FINSENY

Future INternet for Smart ENergY

FINSENY Vision, Mission and Strategy

FINSENY Vision

« A sustainable Smart Energy system in Europe, combining critical infrastructure reliability and security with adaptive intelligence, enabled by open Future Internet Technologies. »

White Paper

FINSENY Mission

« Demonstrate, by 2015, how open Future Internet Technologies can enable the European energy system to combine adaptive intelligence with reliability and cost-efficiency to meet, sustainably, the demands of an increasingly complex and dynamic energy landscape. »

Abstract

This white paper presents the main guiding principles that are governing the FINSENY project consortium. It introduces the scope and strategy of the project that seeks to define and test advanced ICT solutions for Smart Energy within the Future Internet Public-Private Partnership (FI-PPP). The paper sets out the motivation, vision, mission, strategy and scenario descriptions for the FINSENY project.

Introduction

Our natural, social, technological and economic environments are characterised by increasing complexity and rates of change, and there is a growing acceptance of the role of human activity in this process. Demographic, economic and urban developments have led to an all-time high use of energy, still primarily derived from non-renewable fossil fuels. Achieving sustainability of energy production, storage, distribution and use remains a major challenge, which is attracting increasing investment of time and resources. As an indicator of the level of activity, SBI Energy forecasts a Compound Annual Growth Rate (CAGR) of 22% in the global market for Smart Grid enabler products, set to surpass $186 billion by 2015.

The energy supply will need to evolve into a dynamic system to provide the Smart Energy infrastructure needed to support society in 2020 and beyond. Future Internet technologies will play a critical role in the development of Smart Energy infrastructures, enabling new functionalities while reducing costs. In the FINSENY project, key actors from the ICT and energy sectors are collaborating to identify the ICT requirements of Smart Energy systems. The project is expected to have a significant impact on both the Future Internet and the Smart Energy landscape, including their technical, business, social and legal perspectives. It aims to strengthen industry competitiveness as well as the environment and society of the EU by providing innovative solutions for a future energy supply with optimum trade-offs between reliability, sustainability and costs.

By analysing Smart Energy scenarios, identifying ICT requirements, developing reference architectures and preparing pan-European trials, FINSENY will shape the Future Internet ICT platforms for European Smart Energy. In a three phase programme, FINSENY will plan and deliver trials for selected scenarios to demonstrate that Smart Energy needs can be fulfilled through an ecosystem of generic and Smart-Energy-specific ICT enablers running on top of open Internet technologies whether transported in the public Internet or private network domains.

Motivation

The challenging change of today's energy system and the need for more ICT

The energy sector is key for the competitiveness of the European market because all other sectors of the economy rely on it. A reliable, sustainable and cost-efficient energy supply is becoming increasingly prominent on political agendas worldwide. The European Union ranks the future energy supply high amongst its priorities.

In order to maintain sustainability, Europe has committed to 20/20/20 targets (20% reduction in greenhouse gas emissions compared to 1990 levels, 20% renewables in energy consumption and 20% reduction in primary energy use by 2020). As part of achieving these targets, and in concrete, to assist the active participation in the electricity supply market, the wide-scale deployment of smart metering in Europe has been launched by the 3rd Energy Package, Directive 2009/72/EC.

Smart Metering, however, is only a part of the energy system transformation to cover society's energy needs in the future. The following challenges must also be addressed through more active approaches:

- Integration of distributed and intermittent generation sources, like combined heat and power generation, solar and wind power overcoming grid constraints, volatility and uncertainty which are caused by increasing penetration of these sources.
- Integration of Smart Buildings and Microgrids.
- Engagement, education and empowerment of private and commercial customers to take a more active role in the energy market.
- Active shaping of the demand curve, e.g. to flatten the demand in peak load hours (peak shaving).
- Support for an electric vehicle charging infrastructure with mobile loads.
- Enable new trading and information services on an electronic marketplace.

Distribution Grids, which are the final stage in the delivery of electricity to end customers, are at the heart of the energy system. Throughout Europe, the monitoring and control of the power grids have been deployed mainly in the high voltage network, covering in a limited way some parts of the medium voltage network, with much less automation and very limited coverage at the low voltage network. In order to cope with the above-mentioned challenges, the Distribution Grids need to become smarter so that they support:

- A decentralized control and monitoring structure across the medium and low voltage network.
- The automation of grid operations.
- An automatic detection of fault conditions and initiation of restoration actions.
- Dynamic adaptation mechanisms for active management of grid constraints and voltages.
- Improved forecasting of generation and demand for more effective operations and decision making.

Developing these mechanisms needs to be achieved at reasonable costs. For example, it is likely more economically efficient to take advantage of intelligent devices as opposed to building more grid infrastructure. ICT will play a crucial role in this context. While today's distribution grid has only a few thousands of intelligent elements, a Smart Energy system implies millions of new intelligent devices in homes and buildings and tens or hundreds of thousands in Distribution Grids (e.g. (secondary) substations and reclosers) in each European country. In order to make the best use of these intelligent devices, they must be interconnected by means of communication networks. This leads to a significant investment in communication equipment.

Additionally, intelligent devices could be owned by an increasing number of stakeholders within the downstream system (e.g. by Prosumers, Distributed Generators, Virtual Power Plants or Aggregators). Thus, interoperability must be sought not only between devices of a single stakeholder but between different stakeholders as well and for that open standards are needed.

In summary, a radical change in the energy system is expected in the upcoming years. As a consequence, an adequate information and communication infrastructure is required, enabling many new devices and new applications. The standardization and the definition of a common and shared communication and service infrastructure could be the basis for a competitive European market.

Why the Internet can be useful for the energy system and what are its current limitations?

The Internet is a global system of interconnected computer networks that use the standard Internet protocol suite to serve billions of users worldwide. Beyond the basic TCP/IP protocol various protocols up to the application layer are provided and in a wider sense all the features and functions that make up the World Wide Web today are included. Furthermore, the Internet protocol is today supported by almost all communication network technologies from copper to fibre and wireless solutions. Today's Internet standards will be a useful base for further standardisation to provide the interoperability between Smart Energy elements and actors. The energy system with its increasing number of intelligent devices would benefit from the scalability of the Internet, a global system with outstanding economy of scale.

Additionally, the Internet is evolving itself to a Future Internet. Today, people use the Internet to communicate with each other and access information and services; in the future, more and more machines and devices ("things") will also be connected to the Internet as part of the so-called "Internet of Things". This evolution fits well with Smart Energy, which as already stated can be considered to be a large number of interconnected intelligent energy devices.

Because of all these reasons, the Internet or Internet technologies have been used for energy applications (e.g. metering, substation integrated control systems, tele-control of reclosers, etc.) since 2000. Before, utilities used to employ dedicated point to point or multipoint technologies with very specific protocols. Developments in data networks have helped to unify the network to manage all kind of services, including tele-control services which have allowed a reduction in infrastructure operating costs. The consolidated network is based on TCP/IP protocols. Energy applications have joined to this unification by means of new standard protocols that use TCP/IP in its native form (without encapsulation).

However, the current Internet presents limitations for a ubiquitous use in the energy system. These limitations can be summarised by the following restrictions:

- Internet technology is currently not well suited for mission critical applications that require guaranteed high priority.
- Internet could introduce security gaps for Smart Energy applications.
- Internet technology does not fulfil the short and deterministic latency requirements for some functions in the energy landscape (e.g. tele-protections).

As a result of these restrictions, the energy system often uses proprietary or application-specific solutions that limit the economies of scale and the interoperability of its intelligent devices. These specific solutions are characterized by using different protocols for their different applications within the energy landscape, which compounds the interoperability issue.

FINSENY Vision

> *« A sustainable Smart Energy system in Europe, combining critical infrastructure reliability and security with adaptive intelligence, enabled by open Future Internet Technologies »*

This Vision statement provides the context for the FINSENY project. It is based on the likely and potential evolution of both, Smart Energy and the Future Internet, as well as their interaction, as discussed in this section. The FINSENY Mission and Strategy, which define what the project plans are, and how they will be accomplished, are presented in the next section.

How is the Smart Energy landscape likely to evolve?

Figure 1 illustrates, in three dimensions, different paths in the evolution of the energy system in Europe in terms of its information system, provision system and market system. The broad trends are from centralised to decentralised control and generation, in parallel with market liberalization and open energy markets.

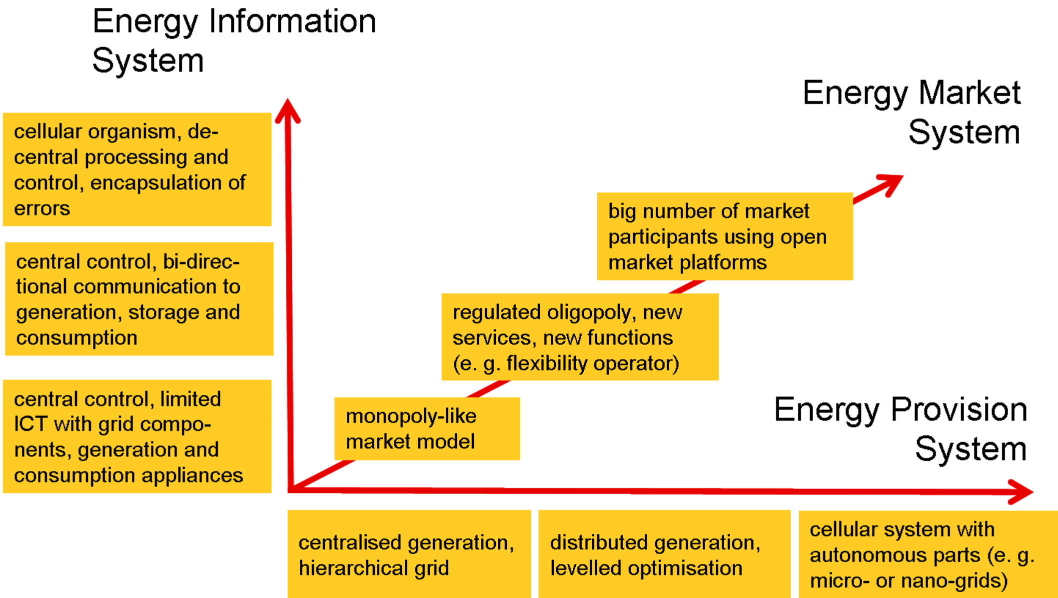

Figure 1 : Energy Information, Market & Provision systems evolution

The evolution of the Smart Energy landscape will differ from country to country, and is subject to a level of uncertainty which increases as one looks further ahead in time. With the focus on ICT for Smart Energy, it is beyond the scope of FINSENY either to predict the likelihood of each evolutionary step or to evaluate the different combinations. However, it seems clear that the Smart Energy system of the future will include the following critical features:

- **Reliability** – minimal interruptions to supply at all customer levels.
- **Safety** – all members of society will be protected from dangerous occurrences.
- **Security** – ensure compliance in the use of information and protect the network from unwanted intrusions whether physical or cyber systems.
- **Adaptability** – be capable of operating with a wide mix of different energy sources and be self-healing through decision-making on a local level.
- **Utilisation** – improved utilisation of assets through monitoring and control.
- **Intelligence** – the gathering and management of information relating to customers and assets throughout the network and using such information to deliver the features above.

The evolutionary process will begin with local smart solutions to specific problems relating to the mix of energy sources, demand management, electric vehicles (EVs) and/or the operation of Microgrids. Solutions capable of supporting local solutions must be scalable in order that the local solutions join together to form larger and larger smart networks. The speed of such growth will be governed by many factors relating to the policy within an energy company, regulatory conditions nationally and across

Europe, growth and cost of renewable energy, proliferation of EVs and above all, by choices customers will make which the utility cannot influence but to which it must respond in order to deliver on the critical features identified above.

Taking this a step further, the customer, whether large or small, will be a major player in the Smart Energy networks of the future. This is considered in the FINSENY scenarios and use cases.

How is the Future Internet likely to evolve?

The ICT landscape exhibits very short innovation cycles and is continuously evolving. A number of new trends are observable and already shaping upcoming ICT industry solutions. These developments can be summarized by the term “Future Internet”:

- **Evolution of communication networks** – LTE (4G) in the wireless domain as well as new wired technologies (e.g. Fibre-to-the-X) offer not only increased bandwidth but also different Classes of Services approaching real-time requirements. Furthermore, with innovations in network virtualisation, new flexibility for network control emerges.
- **Internet of Things** – New mechanisms are developed to easily manage huge numbers of interconnected devices which interact with their environment. Sensor data can be collected, aggregated, processed and analysed to derive contextual awareness and improved control decisions.
- **Internet of Services** – facilitates the establishment of complex business relationships between multiple stakeholders, paving the way for innovative business applications.
- **Cloud Computing** – private or public, supports a transition of business models towards the “as a service” paradigm.

Additionally, with steadily increasing volumes of data, a combination of these technologies support the exchange, processing and analysis of massive amounts of data to derive useful information. Finally, the Future Internet includes the seamless integration of the plethora of new technologies to realise secure solutions for systems with increasing complexity.

How can the Future Internet enable Smart Energy?

The ICT challenge of Smart Energy is to exchange information across multiple domains, among devices and between subsystems of diverse complexity. In addition to interoperable and standardized communications between such elements, future Smart Energy systems will rely on the availability of access and correct configuration of systems across ownership and management boundaries such as between energy management systems, energy markets, electricity distribution with distributed resources. Interactive customers with smart meters, building energy management systems, intelligent appliances and electric vehicles have to be integrated. Future Internet technologies offer several opportunities for Smart Energy solutions, including:

> **Connectivity** – Future Internet will bring end-to-end connectivity between large varieties of grid elements, including distributed energy resources, building energy management systems and active resources such as electric vehicles. For a general and cost-effective approach the use of common and public communication infrastructures has to be targeted. While current 2G/3G networks are sufficient as access technology for first generation Smart Grid applications such as

metering, LTE, IPv6 and other Future Internet communication technologies offer the capabilities for demanding and delay sensitive applications. For certain Smart Energy applications real-time communication plays an important role to fulfil the requirements for synchronisation and guaranteed reaction times of control actions. Advanced Future Internet forwarding and control plane solutions have to be considered in order to fulfil these requirements. Network virtualisation techniques can provide means to run dedicated Smart Energy communication networks, e.g. mission critical communication, on top of public infrastructures.

Management – Smart Energy introduces a lot of new managed elements with dramatically increased data volume in the network and data centres, resulting in additional management burden, complexity and cost. There are opportunities to utilise elements of the Future Internet architectures and concepts in Smart Energy management: (i) Device management and flexible object registries / repositories support mass provisioning, software maintenance. (ii) Flexible secure data management: aggregation, correlation and mediation. (iii) Network management evolves towards scalable multi-tenant (cloud) operations where organisations can manage their own objects as required. (iv) Services enabling platforms will simplify service application development. (v) Local management and decentralised data processing solutions will support Microgrids and islanding operation modes. (vi) Telecom billing and rating solutions support already huge capacities and flexibility for the various post and prepaid business models. Dynamic load and time based pricing of energy can easily be added.

Service enablement – Future Internet provides novel technologies for instant collaboration between suppliers, network operators, and prosumers. Timely, reliable and highly confidential information on the status of the grid will become accessible for all relevant stakeholders. But beyond monitoring as currently performed with smart meters, the Future Internet enables new web services based on bi-directional communication and interaction between suppliers and consumers: demand response, balancing and ancillary services, dynamic pricing, buying and selling of power are just a few of the promising future applications, which will be enabled by advanced ICT solutions.

Decentralised and distributed intelligence of the grid – Future Internet technologies will introduce new techniques in hardware and even more in software; injecting effectively intelligence into the grid. The electricity system that we inherited from the 19th and 20th centuries has been a reliable but centrally coordinated system. With the liberalisation of European markets and the spreading of local, distributed and intermittent renewable energy resources, top-down central control of the grid no longer meets modern requirements. Tomorrow's grid needs decentralised ways for information, coordination, and control to serve the customer. ICT is essential to achieving these innovations as we have already seen in today's networks – telecommunication networks and the Internet itself being noteworthy examples.

Security & privacy – Electricity grids are a critical public infrastructure. It is very important to underline the importance of security and trust, expressed as both reliability and privacy. Future Internet technologies will provide new and improved means to support security and privacy. Authentication and integrity protection of the control communication and data exchange plays an important role for the Smart Grid operation. Highest security standards have to be applied especially for mission critical infrastructure. Privacy of the European Union citizens personal life will be considered in depth as any privacy loophole will strongly impact the acceptance of Smart Energy services and solutions by the public. Future Internet privacy solutions have to be provided especially for the Smart Building and Electric Mobility scenarios and whenever user data is handled.

The Future Internet will enable Smart Energy systems by fulfilling the stringent requirements of the energy system and by providing high quality: reliability, scalability and security.

FINSENY Mission & Strategy

FINSENY Mission

> *« Demonstrate, by 2015, how open Future Internet Technologies can enable the European energy system to combine adaptive intelligence with reliability and cost-efficiency to meet, sustainably, the demands of an increasingly complex and dynamic energy landscape. »*

FINSENY Strategy

FINSENY is specifying use cases, ICT requirements and architectures in the Smart Energy domain for five scenarios, as also shown in Figure 2, which have been identified as strongly benefiting from Future Internet technologies:

a) ***Distribution Networks***,
b) ***Microgrids***,
c) ***Smart Buildings***,
d) ***Electric Mobility*** and
e) ***Electronic Marketplace for Energy***.

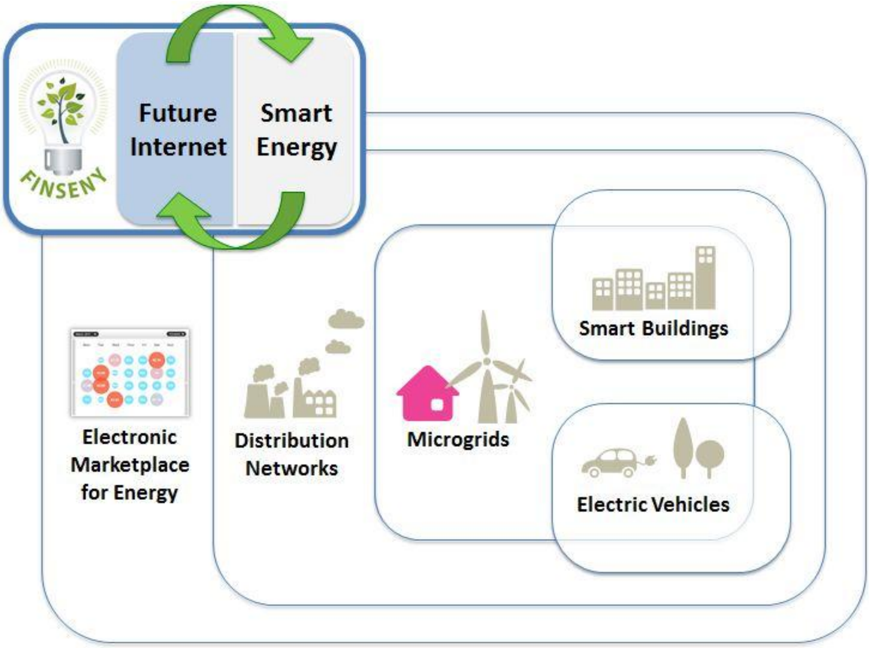

Figure 2: FINSENY's scenarios

The FINSENY Smart Energy usage area is clearly challenging the Future Internet in general and the FI-PPP platform in particular. On the one hand, it addresses use cases with severe operational, societal and economic implications and significant technical challenges: robustness, reliability, security, latency, connectivity, etc. On the other hand, it has to cope with the competing constraints of openness and security, locality and scalability, reliability and cost-efficiency, cooperation and autonomy. These challenges and constraints will impact our scenarios differently and will require major improvements of today's Internet, which has foremost a best-effort design philosophy.

The strategy of FINSENY is based on the following three pillars:

1. Industry-wide and FI-PPP programme-level collaboration and dissemination to match and find opportunities between the Future Internet and the energy sector.
2. Identify and work on FINSENY's five Smart Energy scenarios to focus the technical framework of the project on use cases that benefit most from the use of Future Internet ICT enablers and will lead to large scale pilots in the second and third phase.
3. Ensure coherence among the project's five Smart Energy scenarios, by consolidating a single homogenised set of requirements and an architecture framework that will enable the handling of services in a formal manner to promote the scalability and effective use of the energy and ICT related assets.

In order to understand the strategy of FINSENY, it is important to distinguish the basic stakeholders and the value added to their business by the solution that FINSENY will deliver (see Figure 3), based on the use of ICT enablers for advanced scenarios envisaged presented in the section below.

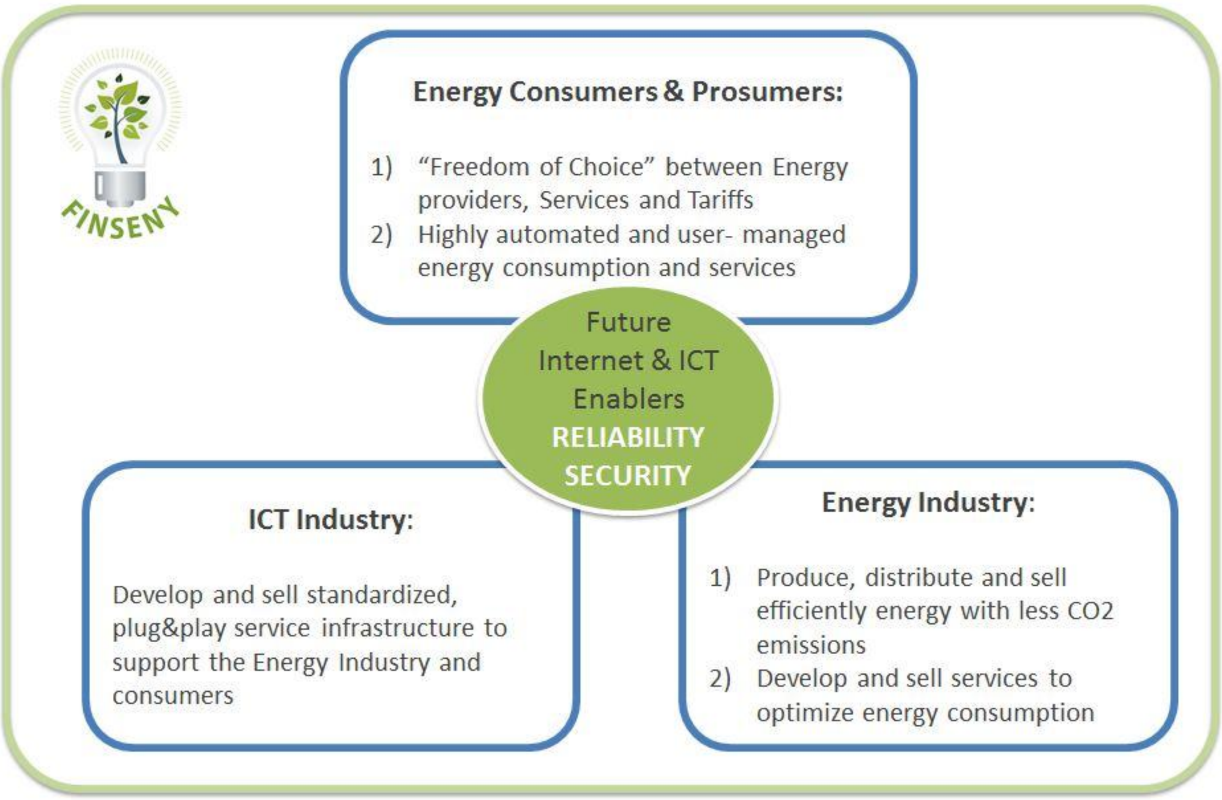

Figure 3 : FINSENY goals for the different stakeholders addressed

FINSENY and the FI-PPP

FINSENY is an Integrated Project that is running under the Future Internet Public Private Partnership (FI-PPP) programme[1] launched by the European commission in 2011.

The objectives of the above programme are in short to:

- Increase the effectiveness of business processes and infrastructures supporting applications in areas such as transport, health, and energy.
- Derive innovative business models that strengthen the competitive position of European industry in sectors such as telecommunication, mobile devices, software and services, and content provision and media.

FINSENY is related to Smart Energy, but innovative applications in many other usage areas, like intelligent transport systems, logistics or smart city applications, will also require significant use of Information and Communication Technologies (ICT) which fit to the corresponding requirements. And many of these requirements are expected to be quite similar so that they should be provided in a generic way. This is the key idea of the FI-PPP: FINSENY and seven other FI-PPP projects are currently investigating different usage areas and FI-WARE, as the technology foundation project, will provide a novel service infrastructure, building upon elements (called Generic Enablers) which offer reusable and commonly shared functions making it easier to develop Future Internet applications in multiple sectors.

Relationship between Future Internet Technology and ICT for Smart Energy

To support the evolving Smart Energy systems advanced ICT solutions are certainly required. A major role within the necessary ICT is foreseen for Future Internet technologies. In Figure 4, we draw the new landscape that FINSENY is proposing with respect to the FI-PPP approach comprising these ICT solutions in one abstract layer denoted *ICT for Smart Energy* consisting of Generic Enablers provided by the Future Internet core platform and domain-specific enablers for Smart Energy.

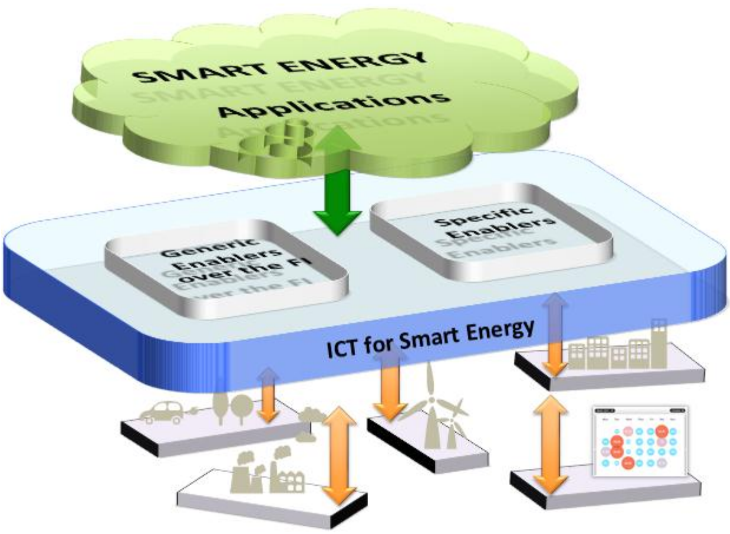

Figure 4: FINSENY Smart Energy ICT Layer for the Smart Energy landscape

All five scenarios targeted in FINSENY will rely on an information and communication framework that will in fact define open and standardised APIs based on Generic and Domain-Specific Enablers. The Generic Enablers (GE) candidates will be consolidated and developed in the FI-PPP project FI-WARE.

[1] http://www.fi-ppp.eu/

The Domain-Specific Enablers (DSE) will add specific capabilities to the Future Internet core platform which have e.g. to meet the requirements of critical infrastructures. Figure 5 shows the enabler mapping process between FINSENY and FI-WARE.

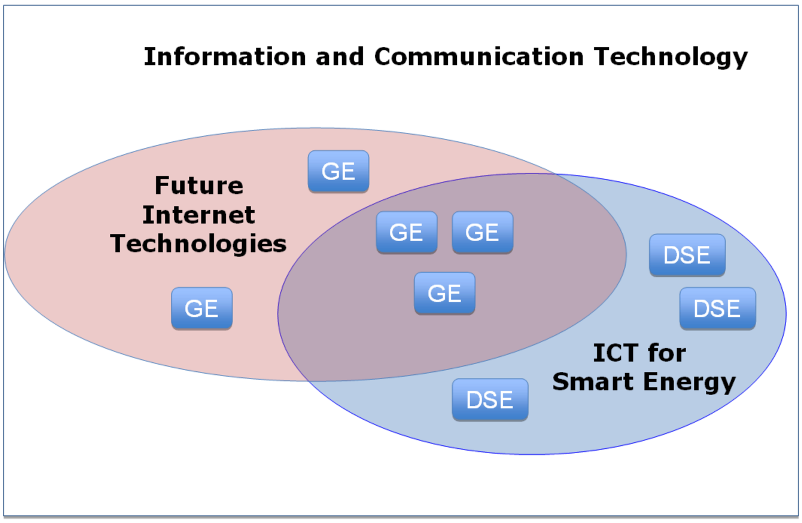

Figure 5: Enabler Mapping Process

Design principles for ICT to enable Smart Energy

From the FINSENY vision it is obvious that the future Smart Energy systems will be guided by a set of design principles which in turn will impose a set of design principles on the corresponding ICT (and FI) architecture.

In the following we list the prominent Smart Energy design principles:

- **Openness** to new service providers and business models.
- **Flexibility** to incorporate new customers (generation and consumption) as well as mobile loads.
- **Decentralisation of control** to support distributed generation and consumption.
- Introduction of **autonomous energy cells** (e.g. Microgrids, Smart Buildings).
- **Security and safety mechanisms** on all customer-, system- and service-levels.
- **Automation** of critical control processes.
- **High reliability and availability** of all systems and services.
- **Cost efficiency**.

These future Smart Energy design principles can be translated into those for supporting the future ICT infrastructures. These deduced ICT and Future Internet design principles will help the developers of enablers to properly tackle the right priorities while conceptualising the functional blocks of the solutions envisaged within the FINSENY domains and to thoroughly check the Generic Enablers proposed by the core platform-project FI-WARE[2]. A selective set of ICT and Future Internet design principles is:

- **Open (and standardised) Interfaces** guarantee the compatibility and extensibility of the system.
- **Simplicity** limits system complexity and improves maintainability.
- **Flexibility** allows for adaptability and loosely coupled systems.
- **Scalability** ensures that the system continues to function under changes in e.g. volume or size without affecting its performance.

[2] http://www.fi-ware.eu/

- **Modularity** promotes vertical encapsulation of functions.
- **Maintainability and Upgradability** lead to suitable manageable and sustainable designs.
- **Security & Privacy by Design** comprises the complete system development process.
- **Support of Heterogeneity** is a major design principle.
- **Reasonable Dimensioning** to optimise cost-efficiency without compromising overall performance.
- **Robustness** ensures systems to survive failures.
- **Locality** guides the design of self-healing and robust logical systems.
- **Encapsulation/Isolation** of faults supports the concept of Locality.
- **Auto-configuration** supports the concept of Plug&Play.
- **Quality of Service (QoS)** classes guarantee well-defined performance metrics.
- The **Decentralisation of Control Structures** supports scalability, performance and locality.
- The **Decentralisation of Processing** demands for distributed data storage and processing units, and may introduce hierarchies.
- **End-to-end Connectivity** ensures that a network provides a general transport service that is transparent to applications.
- The **Networks of Networks** principle supports the decomposition into a collection of autonomous networked sub-systems.

FINSENY Scenarios

The FINSENY mission will be further elaborated in each scenario below. Each scenario corresponds to a work package within the FINSENY project.

Distribution System (DS)

1. **Problem Statements**
    - The increasing amount of volatile DER generation in the Distribution System will change today's well planned, standard load profile based operation to a dynamic demand response based approach based on actual status information from the medium down to the low voltage parts of the grid.
    - Energy flows are increasingly bidirectional, intensifying person safety and grid overload issues and demanding an increase of efficiency of energy distribution.
    - New smart energy applications are to be incorporated which handle the need for varying generation and demand levels to be balanced while optimally utilising grid resources.
    - Ubiquitous ICT solutions need to be defined, designed, financed, built, operated & maintained (see design principles in the above section).
2. **Mission**

"Design a future ICT solution for Distribution System automation & control to increase energy quality, reliability, robustness and safety and to ease integration of Distributed Energy Resources."

3. **Focus**
   - Automated fault restoration, power analysis & control, grid maintenance.
4. **Customers and Benefits**
   - DSOs will get the solutions to optimally handle grid capacity and energy flows.
   - Service providers will get the interfaces to provide innovative energy services.
   - Prosumers can optimise their generation and consumption based on a stable distribution grid.
5. **Key factors to judge the quality of the outputs**
   - Reliability, safety, security and cost-efficiency of the solutions.
6. **Key Features and Technologies**

- Decentralised operation, connectivity and control by scalable ICT solutions.

7. **Outputs Critical Factors**
   - Interoperability and integration (with legacy systems), scalability, allowing both centralised and de-centralised control, open & secure ICT solutions.

Microgrid

1. **Problem Statements**
   - How to operate local low voltage or even mid-voltage distribution systems with Distributed Energy Resources (DERs) and storage devices to satisfy demand of energy consumers in an autonomous (islanding mode) or semi-autonomous (interconnected to the main grid) way.
   - How to build the Microgrid platform on Future Internet technologies to be more cost-efficient, flexible, secure, scalable, reliable, robust and modular.
2. **Mission**

"Design a reliable and cost-efficient Microgrid platform which ensures flexibility, scalability and robustness. The design will be modular and applications/services will be loosely coupled. Devices in or at the edge of the grid (e.g. DERs) will be easily integrated and control/communication networks will be managed to ensure the right level of QoS."

3. **Focus**
   - Microgrid Control Centre and interface to the control and communication network to operate the system and integrate prosumers with e.g. DERs or Smart Buildings.
   - Configuration, monitoring & control, data management & processing.
4. **Customers and Benefits**
   - Microgrid operator has a flexible Microgrid platform to deploy in his environment.
   - Prosumers have an aggregation platform to include their DERs and flexible demand.
5. **Key factors to judge the quality of the outputs**

- Internet of Things technologies for device & resource management, connectivity services at the interface to networks, data management and security.

6. **Key Features and Technologies**
   - Decentralised operation, connectivity and control by scalable ICT solutions.
7. **Outputs Critical Factors**
   - Regulatory hurdles, but already aligned with the governmental goals for an increased share of renewable energy and higher reliability by providing cost-efficiency.

Smart Buildings

1. **Problem Statements**
   Comprehensive building energy management:
   - With the combined goals of building-scale optimisation (local source-load-storage balancing and efficiency and grid-scale optimisation (demand-response)).
   - Under constraints of scalability, separation of concerns and auto-configuration.
2. **Mission**

   "Design of future comprehensive Building Energy Management Systems as flexible edge of the Smart Energy system and as key element for shared Future Internet platforms."

3. **Focus**
   - Make it possible to monitor and control all energy-relevant building subsystems, appliances and other physical entities operating on top of a shared platform, a building "operating system" provided to all building applications.
   - Managing all entities through common interfaces based on a generic model akin to that of a peripheral driver in a computer operating system.
4. **Customers and Benefits**
   - Building owners and stakeholders
   - Facilities managers and building services providers
   - Building end-users
   - All shall benefit from a horizontal building energy management system that interoperates fully with other building automation systems operating on top of the same shared building operating system.
5. **Key factors to judge the quality of the outputs**
   - Use smart building "operating system" providing interface to the buildings physical entities and common service layer to be shared by all building applications.
6. **Key Features and Technologies**
   - Provide information models and interfaces that encompass all energy-relevant legacy building hardware and equipment. Demonstrate corresponding monitoring and control interfaces for key types of such equipment.

- Provide information models and interfaces that make it possible to interoperate with existing building ICT systems. Demonstrate corresponding monitoring and control interfaces for such systems.
- Specify application layer that combines local and global energy optimisation.

Electric Vehicles

1. **Problem Statements**
    - As the number of electric vehicles on our roads increases, the charging of electric vehicles will become a major load on the electricity grid and it's management poses challenges to the energy system as well as offering a contribution to solutions to balancing the volatility of energy generation from renewable sources.
    - The provision of a seamless infrastructure for charging electric vehicles in Europe poses challenges to the transport, the energy and the payment infrastructure owners as well as well as to regulators. At the same time, electric vehicles, if connected wirelessly to the transport infrastructures, offer the potential to support multi-modal transport solutions.
2. **Mission**

> **"Design Smart Energy solutions so that electric vehicles will be an integrated part of the energy infrastructure, maximising their benefits to the energy infrastructure."**

3. **Focus**
    - Defining the role that electric vehicles can play in the Smart Energy infrastructure.
4. **Customers and Benefits**
    - Energy stakeholders are provided with scenarios for integrating electric vehicles into their plans for evolution towards Smart Energy solutions.
    - Energy stakeholders are given an overview of the ICT requirements and functional architecture issues from the perspective of electrical vehicle usage.
    - Users can charge in a user friendly way and can use electric vehicles as part of multi-modal transport solutions.
    - Energy stakeholders could possibly use the control of charging times for the vehicles to assist in energy grid management.
5. **Key factors to judge the quality of the outputs**
    - Defined ICT requirements and functional architecture enabling the integration of electric vehicles into the energy infrastructure.
6. **Key Features and Technologies**
    - Scalable solutions as number of vehicles grow, access to services wherever the user is via cloud computing and defined network interfaces. Wireless and fixed converged networks, infrastructure as a service.
7. **Outputs Critical Factors**

- Open interfaces and secure ICT solutions are needed. The high speed of change in the market as the commercial side of electric vehicles develops is already evident creating timing issues for the introduction of common solutions. Regulatory issues will play a key role in this emerging market.

Electronic Market Place for Smart Energy

1. **Problem Statements**
   - Those who are going to participate more actively in the energy supply, such as DSM customers, Prosumers, Microgrids, DERs, need a kind of electronic market place (for information and services). The services should be offered via the Future Internet. This electronic market place could in particular give information useful for balancing supply and demand and to check grid restrictions.
2. **Mission**

> **"Design ICT systems to extend web based energy information, demand shaping and energy trading services for the emerging energy market players."**

3. **Focus**
   - ICT systems to enhance contract negotiation, competitive price awareness and energy trading also at regional-level.
4. **Customers and Benefits**
   - Final Energy customers should be more aware and have a broader choice of Energy supply; energy trading at micro levels will be available for new prosumers, as well as better management of grid stability and planning for utilities.
5. **Key factors to judge the quality of the outputs**
   - Very flexible and secure web based energy services.
6. **Key Features and Technologies**
   - Large scale data gathering and management via web, Internet of Energy linked objects and customers-prosumers.
7. **Outputs Critical Factors**
   - Perceived marketplace trustworthiness from energy stakeholders will be fundamental together with the user engagement via the Internet in Smart Energy services promoted in FINSENY.

Conclusion

FINSENY is a Future Internet (FI) project studying innovative new FI technologies to apply them to the Smart Energy landscape. The need for more ICT as described in this paper is widely agreed in the Smart Energy community to accomplish the challenges of the envisioned energy system. Future Internet technologies offer several opportunities for Smart Energy solutions, including connectivity, management, service enablement, distributed intelligence as well as security and privacy.

In the FINSENY project, key players from the ICT and energy sectors teamed-up to analyse the most relevant Smart Energy scenarios, identify prominent ICT requirements, develop reference architectures and prepare pan-European trials. As part of the FI-PPP, FINSENY will demonstrate over the three phases of the programme that Smart Energy needs can be fulfilled through an ecosystem of generic and Smart Energy specific ICT enablers running on top of an open Future Internet platform.

FINSENY will shape the European Future Internet ICT platform(s) to support the emerging European Smart Energy era as summarised in Figure 6. The growing Smart Grid Stakeholder Group will provide broad visibility of the on-going project work in the energy community, enhancing the acceptability of the project results and facilitating the development of the Smart Energy landscape.

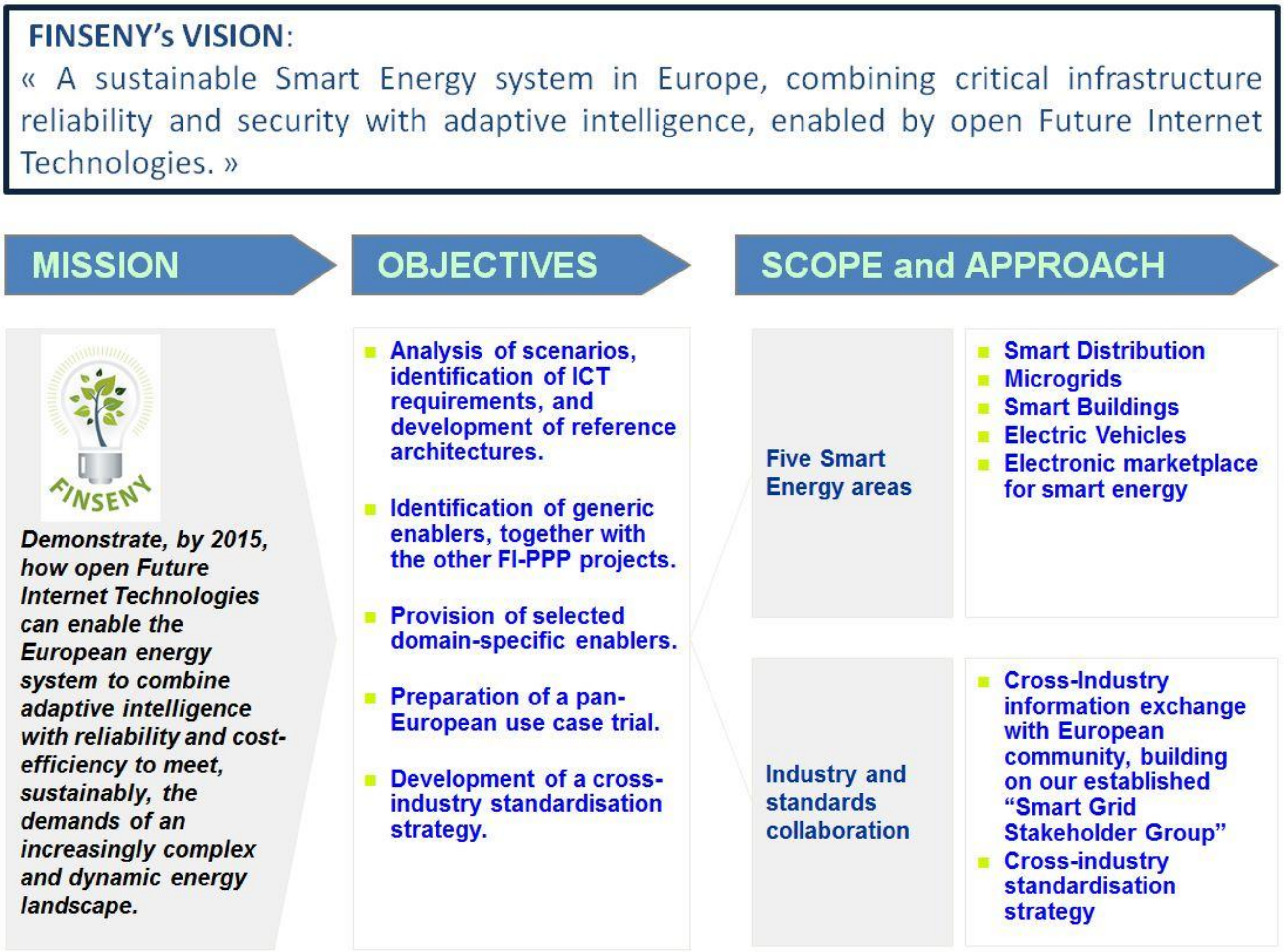

Figure 6: FINSENY Summary Vision

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