

# ICT Enablers for Smart Energy

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**Abstract**—Almost all innovative applications in usage areas like energy, transport & logistics, healthcare rely on specific Information & Communication Technologies (ICT). These services often need to fulfill very stringent requirements which cannot easily be fulfilled by today's technologies. Developing usage area specific ICT solutions is not the solution since this prohibits benefiting from an economy of scale. Initiated by the European Commission (EC) the Future Internet Public Private Partnership (FI-PPP) has been setup to systematically identify ICT requirements from different usage areas and address as many of them as possible by so-called generic Future Internet / ICT enablers. Obviously, Smart Energy is a very important usage area which is addressed by the FI-PPP project FINSENY. This article will provide a detailed description of the project setup and its methodology.

**Index Terms** — Future Internet, ICT, Smart Energy, Smart Grid

## I. INTRODUCTION

SUSTAINABLE energy supply is currently one of the most important and critical topics. It is heavily discussed at technical and political level. Consequently energy from renewable sources like wind and solar are playing a very critical role. Beside sustainability, also reliability and affordability of energy are two dimensions which are in the focus as depicted in Figure 1. In fact optimum trade-offs need to be found between sustainability, reliability and costs. One of the challenges is the volatility of many of those energy sources. Another challenge will be unpredictable loads e.g. from electric vehicle loading. It is commonly understood that this requires significant use of Information and Communication Technologies (ICT) which fit to the corresponding requirements.

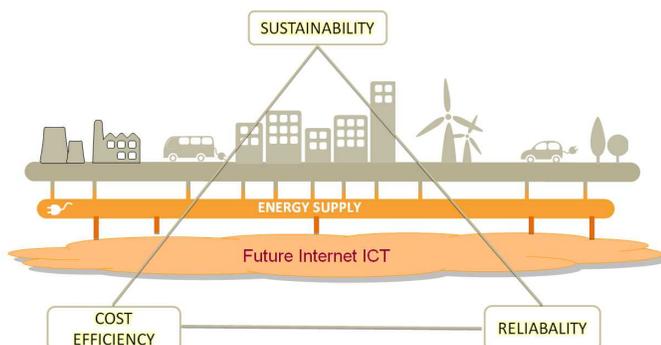


Fig. 1. Energy Supply Triangle

Innovative applications in many other usage areas, like intelligent transport systems, logistics or smart city applications, will also require ICT functions. And many of these requirements are expected to be quite similar so that they should be provided in a generic way; such functions are called generic ICT enablers. This avoids the development of similar ICT functions in a different way for different usage areas which finally would end up in breaking the economy of scale. In order to avoid fragmentation and a lack of interoperability, the Future Internet Public Private Partnership (FI-PPP) [1; 2] has been recently installed by the EC.

Within the FI-PPP all ICT requirements will be identified for a certain set of usage areas. An understanding will be commonly achieved, which of them need to be addressed in a generic way and which must be taken care of by every usage area itself. Large-scale trials will be prepared for a later phase of the program to be able to demonstrate that finally generic ICT enablers and specific ICT enablers are indeed the enablers of innovative and impact creating applications in the respective usage areas. In this context, the usage area project dealing with Smart Energy is FINSENY, Future INternet for Smart ENergyY. This article provides a detailed overview of the work being done in FINSENY. Due to the start of the project on 1st April 2011, no project results can be provided yet, but the approach and methodology will be described in detail.



Fig. 2. FINSENY Consortium

## II. SMART ENERGY – KEY DRIVERS & CHALLENGES

Increasingly, renewable decentralised energy generation will be used in order to limit climate change and to replace nuclear power generation. Renewable energy generation is depending on changing weather conditions and the energy system has to cope with this volatility. The entire system has to optimally use existing grid infrastructures and adapt them to the new requirement. That is not only a question of electrical engineering but also a question of bringing more intelligence to the entire power system. In addition, the liberalisation of the energy market allows for and even calls for new services and new market roles. These developments require a combination of action fields like smart grids and smart home as well as smart grids and electric mobility. The key enabler for the smart energy world is ICT – Information and Communication Technology.

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 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 the boundaries between energy management systems, energy markets, electricity distribution with distributed resources and the boundaries between interactive customers with meters, smart appliances and electric vehicles).

## III. FINSENY'S APPROACH

The FINSENY project represents a European consortium with partners from the ICT domain, the energy utility and manufacturing domain, SMEs, Associations, R&D centres and universities. Figure 2 gives an overview of the FINSENY consortium with partners from many European countries.

FINSENY will use scenario techniques to identify the prominent ICT challenges. The term 'scenario' refers to an application domain in the evolving Smart Energy landscape, expected to be of significant importance, and requiring advanced ICT technologies. The following five smart energy scenarios will be addressed in the project:

- Distribution network,
- Regional-/microgrid,
- Smart buildings,
- Electric mobility, and
- Electronic market place for energy.

To focus work on each individual scenario, FINSENY will assume that energy transport and energy distribution takes place solely as electricity. For every considered scenario four main tasks have been identified:

### *Task 1: Scenario Evaluation*

Every scenario will be evaluated in detail by describing the framework conditions, the roles and players as well as the detailed most relevant use cases. Obviously there are quite

some activities ongoing in these fields which will be taken into account. This will avoid repeating work and allows for making use of it. The relevance of the use cases will be evaluated according to their potential to induce remarkable ICT requirements. Finally, selected use cases will be described according to common templates.

### *Task 2: ICT Requirements*

Based on the use case descriptions the ICT requirements will be identified. These will be described along a certain template which needs to be agreed upon not only within the FINSENY project but within the entire FI-PPP program. In the following there are two different stages of ICT requirements consolidations required: first between all the scenarios within the FINSENY project, and second between all usage area projects within the FI-PPP. Finally, a detailed understanding will be available, which of the ICT requirements will be addressed by generic ICT enablers and which ones require domain-specific ICT enablers that each usage area needs to take care by itself.

### *Task 3: Functional ICT Architecture*

Based on the detailed understanding of the respective scenario, the generic ICT enablers being made available by the ICT industry, and the domain-specific ICT enablers taken care of by the energy & ICT industry, a functional ICT architecture will be developed. This will result in an architecture, which describes how the scenario use cases shall be supported and equipped with the available ICT enablers. This will also require coordination between the scenarios, since they are obviously not disjoint. Where scenarios are interfacing to each other or even overlapping, the respective functional ICT architectures need to be consistent.

### *Task 4: Trial Candidates*

Following the overall process of the EC's FI PPP, pan-European trials will be prepared, which – after a further Call for Proposal in the European Framework Programme 7 – are expected to start in April 2013. To prepare for such a suitable trial in the Smart Energy domain, every FINSENY scenario will propose candidates and work out a potential field trial design in more detail. Thus, the FINSENY proposal for a Smart Energy trial will involve existing and promising demonstration projects as well as new approaches at various test sites all over Europe.

Intensive cooperation on all levels will be an important success factor. This is on the one hand side organized through a Smart Grid Stakeholder Group as described below and on the other hand side via interactions with other projects in the field and the FI-PPP. This includes European funded projects (like ADDRESS, BeAware, FENIX, PREMIO, SAVE ENERGY, Web2Energy, etc.), national programs (like E-Energy in Germany, Energy@Home in Italy, SG Model Regions in Austria, etc.), and further industrial initiatives. For this purpose all projects and initiatives are being collected, stored and assessed in the FINSENY database.

#### IV. FINSNEY'S SCENARIOS

All five smart energy scenarios investigated by FINSNEY are large domains. As mentioned before, a detailed evaluation of them is the first step FINSNEY is working on. Just to give a rough impression what the scenarios are about this section shortly summarizes the most relevant aspects in terms of ICT requirements and in terms of the progress beyond state-of-the-art which shall be achieved by FINSNEY.

##### Scenario Distribution Network

Advanced automation, control and management of distribution networks are needed in order to meet the anticipated increase in distributed energy generation and to tackle new challenges such as the charging of electrical vehicles. This involves new methods of load prediction and demand side management as well as interfaces with the existing and new market.

TABLE I  
ADVANCEMENTS BEYOND STATE-OF-THE-ART FOR THE SCENARIOS  
"DISTRIBUTION NETWORK" & "MICROGRID"

<b>Distribution Network &amp; Microgrid</b>	
<i>State-of-the-Art</i>	<i>Beyond State-of-the-Art</i>
Supervision and Control of primary substations and their periphery only	Supervision and control of all active components in the Distribution Network, e.g. to assure power quality even with high percentage of renewable energy
Indirect fault detection and vague fault localization	Extensive use of sensor data and of an ICT-based control infrastructure for fast fault detection, precise fault localization and automatic restoration
Standard profiles to predict consumption and adapt generation	Detailed consumption information and means to adapt consumption to production (demand side management)
Uncontrolled feed in from (volatile) distributed power generators	Controllable inverters including ability to provide system services (e. g. reactive power)
<i>in particular for Microgrid:</i> Island control only for object networks (small-scale) and transmission systems (large-scale)	Independent operation in case of macrogrid connection-loss, assurance of power quality even with high percentage of renewable energy generation

##### Scenario Microgrid

The large scale introduction of distributed generation supports the establishment of local or regional microgrids. Using techniques like virtual power plants or virtual power systems they strive for aggregating and autonomously controlling their own supply and demand side resources to balance production and consumption in as small as possible entities. Interaction with the surrounding distribution network and with the connected production, storage and consumption appliances is the key to the efficient control of such grids.

##### Scenario Smart Building

Efficient energy management in buildings requires extensive use of communication network infrastructure to and in buildings as well as the provision of the necessary interfaces to local appliances, local distributed generation and energy and service providers.

TABLE II  
ADVANCEMENTS BEYOND STATE-OF-THE-ART FOR THE SCENARIO "SMART BUILDING"

<b>Smart Building</b>	
<i>State-of-the-Art</i>	<i>Beyond State-of-the-Art</i>
Legacy buildings and legacy equipment within these buildings cannot easily be equipped with or adapted to advanced ICT technologies for building automation	FINSNEY together with the Technology Foundation will provide a shared open platform for building-based ICT services (including building-scale energy management building automation, building security services, even in legacy buildings. This platform will allow for the integration of legacy equipment in a comprehensive building energy management system.
Separation of Building Management System (BMS) and "ICT infrastructure for "regular" ICT services (telephony, internet).	Integration of BMS and other ICT services on the same platform allows for economies of scale and more efficient energy management. Availability of additional context data for BMS
High Complexity of setting up, configuring and maintaining building energy management systems, experts know-how required	Self-configuration and self-management of integrated and shared ICT infrastructure for building energy management and building automation is the long-term objective that FINSNEY will strive to achieve;
Brittle centralized and difficult to scale / analytical energy optimization solutions	Minimal manual programming, scalability and adaptability of building energy optimization engines, using such technologies as multi-agent systems

##### Scenario Electric Mobility

The large scale introduction of electrical vehicles will have an impact on the energy infrastructure. Providing the necessary charging points requires interaction between the energy infrastructure, the transport infrastructure, the vehicle information systems and the communication network infrastructure in order to collect, process and deliver the needed information, e.g. for charging and billing.

TABLE III  
ADVANCEMENTS BEYOND STATE-OF-THE-ART FOR THE SCENARIO "ELECTRIC MOBILITY"

<b>Electric Mobility</b>	
<i>State-of-the-Art</i>	<i>Beyond State-of-the-Art</i>
Focus on single energy provider and national / small-scale scenarios → proprietary solutions	Full integration of energy management systems for electric mobility and the grid operation Pan-European solution, involvement all energy providers ("roaming")
Missing common solution for business-process interaction between all different actors of electric mobility	Standardized ICT Support to enable Business-relationship handling between all actors of electric mobility throughout business domains

##### Scenario Electronic Market Place for Energy

The introduction of Smart Energy Grids and deregulation results in a transformation of the European energy market. New players are appearing and the roles of incumbent players are changing. An electronic market place for energy must support all these players and roles by providing the necessary interfaces and information exchange. It should also be open to support new applications, players and roles.

TABLE IV  
ADVANCEMENTS BEYOND STATE-OF-THE-ART FOR THE SCENARIO  
“ELECTRONIC MARKET PLACE FOR ENERGY”

Electronic Market Place for Energy	
<i>State-of-the-Art</i>	<i>Beyond State-of-the-Art</i>
Current energy market dynamics is not accessible for many energy stakeholders.	Access to an extended virtual marketplace for all energy stakeholders.
Missing tools for all energy transactions being available to the energy stakeholders	Advanced ICT Tools for enabling Energy Transactions: real-time, reliable, secure
Today, energy trading happens with low granularity in terms of amount of energy and time	

## V. SMART GRID STAKEHOLDER GROUP

Due to the large scope of Smart Energy, one project partnership alone cannot host all relevant stakeholders. Therefore intensive cooperation is required far beyond the FINSENY consortium. Therefore, the Smart Grid Stakeholder Group (SGSG) has been established in June 2010 to foster the information exchange between ICT and energy industry and thus to better understand each others views.

The organization of the SGSG is a task in FINSENY. At least three workshops are planned to present and discuss project findings and to identify further cooperation opportunities. This group is open for all industrial organizations which are interested in Smart Grid / Smart Energy topics. In case of interest to join that group, please contact the authors of this article.

## VI. CONCLUSION

There is common sense that there is a need to act now and to assure that the energy systems become smarter with the help of ICT. FINSENY has been setup to contribute to this goal and to deliver a clear understanding within the coming two years which ICT enablers – generic ones and domain-specific ones – are required and how they fit into the functional ICT architecture of a future internet. It is expected that this will successfully lead into a Smart Energy trial activity which will show that the identified concepts lead to and maintain a sustainable, reliable and cost-efficient energy solutions in a large scale.

## VII. ACKNOWLEDGMENT

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- [2] Future Internet PPP – The future now. <http://www.fi-ppp.eu/>.

## IX. BIOGRAPHIES



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