too.

**Sourt-Korea** has developed a top-down vision with involvement of strong local players - experts from the industry, academia, and research institutes- to outline the national Smart Grid roadmap. The strong involvement of various parties might allow for globally scalable solutions to be developed. Please, see the case study later in this document too.

**Ireland** has guaranteed electric vehicle national ecosystem scalability by giving the major utility (ESB) a mandate to deploy and operate a nation-wide electric vehicle charge point network. The model does not show a native path towards the global market place scalability while the integration to national integrated ecosystem (transmission and distribution) remains very strong.

In the **US**, states have opted either for a “*Energy Service Utility*” model, where integrated, regulated utilities continue to sell generation and operate the Smart Grid (guided by various incentives; like Pacific Gas & Electric Company, Duke Energy, or Austin Energy et al.); or for a “*Smart Integrator*” model (or deregulation proponents’ model), where generation and retail sales are deregulated and transmission/distribution are regulated and operated as Smart Grid platforms (like Northeast Utility).<sup>11</sup> Regulatory policies will most probably need to be updated in the US for any scalable cross-state value added services.

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<sup>11</sup> Peter Fox-Penner. Smart Power. 2010

## CASE STUDIES OF SMART GRIDS: SOUTH-KOREA AND PORTUGAL

### South-Korea

South-Korea launched KSGI in 2009 and was given the mandate to manage comprehensively the government's Smart Grid roadmap; operate a Smart Grid test-bed, pilot city; and extend other policy support for Smart Grid related issues. The Korean government plans to heavily invest in the Smart Grid on the purpose of 1) lowering import expenses from energy, 2) creating jobs, and 3) utilizing Korean market as a test bed of Smart Grid Technology to lead global market. *Note. Especially the single power transmission and distribution company in South-Korea has facilitated the approach taken.*

In November 2009, KSGI collected views of experts from the industry, academia, and research institutes to outline the national roadmap that lead to Smart Grid projects conducted in five areas:

#### 1) Smart Power Grid

Open power grids will be built to allow various kinds of interconnections between consumption and supply sources. The roll-out of such networks will pave the way for new business models, and the building of a power grid malfunction and automatic recovery system that will ensure a reliable and high quality power supply.

#### 2) Smart Consumer

It aims to encourage consumers to save energy by using real-time information and producing smart home appliances that operate in response to electric utility rates.

#### 3) Smart Transportation

It aims to build a nationwide charging infrastructure that will allow electric vehicles to be charged anywhere. It also establishes a V2G (Vehicle to Grid) system where the batteries of electric vehicles are charged during off-peak times while the resale of surplus electricity takes place during peak times.

#### 4) Smart Renewable

It aims to build a smart renewable energy power generation complex across the nation by rolling out microgrids. This will ultimately lead to the emergence of houses, buildings, and villages which can achieve energy self-sufficiency through the deployment of small-scale renewable energy generation units in every end-user premise.

#### 5) Smart Electricity Service

With the launch of a variety of energy-saving electricity rate plans, this service aims to improve consumers' right-to-choose by satisfying their different needs. In addition, it wants to deliver a wide array of added electricity services through the marriage of electricity and ICT, and to put in place real-time electricity trading system for the transactions of electricity and derivatives.

The most noticeable plan in Korea's Smart Grid project is the construction of a Smart Grid Test-bed in Jeju Island. Jeju Smart Grid will become the world's largest Smart Grid community.<sup>12</sup>

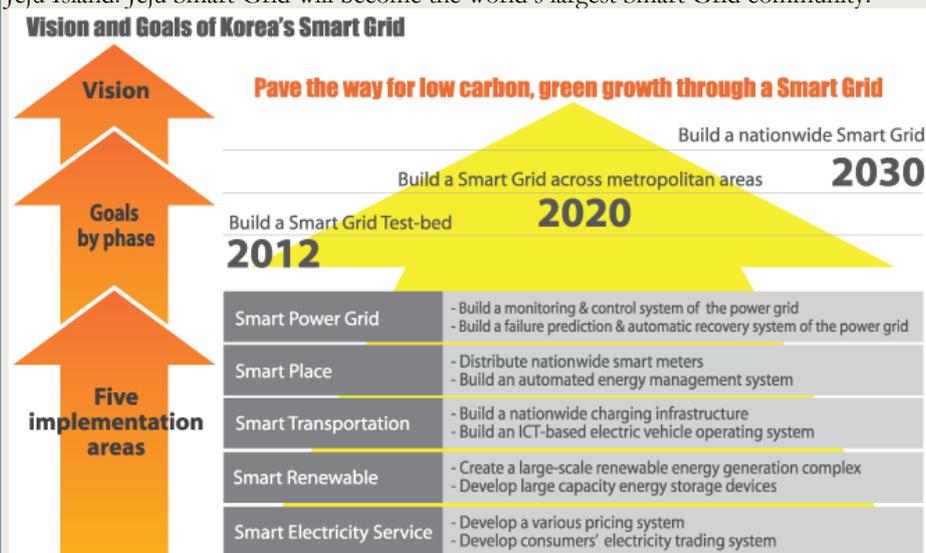


Figure 5: South\_Korea's Smart Grid Roadmap<sup>13</sup>

<sup>12</sup> Finpro, 2010. Electromobility in South-Korea. [http://www.finpro.fi/NR/rdonlyres/EB951714-9966-4647-A351-C601F7F94126/13583/Finpro\\_Electric\\_Mobility\\_in\\_South\\_Korea\\_2013.pdf](http://www.finpro.fi/NR/rdonlyres/EB951714-9966-4647-A351-C601F7F94126/13583/Finpro_Electric_Mobility_in_South_Korea_2013.pdf).

<sup>13</sup> KSGI, Korea Smart Grid Institute, <http://www.smartgrid.or.kr/10eng4-1.php>.

## Portugal

Driven by the growing dependence on oil for energy and by the huge environmental impact of the use of fossil fuels, **Portugal** is investing in new energy models for mobility that aim to improve quality of life in cities and for us all. This has led to the creation of the Electric Mobility Network. An integrated network linking various points in Portugal, managed by MOBI.E, that will enable electric vehicles to recharge, using a charge card. Its main mission is to contribute to a more sustainable mobility model, integrating the electric power system into the functioning and development of cities and maximizing the advantages of renewable electric power.

Mobi.E is the first phase in building a nationwide electric vehicle infrastructure. The target is to install 1.350 charging points and an integrated management & billing system by the end of 2011. Mobi.E has following strongholds<sup>14</sup>:

- Developed from the point of view of the end user (citizen), not energy utility: ease of use and wide availability crucial
- Nationwide network, not just one city/location
- Complete national legislation package (DL 39/2010): principles and objectives, electric mobility service and architecture, actors and roles, high level technical specifications, definition of pilot phase
- Open to all players, not only a utility-driven exercise
- Not just a test-bed, but a serious effort to build a competitive system; want to develop sophisticated solutions, not looking for easy way outs
- Integrated system (charging, management, payments etc.)
- Fluid cooperation between Government, companies and municipalities; this kind of business very difficult to start alone
- Highest possible political support: Prime Minister openly and actively supporting; one of the success factors

Mobi.E service platform is an excellent example of a digital overlay on analog electricity grid. This is an initiative that could be replicated in different locations around the world. The core is the information management system. Figure 6 establishes the Mobi.E Technological architecture.

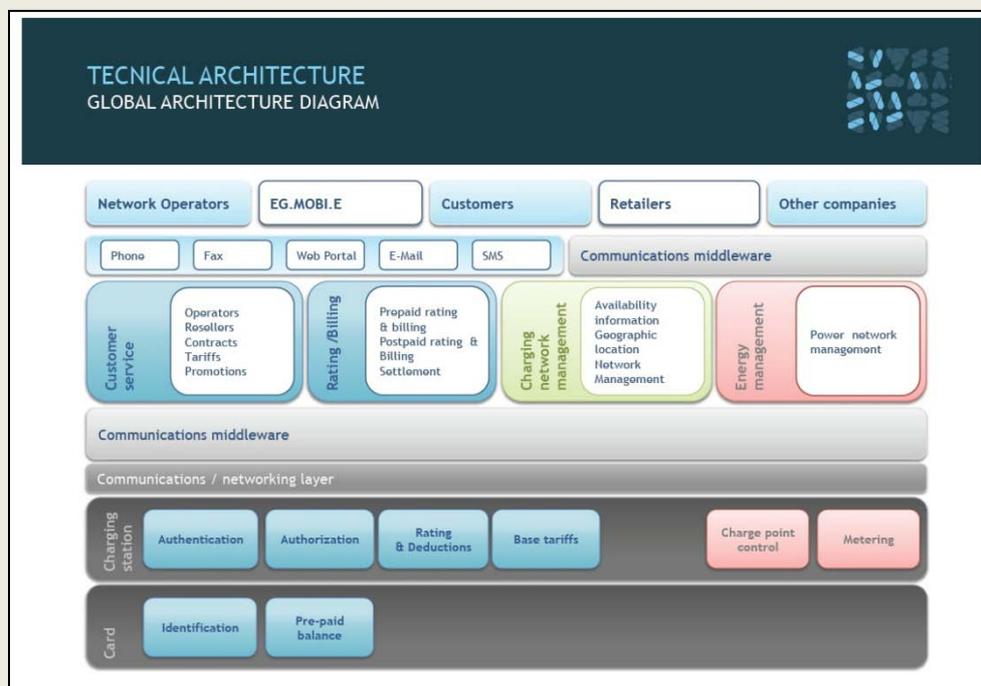


Figure 6: Mobi.E Technical Architecture<sup>15</sup>

<sup>14</sup> Finpro, 2010. Benchmarking the Portuguese Mobi.E. [http://www.finpro.fi/NR/ronlyres/EB951714-9966-4647-A351-C601F7F94126/13589/FinproElectricMobilityinES\\_POR\\_ITA2011.pdf](http://www.finpro.fi/NR/ronlyres/EB951714-9966-4647-A351-C601F7F94126/13589/FinproElectricMobilityinES_POR_ITA2011.pdf) ; <http://www.mobie.pt/en/mobie> .

<sup>15</sup> Mobi.E - The EV Charging Network. Presentation. 25.11.2010. <http://www.finpro.fi/NR/ronlyres/EB951714-9966-4647-A351-C601F7F94126/13554/MobiEEVChargingNetworkHelsinki20101125V13.pdf> .

## ABOUT FINPRO

**Finpro** is a globally operating organization that helps Finnish companies grow internationally and successfully. Finpro has over 350 professionals working in 65 offices in more than 40 countries. Finpro serves companies by enabling them to be at the right markets at the right time with a competitive offering and concept.

Finpro's active Foresight work, internationalization expertise, competitive services and global network provide an excellent platform for the development of Finnish companies' international business and competitiveness. In addition to the assignments for Finnish companies, Finpro manages substantial international initiatives such as [Cleantech Finland](#), Future Learning Finland, and FinNode.

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