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SME Case Study

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Abstract:

The deliverable will show how FIWARE technology can be used by SMEs to support the software development in the IT sector. For this purpose the work of the FINESCE partners, that won the open call is analysed. Three different views on the involved SMEs are presented in this deliverable:

1. The integration of the SME's application into the trial environment will be described,
2. the integration of FIWARE components into the SME's software products for the energy sector will be analysed and
3. the business exploitation model and first experiences with the utilisation of FIWARE based products will be explored.

The work documented here is performed in within the framework of Task 6.3. It uses the deliverables D1.1, D2.1, D3.1, D4.1 and D5.1, D6.6 as input and initial point. It is an iteration of D6.4 FINESCE roadmap.

Keyword list:

Open call, SME, FIWARE, FINESCE, trials, smart energy, applications, IOT, architecture models, business models

Executive Summary

One strategic goal of the FINESCE project work is the integration of Third parties 'applications into the trial architecture with a focus on SMEs.

It is an evaluation of the "Utility 4.0" concept which promotes the service-oriented utility. The service-oriented utility provides ICT platforms for third parties to offer their application and services to the utility itself and the utilities' customers. The idea behind is a faster development and deployment of smart services for utilities to be more competitive in a fast-changing market and the better integration of renewable energies into the energy system of the future via ICT platforms.

The technical approach is built on two fundamental components:

1. The use of FIWARE as a standard cross-section software platform. It offers the opportunity for ICT companies to use software blocks that cover the basic functionality of the Future Internet in general (using FIWARE Generic Enablers) and the common requirements regarding Future Internet of the smart energy sector in particular (using FINESCE Domain Specific Enablers), rather than continuously reinventing the wheel by developing apps from scratch.

2. The use of open APIs to get access to software services and trial data rather than the creation of closed proprietary solutions. Contributions to a system of systems that can be enhanced to a network of Smart City applications which share data and services amongst the system's actors and which makes the software development cost-effective and the services easily scalable.

FINESCE promoted its Open Call on several innovation events throughout Europe to attract the most innovative SMEs to the FINESCE trial sites.

Regarding the business approach the applications of the SMEs can be divided into three categories:

1. High level services that build the foundation of new services to customers (e.g. data analyses, visualisation of data, integration of devices etc.) and

2. applications that directly provide a benefit for customers which can be commercialised as white label products (e.g. the heat monitoring tool)

3. Domain specific enablers that can be used as standard software building block within the system

The open architecture of FIWARE utilised in the FINESCE trial sites allows SMEs the provision of new energy services on all levels. Main actors in the energy market like utilities become part of a Smart Energy Ecosystem (which is part of a Smart City Ecosystem) that enables the fast and cost-effective integration of new ideas and solutions of third parties because the basic software blocks (FIWARE GEs), standards and interfaces are already defined and widely used.

This way the development of the emerging smart energy system becomes a shared process on multi levels (FIWARE GEs-> energy DSEs->high level services->applications) which offers innovative companies a great variety of opportunities to participate.

It will accelerate solutions for current challenges in the integration of distributed renewable (and volatile) energy generation and offers data and services for an integrated and citizen-oriented Smart City World.

The FINESCE Smart Energy Platform based on FIWARE will be further developed and improved in upcoming projects and programmes ("FEN Flexible Energy Networks", "ELSA", "Era-Net Programme")

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Table of Contents

Table of Figures

1. Introduction

The energy market is changing. New challenges are arising in grid and energy supply due to the increasing share of volatile and distributed renewable generation

The traditional energy business (energy generation and trading) is under pressure, utilities are looking for new services and business models.

Improving and optimizing this new energy system is one of the great challenges of our times – and a great opportunity for innovative ICT companies. There is a need to better manage our use of energy at home, at work and while on the move. Energy generation, consumption and storage appliances must communicate to synchronize the energy provision system.

Data analysis will be a key factor. Automation and business software will provide the best options for the individual actors in the modern Smart Energy world: grid operators, flexible home owners and enterprises, storage providers, energy suppliers and retailers.

FINESCE contributes to the development of these new services by offering collaboration, Opportunities and enablers between innovative SMEs and the FINESCE trials. The integration builds on three components:

- To develop an idea of an innovation ecosystem placed around a service-based utility ("Utility 4.0")
- To use open Smart Energy platforms based on FIWARE GEs and FINESCE DSEs
- To include SMEs into the work of the FINESCE trial sites via the FINESCE Open call

In this document the results of this approach are described and evaluated.

1.1 The service-based utility ("Utility 4.0")

A new sector of innovative energy service providers is developing in a highly regulated market. Utilities are looking for new services but often do not have innovation potential to develop new ideas. The ICT infrastructure is mostly built on proprietary systems.

FINESCE explores how utilities and SMEs providing new services can cooperate and build an innovation ecosystem based on open ICT platforms like FIWARE. Such ecosystem can provide benefits to all stakeholders:

- Innovative SME get access to the regulated markets, utilities and customers and decrease their development costs by using standardized software components
- Utilities can benefit from providing new services to their customers developed by innovative SMEs (e.g. via "white label" products).
- Smart City platform providers can integrate the energy cluster in their portfolio of services. Standardised interfaces and common data models for the whole market can be agreed on and further enable development of new apps and services.

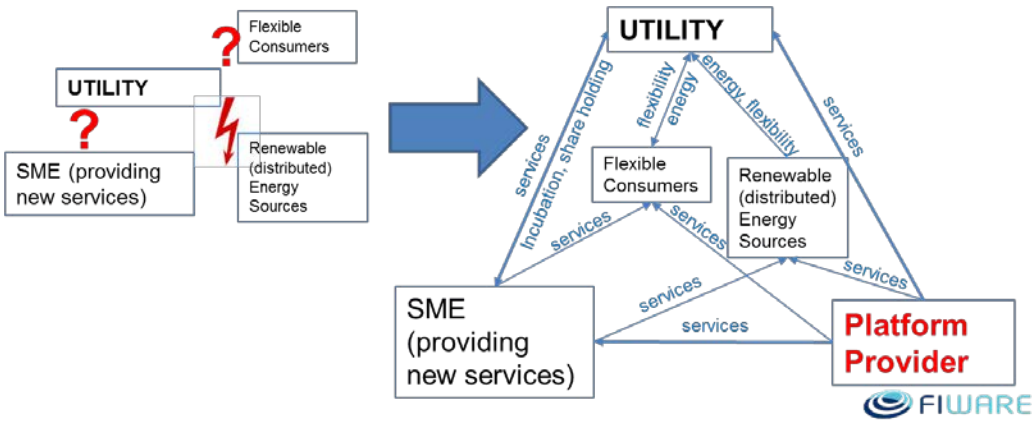

Figure 1: A new market: The Smart Utility Innovation Ecosystem (source: own illustration)

1.2 FIWARE Generic Enablers utilised in the FINESCE trial platforms

FIWARE is an open initiative aiming to create a sustainable ecosystem to grasp the opportunities that will emerge with the new wave of digitalization caused by the integration of recent Internet technologies. The initiative is based on the following pillars:

The FIWARE platform provides a rather simple yet powerful set of APIs (Application Programming Interfaces) that ease development of Smart Applications in multiple vertical sectors. The specifications of these APIs are public and royalty-free. Besides, an open source reference implementation of each of the FIWARE components is publicly available so that multiple FIWARE providers can emerge faster in the market with a low-cost proposition.

FIWARE Lab is a non-commercial sandbox environment where innovation and experimentation based on FIWARE technologies take place. Entrepreneurs and individuals can test the technology as well as their applications on FIWARE Lab, exploiting Open Data published by cities and other organizations. FIWARE Lab is deployed over a geographically distributed network of federated nodes leveraging on a wide range of experimental infrastructures.

FIWARE Ops is a collection of tools that eases the deployment, setup and operation of FIWARE instances by Platform Providers. It is designed to help expand the infrastructure associated to a given FIWARE instance by means of federating additional nodes (datacentres) over time and allowing cooperation of multiple Platform Providers. FIWARE Ops is the tool used to build, operate and expand FIWARE Lab.

The FIWARE Acceleration Programme aims at promoting take up of FIWARE technologies among solution integrators and application developers, with special focus on SMEs and start-ups. Linked to this program, the EU launched an ambitious campaign in September 2014 mobilizing 80M€ to support SMEs and entrepreneurs who will develop innovative applications based on FIWARE. Similar programmes may be defined in other regions.

Although it was born in Europe, FIWARE has been designed with a global ambition, so that benefits can spread to other regions. The FIWARE Mundus programme is designed to bring coverage to this effort engaging local ICT players and domain stakeholders, and eventually liaising with local governments in different parts of the world, including Latin American, Africa and Asia.

FIWARE aims to fulfil the requirements of a modern cross-domain internet-based platform:

- Avoid vendor lock-in:
    - Standard Southbound APIs for sensor providers

- Standard Northbound APIs offered to applications
- Portability across platform providers
- Interoperability of apps on top of different providers

- Larger community of developers
  - True innovation
  - More competition, leading to cost savings
- Not any standard is enough
  - Modularity
  - Allow different business models
  - Integration with standard open data platform
  - Non-intrusive

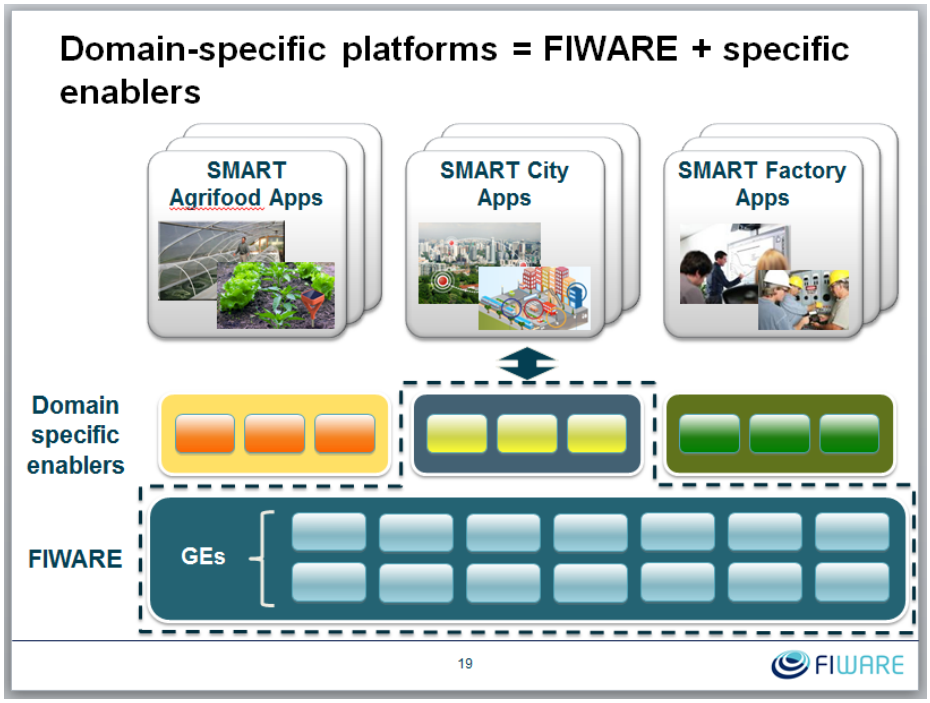

Figure 2: Domain-specific platforms: FIWARE GEs and specific enablers (source: own illustration)

The overarching aim of the FINESCE activities was to leverage FIWARE GEs, contribute specific smart energy enablers and enhance innovation opportunities for SMEs in the smart energy sector:

- By giving them the opportunity to develop new products and services with low investments
- By developing plans for large scale expansion of the platform and
- By the co-creation of products and services in tight cooperation with users at the trial sites.

The use of FIWARE Generic enablers utilised by the FINESCE API offers this opportunity technically.

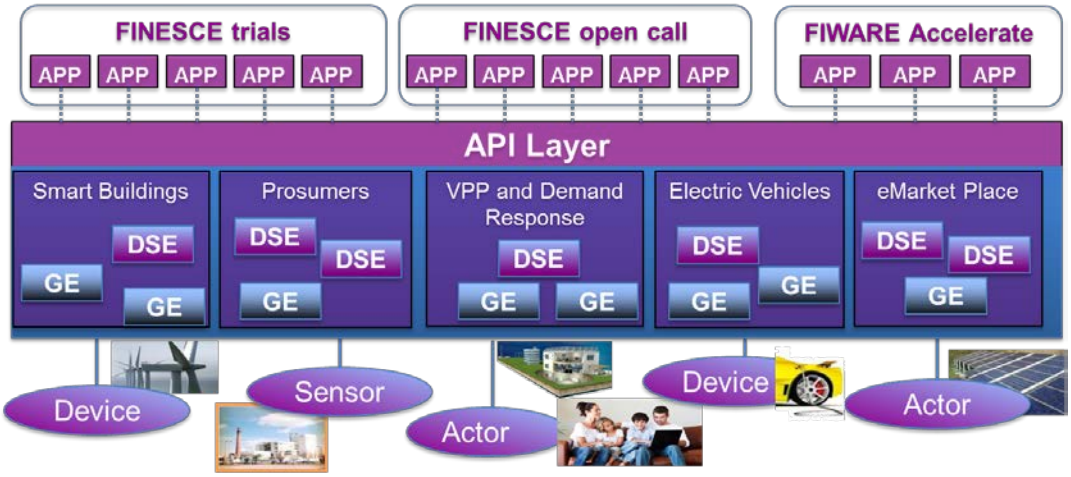

Figure 3: FINESCE App Architecture (source: own illustration)

Each FINESCE trial provides open data and an open ICT architecture based on FIWARE GEs and FINESCE DSEs made available via the FINESCE API.

In the area of energy applications this concept is rather revolutionary as currently closed proprietary software systems dominate the market for utilities.

1.3 The FINESCE SME approach

The FINESCE project has a strong emphasis on supporting business opportunities for Small and Medium Sized Enterprises ("SMEs") in the field of Smart Energy reflected in the FINESCE goals regarding SMEs:

1- Create an ecosystem for SMEs using FIWARE in the smart energy sector
   a. Building a community of SMEs and students to collaborate with the FINESCE trial sites via Open call and student case competition
   b. Supporting FIWARE Accelerate program (for start-ups and SMEs) and preparation for the large scale roll-out of FIWARE technology in the field of Smart Energy
2- Attract SMEs for Smart Energy business via
   a. Open interfaces and open standards (access to trial site data via the FINESCE API which was further developed into the FINESCE Smart Energy Platform concept)
   b. cost-effective business model innovation (SMEs must have the opportunity to develop new products and services with low investments)
   c. Enhance innovation opportunities for SMEs in the smart energy sector by collaborating directly with utilities from the FINESCE consortium ("Utility 4.0" concept)
   d. Co-Creation of products and services with user or test business models with users at the trial sites

One of the goals of the FINESCE project was to create an ecosystem for SMEs using FIWARE in the energy sector and to populate the FINESCE trial sites with this community of SMEs. For this purpose five Innovation Days in Germany, Ireland, Sweden, Denmark and Italy have been hosted to prepare the Open Call and to find the best fitting SMEs for the FINESCE trial sites (see deliverable D6.6), to support the consortium by undertaking R&D within the trial sites. The Open Call resulted in the selection of ten SMEs who implemented their projects within the seven trial sites, using Generic Enablers and Domain Specific Enablers (see Deliverable D6.6).

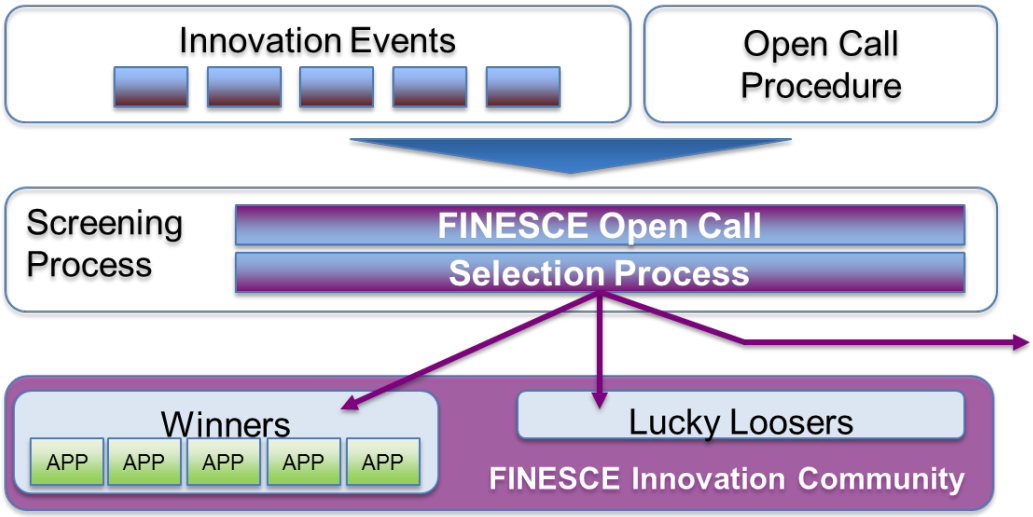

Figure 4: Innovation Process for SMEs (source: own illustration)

1.4 Evaluation of integration results

This SME Case study explores how the integration of the SMEs into the trial sites succeeded in the following terms

1. Work package integration
   (How was the product/service/application integrated within the trial site architecture. Why was the SME integrated into the work of the work package and how have the results been utilized?)

2. Technical integration based on the usage of FIWARE GEs and FINESCE DSEs
   (How did the SME worked with DSEs, GEs and how has it been integrated into the technical architecture of the trial site. Which experiences have you made with FIWARE/open FINESCE software architecture regarding resource efficiency (time, workload, effort, skills)

3. Development of business models.
   (Which product has been tested/ developed within the trial site and what is the business model and marketing approach behind it?)

How does this approach contribute to the development of a future energy system? Which new services were developed in the trials? How is this approach picked up in other activities?

2. Integration of selected SMEs into the FINESCE trial sites

2.1 Overview of SMEs

The following table gives you an overview over all SMEs who became part of the project after the Open Call.

Name of the SME	Country	Sector of industry	Trial site/ Work package	Short description of trial site activities
Develco Products	Denmark	Communication systems	Smart Region, Denmark, WP 2	Developing a ZigBee based device which offers the opportunity to include "live" measurements of the produced electricity for the users.
devolo	Germany	Powerline communication	eMarket, Italy, WP 4	Developing, verifying and testing a high-speed narrow-band powerline communication infrastructure for Smart Grid applications
DunavNET	Serbia & Ireland	IT applications and products	Dissemination WP 6	Development of a serious game
FUNITEC R&D	Spain	R&D IT	Smart Grid Communications, Ireland, WP 5	Extending the reach of FINESCE into the distribution Smart Grid by using the INTEGRIS project concept
SEnerCon	Germany	IT tools for energy efficiency	Smart Region, Denmark, WP 2	Heat Monitor, a web application for customers and prosumers of smart buildings to understand, manage and optimise their electricity and heat energy demand
SOPTIM	Germany	IT	Virtual Power Plant and Smart Factory, Germany WP3	Development of an energy balancer that analyses possible production plans of the Smart Factory and energy generation forecasts of the Virtual Power Plant for energy balancing
TM-TeamWare	Italy	engineering	eMarket, Italy, WP 4	Intelligent Automated Metering (IAM), which supports the implementation of an energy marketplace, enabling the local actors of a smart energy system (DSO, aggregator, energy retailer and Prosumer) to trade their energy capacity and in a way to reduce transmission losses.
ISMB	Italy	R & D ICT	eMarket, Italy, WP 4	
Yucca	Portugal	Game development	Dissemination WP 6	Serious Game with a Massive Multiplayer Online Game (MMOG) called ‘Energy Town’ for mobile devices

Name of the SME	Country	Sector of industry	Trial site/ Work package	Short description of trial site activities
XLAB	Slovenia	R&D ICT	Smart City, Sweden WP 1, Smart Region, Denmark WP 2, Virtual Power Plant and Smart Factory, Germany WP 3	Standardized visualisation widgets to get a holistic view on energy consumption and generation, weather, in-house temperature, and other data in real-time or as measured historically

Figure 5: Description of SMEs from the Open Call

2.2 Develco Products

The Danish company Develco Products is specialized in communication systems for Automatic Meter Reading, Advanced Meter Reading and Smart Metering combined with Home Automation. For the FINESCE project, they developed a new ZigBee based device which offers the opportunity to include "live" measurements of the produced electricity for the users. The measurements are integrated in the trial site in Horsens the same way as the existing measurements and hence taking advantage of the trial infrastructure based on Generic Enablers.

2.2.1 Workpackage integration

Develco Products has developed and implemented a ZigBee tunnel in accordance with the project description. Insero is using the Develco Products ZigBee infrastructure to collect data from meters.

Originally, it was the intention to collect data from the photovoltaic inverter by developing a ComLynx interface to the Danfoss Inverter.

In the course of the FINESCE project, Danfoss has sold their inverter business division. Since Danfoss has hence stopped producing inverters, it did not make sense to spend resources on developing an interface for this. Instead, Develco Products has still developed and implemented the ZigBee tunnel. To fulfil the project requirements, we have further developed and adopted a dual three phase power meter making Insero capable of getting real time data (instead of day-old data) to be used for the Generic Enablers.

2.2.2 Technical results of work package integration

Since Danfoss has hence stopped producing inverters, it did not make sense to spend resources on developing an interface for this. Instead, Develco Products has still developed and implemented the ZigBee tunnel as originally intended. This tunnel has successfully been put to the test for Kamstrup power meters. The results have been fully satisfying.

In order to fulfil the FINESCE project requirements, delivering quick data to the Generic Enablers, we have further developed and adopted a dual three phase meter that is capable of monitoring the photo voltage power production and at the same time monitor the power consumption of the house. These data are sent to the Insero software meaning that they can now have real time data instead of daily consumption information. All results are fully compliant with the project trial intention.

2.2.3 Business model development

The ZigBee tunnel as well as the power meter are both very valuable contributions to Develco Products' business. The power meter is of high relevance to a huge German utility and we expect to sell a large quantity of the meters, though in a slightly different version, to this utility.

Other utilities have also expressed their interest in this product which would not have been developed without the FINESCE project.

The integration to Insero software applications are a valuable asset for Develco Products. We only provide hardware and embedded software, and the trial site in Stenderup has proved that there is a huge business potential within this field.

The products developed and integrated by Develco Products in the FINCESCE project means, that the data can now be put at other's disposal. Everybody who wants to make applications related to solar power cells can now reach these data by using the developed products.

2.3 Devolo AG

Devolo AG, based in Aachen, is the global market leader in the powerline segment and has one of the largest powerline developer teams in the world. In FINESCE they combined an advanced metering infrastructure with a demand side management for the Trial Site in Terni, Italy. It enables all stakeholders to optimize the degree of capacity utilization while maintaining grid stability. Devolo

supports FINESCE by developing, verifying and testing a high-speed narrow-band powerline communication infrastructure for Smart Grid applications.

2.3.1 Workpackage integration

The challenging objective of the WP4 is to read the measurement data for power with decentralized generation and consumption in a 5-minute rhythm. This is essential for applications involving "grid management in a smart city Terni"; the short cycle serves as a means of analysis to ensure power generation and consumption are in line. Devolo has been involved in WP4, developing and deploying a reliable, secure and high-speed powerline communication (PLC) technology for the Automatic Meter Reading applications. This issue has been addressed by devolo in Task 4.10: FIPONET: Fully interoperable power line network for smart grid. The G3-PLC modems have been developed during the project time to be deployed between meters and a central system. The main feature of the G3-PLC is the integration of smart metering into a reliable and cost-effective IP-based data communication via existing power line networks. The benefits of the technology are listed as follows.

- Transport of arbitrary IPv4/IPv6 packets
- Up to 240 kbps data rate on Powerline
- G3-PLC compliant (ITU G.hnem G.9955)
- 150 kHz to 490 kHz operating frequency
- Dynamic routing mechanism supports mesh networking
- Automatic repeat request (ARQ) enhances error detection and data reliability
- Dynamic link adaptation to select optimum data rate based on channel condition
- 230V AC and 400V AC connectivity
- 1 or 3 phase coupling

2.3.2 Technical results of work package integration

The network topology of the G3-PLC access technology is constructed in a way that every meter will communicate with the distribution station via power lines. The network coordinator is installed in the distribution station. Each G3-PLC modem on the LV network has been connected by Ethernet to a smart meter that relays the measurement data across the network using the IP communication. The following figure depicts the architecture implemented for this type of meters.

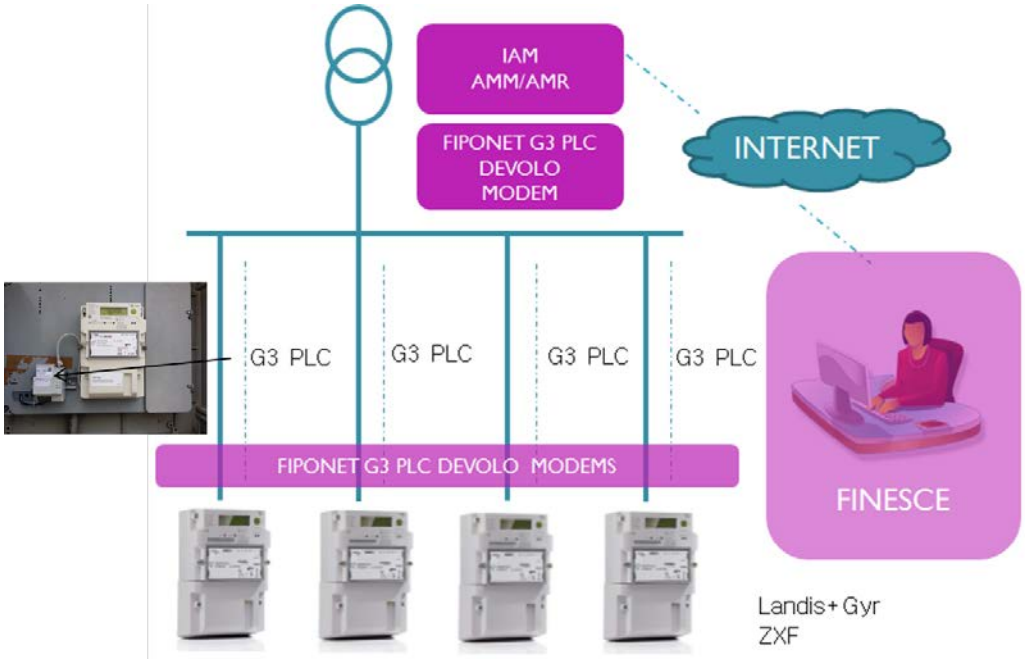

Figure 6 AMI architecture with the G3-PLC

The technical aspects of G3 PLC have been successfully proven through field trials, leaving no doubt about the advantages of PLC. By the time it finished, the field test showed excellent results for G3-PLC. G3-PLC provided a stable, reliable connection between nodes and achieved a speed of up to 80 kbps at the IP level—all without using a repeater and even at long distances. The technology also showed its strengths, particularly—compared to competing PLC technologies—its ability to withstand interference in the network. It has been concluded that the devolo's 500 kHz G3-PLC access technology is a strong technology for the concept of grid management in the smart city.

2.3.3 Business model development

The main focus is how to market this technology in order to provide customers with convenient and value-added services, and create new and profitable business models for the energy utilities. At the end, the telecommunication infrastructure is a choice of the utilities, provided the minimum requirements of a telecommunication infrastructure are fulfilled. The close collaboration with the energy utility ASM Terni within the framework of FINESCE project have allowed different business entities involved as partners in WP4 to examine utility requirements closely and gain experience to improve the related PLC prototypes. More specifically, devolo plans an industrialization and commercialization of the 500 KHz G3-PLC modem after the FINESCE project.

2.4 DunavNET

DunavNET was established in 2006 and is specialized in development Internet of Things and augmented reality based mobile and web solutions, including mobile games. In the FINESCE project they developed an augmented reality based application and a serious game. The augmented reality application is used to promote FINESCE pilot sites and the work done in an interesting manner. The serious game is targeting general population and aims to provide an engaging way to understand the general FINESCE concepts and their potential benefits for the society in general.

2.4.1 Workpackage integration

DunavNET was integrated into WP6 as the activities were mainly targeting dissemination and promotion of the FINESCE pilot sites and the outcomes of their activities. The outcomes of DunavNET work were used in several events where FINESCE participated, including Utility week.

2.4.2 Technical results of work package integration

DunavNET analysed GEs and DSEs used and offered by the pilot sites. Of particular importance are those enablers that can be used to interact with the pilot sites in order to extract data generated by the sites and relevant for use in the game. Having in mind the aim of the serious game, the most efficient way of using live data is when users can relate to the data, i.e. when the data is coming from their own home, building or city as it makes it easier for them to understand the impacts.

During development of the game, analysis was made to understand which data could be used and how it could be extracted. Due to the nature of the solution developed, i.e. a game, integration was done on higher level by taking into account the main pilot site activities and the concepts developed. It was not possible to integrate directly live data from the pilot sites as it would introduce unnecessary complexity and unpredictability into the game. However, the game was designed in such a way that future integration of live data using GEs and DSEs can be done easily (this will be useful when such data is tied to specific user's behaviour).

This screen shot represents the city in which the game is played.

Figure 7 DunavNET Serious Screen 1

On this screen, the player has to find the main components required for implementation of a solution. For each pilot site a different set of components is hidden.

Figure 8 DunavNET Serious Game Screen 2

When a player finds all required components, he/she can progress to the next level.

Figure 9 DunavNET Serious Game Screen 3

Optimizing parameters impacting energy consumption, the player tries to achieve the energy efficiency goals.

Figure 10 DunavNET Serious Game Screen 3

2.4.3 Business model development

The main exploitable item is the FINESCE serious game. As already outlined in D6.4, the main goal of the game is to provide an interesting and engaging way for introduction of new technological concepts and consequently to influence the behaviour of people in order to adopt new approaches when it comes to energy efficiency and sustainability.

In the course of the project, DunavNET was able to gather feedback from the pilot sites in order to present the solutions addressed in the best possible manner. Further to this, FINESCE project provided significant promotional opportunities by presenting the game at several events where main stakeholders were present. This allowed DunavNET to engage both end users in order to get feedback on the game as well as potential clients like utility companies and public administration which could use games to present future smart city and smart energy solutions in their region. These initial contacts are now used to follow up and prepare the next release of the game that will be tailored and adapted towards the specific needs of the clients.

2.5 FUNITEC

Fundació Privada Universitat i Tecnologia (FUNITEC) – La Salle School of Engineering, is one of the research centres associated to the Ramon Llull University, in Barcelona. Its research group on Internet Technologies and Storage (GRITS) is specialized on innovative and unique solutions in the ICT sector, contributing to the FINESCE trial site in Ireland. They combined their experiences from the FP7 INTEGRIS project with the use of Generic Enablers within FINESCE. For this purpose they merged the FINSENY/FINESCE approach with the INTEGRIS approach by adapting the concepts developed in INTEGRIS to the FIWARE eco-system of Generic Enablers (GEs) and cloud approach. The aim of their contribution for the FINSENY, FINESCE and the overall FIWARE concept is that its reach into distribution networks is extended through the upgrade of some tools developed in the INTEGRIS context and its adaptation to the FINSENY/FINESCE context.

2.5.1 Workpackage integration

FUNITEC approach was designed to work in WP5 Stream II (Future Internet in Smart Grid Communications) in order to provide a solution to run more flexible communications and network management in the Smart Distribution Grids. In that sense, their main role has been the integration of FIDEVs in the Irish trial. A FIDEV was defined as an upgrade of IDEVs devices, integrating a set of Generic Enablers (GEs). IDEV devices were initially developed in INTEGRIS project, as a set of subsystems (distributed storage system, TRILL protocol, NMS, QoS) for helping in the management of the Smart Distribution Grid. The inclusion of GEs provides a secure interface to the distributed storage system, which can be used for network monitoring and provide more flexible management functionalities (in this case, for a network manager from a DSO). Among these new functionalities, they provide a homogeneous Cloud Data Management Interface (CDMI) that enables the seamless interaction between FIDEVs distributed storage system and a Public Cloud deployed on FIWARE Lab through the Object Storage GE. In this sense, the system deployed formed by a set of separated INTEGRIS FIDEV's testbed devices (physical or virtualised) placed in Ireland trial site and FUNITEC's lab in Barcelona, which constitute a private cloud, plus the FIWARE public cloud. Data can easily be migrated between the public and private clouds with a manager front-end application according to the decision of their owners (e.g. utility companies).

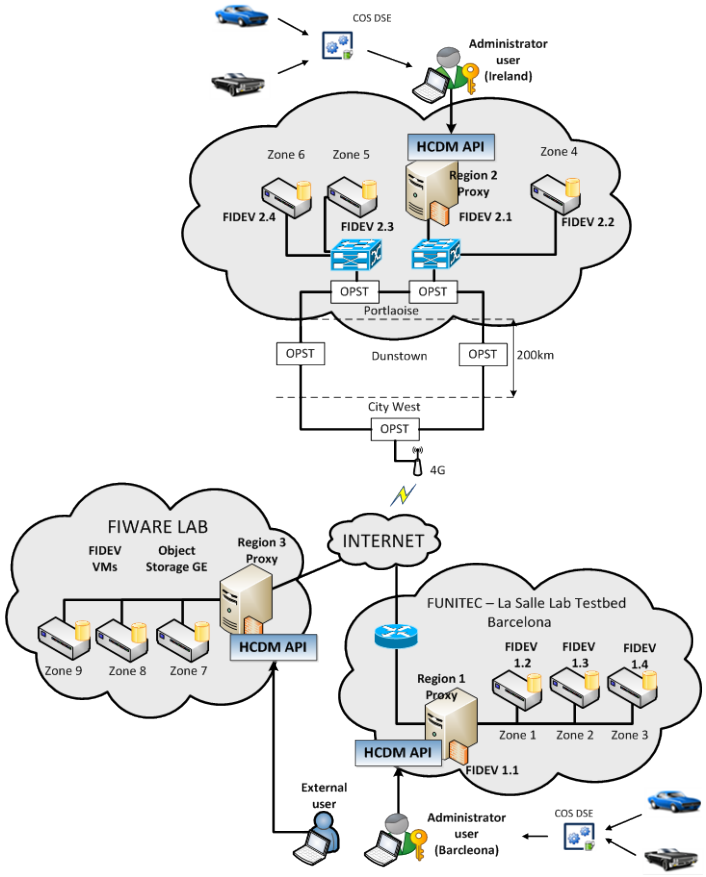

Figure 11. Stream II detailed infrastructure (source: own illustration)

The results of the trial have been used by ESB to evaluate a novel “Software Defined Utility” approach, which consists on high-speed physical communications and flexible software infrastructure over them. FIDEVs would be only elements of this wider approach, focusing the trial on the demonstration of a secure and distributed storage system that can easily migrate data from private infrastructure of the utility/DSO, to public cloud, in order to easily sell or offer this data to external stakeholders. This also provided a platform to manage distributed data among different substations, automatically replicating it in the different locations, which can help to evaluate the substitution of some very expensive electrical network devices by software platforms such as FIDEVs, low-cost sensors and high-speed communications underneath.

2.5.2 Technical results of work package integration

FUNITEC integrated to GEs into the FIDEV platforms, Object Storage GE and Identity Management KeyRock GE. The integration of the already deployed instances in FIWARE Lab were not difficult. Documentation was good enough and the contact people of those GE were active when they had problems. The deployment of local instances was more difficult, and they had some difficulties and misunderstandings with the developers. However, they finally manage to deploy them correctly and they did the integration between local and FIWARE Lab instances. Besides that, the main problem during the whole project was the update of those GEs without previous warning about that. Both GEs API were updated during their integration in the FIDEVs and it delayed some months the development and deployment of the final solution in the trial. From their honest point of view, more stability and more information about the changes in the GE catalogue is needed in order to use them for a long-term support commercial solution.

2.5.3 Business model development

On the one hand, as an academia related institution, FUNITEC will use FIDEV experimental platforms and the whole concept of “Software Defined Utility” approach for enhancing its teaching scope and quality by introducing new findings and technologies into the curriculum. They will

incorporate them in the development of their program portfolio, especially in the Smart Grids and Smart Cities Master courses.

On the other hand, FIDEV platforms could derive in a product in the future. However, they are not mature enough to be the elemental management piece for the “Software Defined Utility” approach that ESB wanted to evaluate and validate. They represent an opportunity for utilities to have more flexible devices (based on software, upgradable, configurable, able to deploy new applications above them), allowing them a lower-cost distribution grid management, as well as providing them means to share their data (from electric vehicle (EV) charging points, smart metering or substation monitoring) to third parties. It can foster new business models, such as selling specific region smart metering data to ESCOs or retailers, providing them high-value information, or EV information to mobility.

2.6 SEnerCon

SEnerCon GmbH from Germany is specialized in interactive online tools for building’s energy efficiency. For the FINESCE Trial Site in Horsens, Denmark, SEnerCon developed a heating monitor branded “HEMON”. HEMON is a premium service of the energy monitoring platform iESA (interactive Energy Savings Account), which helps customers and prosumers with smart buildings to understand, manage and optimise their electricity and heat energy consumption. HEMON utilises smart meter data for heating energy and provides daily statistical feedback on the heat energy consumption after neutralising the outside temperature. The evaluations and graphical visualizations provided by HEMON help inhabitants to identify energy losses, defects and saving potentials. In that way, they can assess their heat energy demand independent of weather conditions.

2.6.1 Workpackage integration

HEMON was integrated into WP2 of the FINESCE project. The WP2 trial in Horsens consists of a community of single family households in a small town near Horsens, in Denmark. The test-bed houses were configured with the following energy equipment and components:

- Heat pump – four different types are used depending on the individual house
- A photovoltaic system
- A thermo solar collector (used only in combination with one type of heat pump)
- Electric vehicle and charger station
- Home automation system
- Smart meters for nearly all significant consumption, including smart heat meters for the heating system

User evaluation is one of the cornerstones of the evaluation of WP2 in Horsens. A major focus of this trial site is therefore user involvement, and the insights of the test families and their interaction with the energy system are valuable test data.

Up to now it is generally difficult to find accessible infrastructures and platforms providing aggregated consumptions and additional data. WP2 sets a perfect test bed here and allowed to start and evaluate energy efficiency communication with end users. It provides a good environment for developing and testing HEMON as an application, as SEnerCon’s expertise lays in providing smart monitoring services, but not in providing a smart metering infrastructure. SEnerCon recognised FIWARE as promising standardised IoT-platform allowing to focus on core competences and provide services to a major number of end users in Europe in the future.

2.6.2 Technical results of work package integration

the beauty of the FINESCE trial site architecture lays in the fact that data which is collected, calculated and stored is made available transparently via a standardised RESTful API. INSERO

has collected the data incorporating (beside other tools) the Orion GE, the Cygnus XML Parser, Cosmos GE and Temporal Consistency DSE. Authentication and Access Control is supported by THA.

The well documented FINESCE API (http://finesce.github.io/api_table.html) is provided in form of an open-source Domain Specific Enabler (DSE), namely the FINESCE API Mediator DSE. SEnerCon has programmed an FINESCE API import module and integrated it into its iESA platform. The integration worked seamlessly and efficiently. The daily import of consumption data for several meter types works reliable and performant with little effort for maintenance. Changes in the trial site architecture did not affect the import and processing of the data. SEnerCon can only hope for more metering services feeding their data into the FINESCE FIWARE platform. This would significantly help to make HEMON and other monitoring and evaluation services inexpensively available to users in Europe.

2.6.3 Business model development

HEMON is an innovative energy service based on daily smart meter data of heating energy consumption. The service helps home owners and property administrators to identify defects and wastage, and to improve planning and monitoring of successes in refurbishment.

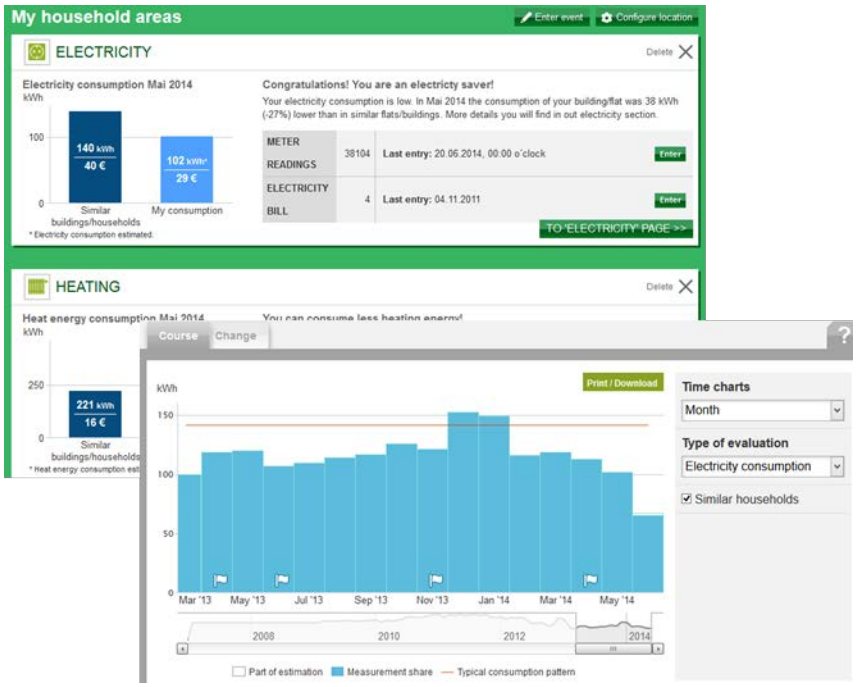

Figure 12: Heat Monitor HEMON (source: own illustration)

This way it provides value for money plus cross-selling and service opportunities for utilities, energy consultants and providers of energy efficiency products. SEnerCon and its sister company co2online Service GmbH are currently testing and improving four sales channels:

2.6.3.1 Direct sales (B2C & B2B)

HEMON is offered as a premium service within the iESA for an annual fee of 12 EUR for detached houses and individual apartments and of 48 EUR for multi-family, administrative and commercial buildings.

Market feedback is positive, but sales don't cover costs, yet.

2.6.3.2 Affiliates marketing (B2C)

HEMON is marketed via affiliates with revenue sharing in a sustainable partner programme. (First partner: "Bundesverband des Schornsteinfegerhandwerks" [Federal Association of Chimney Sweeps])

2.6.3.3 HEMON as customer retention tool (B2B)

HEMON is offered to equipment manufacturers, energy services providers, and energy consultants with a voucher system where HEMON can be used as customer retention tool.

The partners Kieback & Peter, Oventrop and Solvis have purchased contingents of HEMON access vouchers for at least one year.

2.6.3.4 HEMON as white label solution (B2B)

Last but not least energy services providers and manufacturers may bundle HEMON with their services and products and offer a branded version on their web site. Partners can use HEMON to monitor the impact of their offerings on energy consumption, as a warning system or simply as a e-proactive customer service.

This business model is to be tested in Italy with the LNG supplier Liquigas and the meter manufacturer Itron.

2.7 SOPTIM AG

The SOPTIM AG is a German IT-service provider for the energy industry and develops software-products as well as individual solutions for all market roles. For WP3 at the trial site in Aachen SOPTIM developed an energy balancing tool. The trial site focuses on balancing the electricity produced in the virtual power plant (VPP) with the consumption of the smart factory in real-time. The tool extends real-time balancing mechanism to the near future (namely day-ahead) and enables the factory operator to follow agreed consumption plans. The utilization of the FINESCE API and Generic Enablers was essential to realize the project.

2.7.1 Workpackage integration

SOPTIM took part in the development for WP3 of the FINESCE project. WP3 covers the topic of industrial demand-side management. For this purpose WP3 offers services to balance energy consumption of a Smart Factory in Aachen and the energy generation of a cross-border Virtual Power Plant (VPP). To balance the energy generation and consumption, the Smart Factory provides a set of potential production plans for the next day and the VPP provides an energy generation forecast for the next day.

SOPTIM is integrated in the ecosystem of WP3 at the point where data from both partners is available and ready to be processed. The SOPTIM-services then collect both the production plans proposed by the Smart Factory and the energy generation forecast of the VPP. The energy balancing tool matches each production plan with the energy generation forecast. The tool developed by SOPTIM then offers a ranking of the proposed production plans based on how well they fit the energy generation forecast over the course of the day. The ranked list of production plans is then published to both partners. The tool written by SOPTIM also provides the functionality to perform recalculation runs based on new data, for example if the energy generation forecast differs significantly from the actual energy generation for that day or the Smart Factory has to change the selected production plans for any reasons.

2.7.2 Technical results of work package integration

Since the SOPTIM tool developed in this work package is handling context driven data from two parties and SOPTIM itself, SOPTIM decided to use the Orion Publish/Subscribe Context Broker.

The main advantage gained by using the Orion Context Broker is that it is a ready-to-go component with a well-documented API. Beyond that it is based on the REST-Architecture which makes it easy to understand and use. Furthermore the Orion Context Broker offers JSON as the data exchange format which is easily readable and efficient in terms of the data volume consumed.

Using the Orion Context Broker it was quite comfortable to handle data provided from both partners and SOPTIM itself. SOPTIM then subscribed to change-events on the entities which define the energy generation forecasts of the VPP and the production plans provided by the Smart Factory. By that the tool is set up to run a check if both partners provide data for the given day and in this case, run the analysis of the data provided. The use of the subscription model provided by the Context Broker GE also enables the application to process changes in the data provided by the partners in real time which was important to offer functionality for handling different scenarios where the energy consumption or generation differs significantly from the forecasted data.

Similar to the functionality lined out above all partners may subscribe to the entity type which describes the list of production plans ranked following the best possible match for the energy generation and consumption. Doing so each partner will receive the results of the analysis and may process his business accordingly.

To ensure that only authorized users may provide data to the Context Broker, the application was secured with the PEP Proxy GE implementation by Wilma. The PEP Proxy uses the user identities provided by the FIWARE Identity Management GE to determine which user is allowed to access the application. The authentication and authorisation protocol used by the PEP Proxy is OAuth 2 as described in its catalogue entry.

By using the PEP Proxy and the identity management provided by FIWARE, SOPTIM saved a lot of time and work which would have been necessary if SOPTIM had to implement a complete user management itself. Thus SOPTIM focused on specific functionality of the WP3-ecosystem rather than infrastructural work.

The full setup of the work package with the integrated Generic Enablers is illustrated in the following graphic.

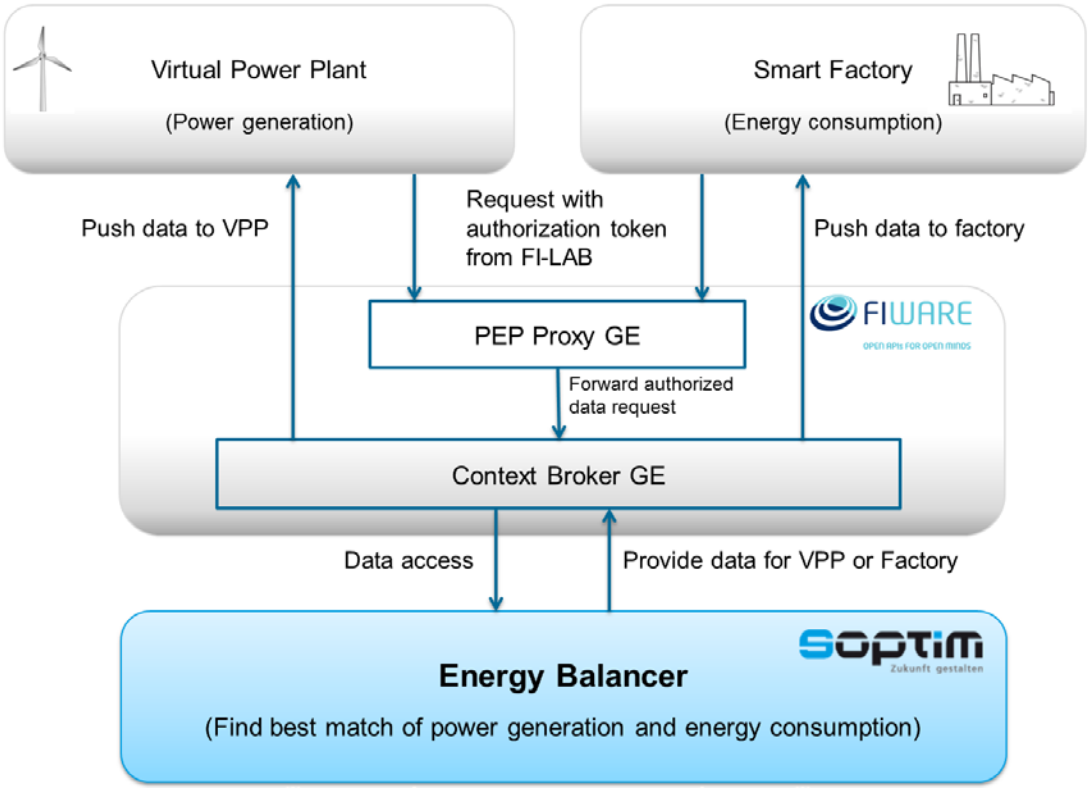

Figure 13 SOPTIM Energy Balancer Integration

Also the idea to have pre-defined APIs with the Generic Enablers where the implementation can be provided by different parties but still are interchangeable because the APIs are similar is great and can benefit the application development as well as the competition between implementation providers to a considerable amount.

2.7.3 Business model development

As a direct result of the Aachen trial site, there is the option to bring the energy balancing service to market. This service addresses the needs of renewable energy plants and production companies.

In addition, this service is of considerable interest for Distribution System Operators responsible for balancing their grid. For this reason SOPTIM plans to provide the energy balancing service for this group to allow planning of the energy flows in the grid as well as to process deviations from the plan properly. In Germany there are around 900 DSOs for the electricity grids and approximately 700 DSOs for the gas grid.

Beyond this, SOPTIM will also provide a central data storage service as a basis for several products using it. This service provides the option to store different market data in the required format and to process or provide this data afterwards. The bundling of this service will allow to use this service as a separate component as well as to orchestrate it with other services. For this reason the packaging of the data storage services has to be adapted accordingly.

The data storage service in combination with data analysis and monitoring services is of high interest for big and medium size business customers. This will enable the customers to ensure their own business. SOPTIM has already potential candidates in the customer portfolio for whom this service would be relevant and it is planned to go live with these services until mid of 2016.

For energy traders SOPTIM will offer the central data storage and analysis services cited above. The analysis will allow to validate the value proposition of existing trading products and show the potential for new products. The timeline for the product development is similar to the former one.

Last but not least SOPTIM will apply the experience gained during the FINESCE-project with the FIWARE-GEs when it comes to implement interoperability and cross-functionality between different IT-systems of different organizations and companies in the energy market.

2.8 TM-TeamWare & ISMB

TW-TeamWare is an Italian engineering company focused on the design and development of electronic equipment and system applications and especially provides innovative solutions applied in the fields of electricity metering and power quality monitoring systems. The Intelligent Automated Metering (IAM) supports the implementation of a marketplace at the FINESCE Trial Site in Terni based on standard DLMS/COSEM energy meters, enabling the local actors of a smart energy system (DSO, aggregator, energy retailer and Prosumer) to trade their energy capacity and in a way to reduce transmission losses. TW-TeamWare is doing this project together with ISMB, an Italian research and innovation centre operating in the ICT domain.

2.8.1 Workpackage integration

The protocol adapter AMM (SENSOR2AMI) DSE implemented realizes a logical link between the utility's energy meters and the FIWARE infrastructure. The data-provider IAMReader module encapsulates all the DLMS/COSEM specific tasks to collect data items from meters, while the IAMServer and IAM-BackendGE are responsible to aggregate measures along defined intervals and transmit them to IDAS Generic Enable of FIWARE.

A great advantage of the adopted DSE implementation is to be independent on the existing billing oriented Automatic Reading System of the utility, which continues to operate normally, allowing a seamless installation and minimizing the impact over the legacy systems. The SENSOR2AMI concentrator server acts totally independent from other existing systems in the utility, without requiring interfacing to proprietary database management systems and/or special add-ons from external supplier of ITC solutions. Moreover, this implementation grants ***interoperability*** between

the AMR (Automated Meter Reading; remote meters) and the AMI (Advanced Metering Infrastructure; the hosts) counterparts, which is achieved by adhering to the DLMS/COSEM standard already adopted by several vendors and by adhering to the new ETSI M2M standard based on the use of SensorML. The use of SensorML adds the compatibility with business information systems that adhere to the ETSI M2M specifications and standards. The FINESCE software is fully compatible with the M2M standard that uses SensorML v. 1.0 (the current implementation of the IDAS Generic Enabler supports SensorML 1.0).

2.8.2 Technical results of work package integration

The Terni trial site is a real application case where to apply a service solution for gathering energy data from smart meters next to real time to be stored and analysed through a Big Data ecosystem.

The DSE implemented solution is deployed locally and runs on a concentrator server located directly at the secondary substation, which connects, on two distinct network paths, to energy meters through G3-PLC transceivers and to external FINESCE platform through a specific routing of the ASM Terni networking infrastructure.

The quantified benefit achieved by this implementation is the increased speed of data processing. Compared with the legacy approach in which the AMI hosts – deputed to the polling of timer-based meters - are remote, the DSE components are running at the premises of the same substation. The communication between the “polling” host (IAM Reader) and the “event-based” host (IAM Server) is more immediate. The distributed and parallelized modality of the data processing appears more optimal. It makes faster the data processing. It reduces the cost of the maintenance procedures. There is no need to interface with external 3rd parties because the FINESCE hosts handle the whole data value chain.

2.8.3 Business model development

TeamWare and ISMB have in mind conceptually different innovative commercial product called EDM meter. Compared with the smart meters from the state of the art, the EDM product is a real time event-based meter that requires the SOA/EDA architecture. In order to be commercialized on the market, the AMR-2-AMI solution that supports and implements the event-based communication with the AMI is requires. The IAM contains the necessary functions. Therefore, we realized that the FINESCE DSE (IAM) is an enabler of this new business.

The independence from any legacy system and the support to DLMS/COSEM standard already adopted by majority of energy meters vendors provided by the AMM protocol adapter DSE make it a fundamental "building block" easy adoptable in any existing infrastructure to implement innovative services strategy by DSO and grid operators, where a "near real time" understanding of the LV grid loads/generators at operational level is required, answering not only the question "how much" but also "when and how" of energy usage (e.g. utilities services aimed to modify energy usage behaviour such as demand/response or offering customers an increased visibility of current load/source profiles). The outcoming services delivered by DSOs to their customers (example real-time data consulting by mobile apps) will have positive effects in terms of a more friendly and transparent image of the utility thus increasing the customer retention.

During the FINESCE project, TeamWare and ISMB developed jointly new business model and submitted the proposal called “FI-Meter” to the FI-PPP Incubators (INCENSE). Our effort is the example of the win-win synergy in business model development. The next planned step is the application to the Horizon-2020 “SME Instrument” funding allowing us to progress further with the detailed business studies, the model development, and its market validation. After that, the new commercial EDM product (real time meters plus the communication features linking them to the AMI and SCADA hosts) using the FIENSCE DSE can be offered on the market to the new smart grid actors (the target) in the newly designed modality.

2.9 Yucca Studios

Yucca Studios, a Portuguese start-up specialized on online games, produced an energy simulation game with a Massive Multiplayer Online Game (MMOG) called “Energy Town”. The game is playable on mobile devices. As a social and engaging serious game it will be connected to social

networks. The aim of the game is to promote the concept of smart energy usage and to learn about smart energy topics. In the course of the game, the user learns and absorbs several aspects related with FINESCE and its trial sites.

2.9.1 Workpackage integration

Energy town is a social serious game. Its main goal is to communicate to the audience, in a light way, the work developed by the FINESCE consortium and to show how that work, interacts with present technology. Being an entertainment game design for educational purposes, we can say that Energy Town is an Edutainment management game designed for a young target group (teenager and young adults).

The player manages a region where he has to make decisions about energy policies where the population has needs and where events happen constantly. The player will be engaged to learn about the transformation of the recent energy system to the future energy system and to have a positive outlook on future energy systems ant their interconnection with future internet services.

The game has key attributes: Energy, population, jobs, pollution, currency and actions. It's in the balance of all those attributes that the player can progress in the game.

2.9.2 Technical results of work package integration

n/a

2.9.3 Business model development

The game has a free model, which can easily be converted to a freemium model. As the main objective of the game is educational it makes sense that the player can freely access the game and therefore be taught without any restraint

The game is available on the Facebook and in mobile devices (iOS and Android) through Apple Store and Google Play.

2.10 XLAB Research

XLAB Research is one of the strongest computer science research teams outside the academic world in Slovenia. The XLAB Research department focuses on topics such as cloud computing and security, high-performance analytics and data visualisation. For the FINESCE they developed the FINESCE Presentation Layer, providing a stack of components to run on top of the trial services. Using them, they implemented visualisation applications for the Trial Sites in Aachen (the FIR's Smart Factory, the QSC's VPP, and the RWTH's energy grid simulation) and in Malmö (the E.On's Smart District). The result is a harmonised view on energy consumption and generation, weather, in-house temperature, and other data in real-time or as measured historically. The visualisation widgets enable the visualisation of a combination of various data sources, various types of gauges and graphs. The web framework and widgets are based on the Application Mashup Generic Enabler.

2.10.1 Workpackage integration

Many of the FINESCE trial partners focused on the technical aspects of collecting, handling and analysing the Smart Energy data within the individual trial. XLAB joined to develop and provide the components to obscure the technical aspects and raw data from the end users, while providing them with the positive user experience and a usable representation of the Smart Energy data. The new services and components have been integrated on top of the services exposed by the existing trials as well as by the newly developed peer SME SOPTIM AG.

The principal aim of the development was to integrate with and fully support the WP3's Aachen trial sites, namely the FIR demand side management (the Smart Factory), the QSC's distributed generation VPP and the RWTH's simulator of the renewable energy resources in the energy grid. In order to assure a wider exploitation potential and to also demonstrate the flexibility and versatility of the solution, XLAB also supported the WP1's Hyllie (Malmö) Smart District trial site. Figure 8

shows the header of the developed graphical interface, which serves as a navigation between the supported use cases.

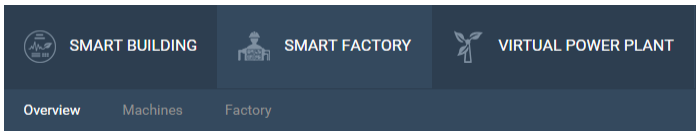

Figure 14: Graphical representation of the use cases supported by the XLAB's work.

2.10.2 Technical results of work package integration

All the integrated trials offer well documented RESTful interfaces, thus connecting the XLAB's services to the trial sites has taken a reasonable amount of time and effort. It turned out that the greatest hurdle would be to have the trials' system administrators to enable traffic between the companies, but even that was not a major problem thanks to the partners' willingness to cooperate.

To our work, the FIWARE provided a number of the GEs that we could integrate into our solutions. The most notably, the GE Publish/Subscribe Context Broker Orion served as an integration point between two of the other partners' solutions: the RWTH's simulation and the SOPTIM's energy balancer service. By using a standard way of communicating, we were able to quickly and reliably connect with the two services. The GE Application Mashup WireCloud was a great assistance to us when designing and early visualising the integrated data. The FIWARE Lab hosted instances of the GEs Identity Manager KeyRock and Authorization PDP AuthZForce provided further essential security features. The only GE that required some more work and could not be used out of the box was the GE PEP Proxy Wilma, but this was due to the fact that we integrated its early version. When we revisited the GE a short time later, we have found that it has matured to a fully usable state. Overall we could use the GEs out of the box in most cases. According to our rough estimations we were able to reach our goal using less time and effort than we would have without the availability of the GEs.

2.10.3 Business model development

The work for the trials will result in the products in the form of the visualisation applications for the Smart Factory, the VPP, and the Smart Building. The services and components comprising the FINESCE Presentation Layer (data gathering, abstraction and aggregation component, visualisation framework and widgets) will also be usable in new custom applications and products, subject to the customer demands. The principal target stakeholders of the XLAB's FINESCE result exploitations include the DSOs and DNOs, Smart Building operators and Production Plant managers. XLAB aims to offer the FINESCE results as stand-alone products and in combination with the other XLAB's offerings such as the data analytics:

- VPP Web Application: VPP operators can take advantage of quick and up-to-date data displayed in an insightful way. The views and elements are tailored to both routine workflow and occasional tasks. User receives visual cues on the level of balance in the VPP and in the Grid.

- Smart Factory Web Application: aimed at the Smart Factory operators. The views and elements are tailored to both routine workflow and occasional tasks. Figure 9 shows an example of the application's view. The web interface will also be the one place for planning low CO_2 energy consumption and monitoring for deviations from plan.

- Smart Building Web Application: The web application lets the energy providers empower their customers by giving them insight into live data on their consumption. The customer trust and satisfaction increases thanks to control they gain and the ability to monitor their energy consumption KPI.

- Visualisation Framework: a component, which supports building custom tailored web GUI applications, created with small effort. The resulting clean and clear user interface requires little training for the end users.

- Visualisation widgets for the GE Application Mashup WireCloud: Enable building blocks for quickly assembling data visualization, important for the data analysts, and designers of web applications. Figure 11 shows some of the possible visualisations enabled in the WireCloud.

- Production Plant Floorplan viewer Widget: Improves visibility into the processes in production and communication of outstanding conditions detected for production machines.

- Production Plant Floorplan editor: Enables a quick way of creating and editing production plant floorplans (Figure 10).

- Data Broker: Consolidated storage and data aggregation for quick access from the clients such as the web application.

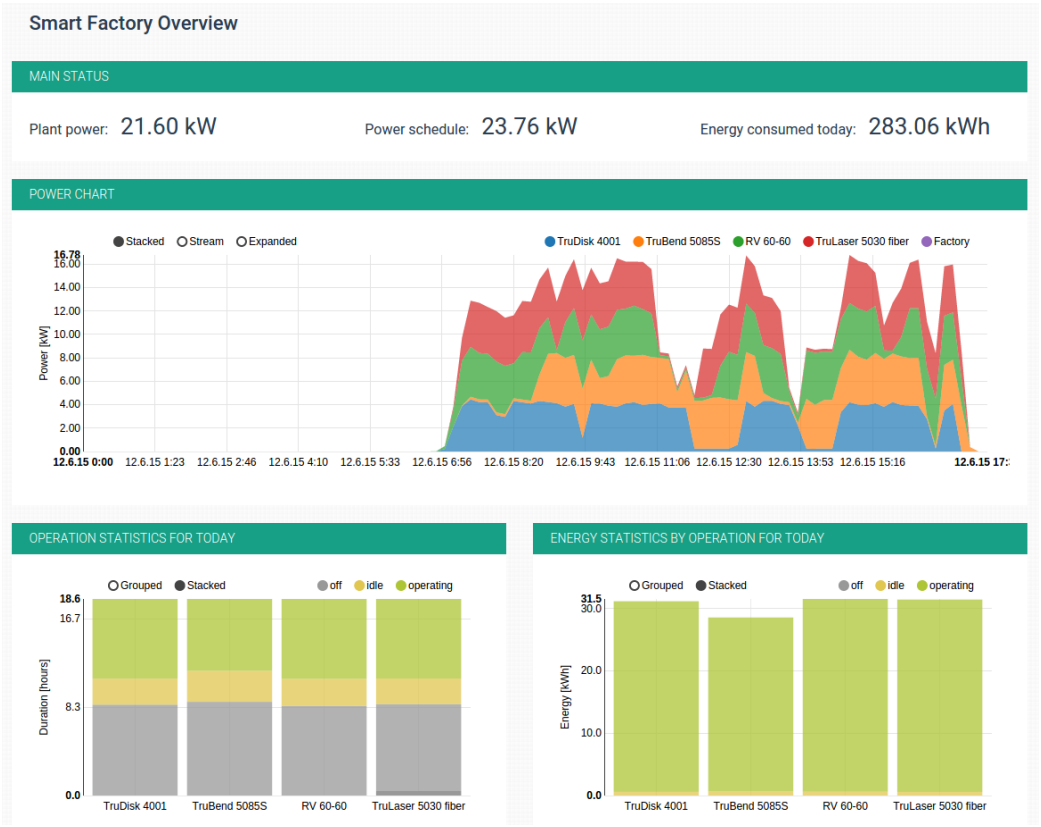

Figure 15: Smart Factory's overview page shows the history and statistics of the current day's energy consumption.

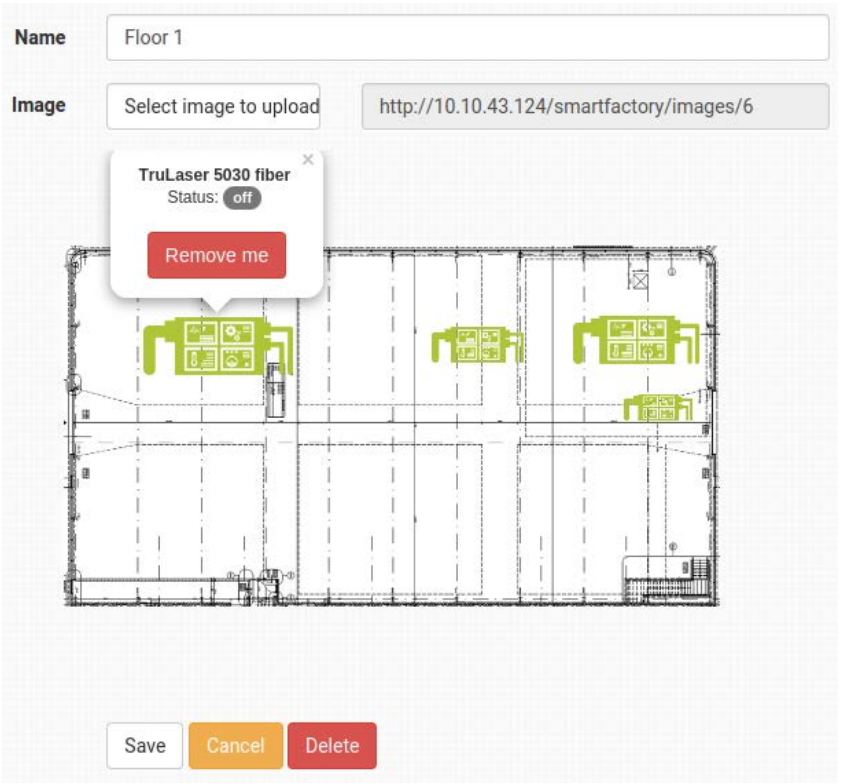

Figure 16: Floor plan editor creates and modifies floor plans in the web browser.

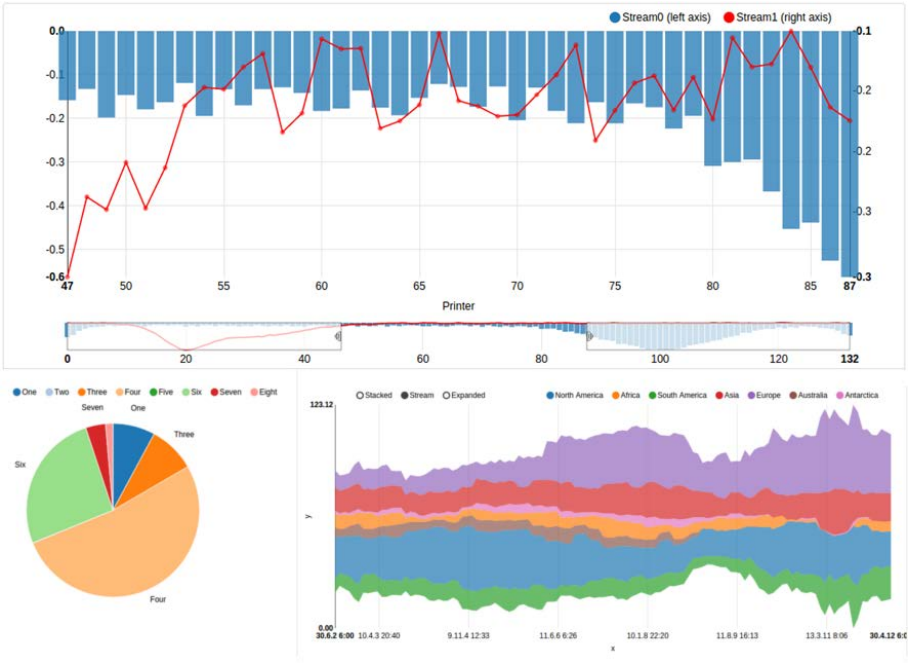

Figure 17: A gallery of charts enabled by the visualization widgets

XLAB has been using its own network of stakeholders to offer the results and the know-how for future projects. This includes performing pilot projects and cost/benefit analyses for the stakeholders on the one hand, and active search for strategic partners, who would offer the hardware (i.e., the smart meters) to complement the XLAB's IT solutions. Additionally, XLAB uses the experience and connections from FINESCE to enter new research proposals.

The knowledge obtained through active use of the FIWARE and the GEs enabled that XLAB can offer consultations to other SMEs and start-ups. They already provided training and mentorship to the Phase III FI-PPP start-ups and SMEs, providing practical information to specific problems. Similar support helped the start-up Olaii Payments to be successfully brought to market, and soon to likely receive a full payment from the accelerator IMPACT. Another start-up is Sentinel, which has recently been admitted to the accelerator programme by IMPACT.

3. Conclusion

This SME Case study explores how the integration of the SMEs into the trial sites succeeded based on the following criteria:

1. Work package integration,
2. Technical integration based on the usage of FIWARE GEs and FINESCE DSEs and
3. Development of business models.

3.1 Conclusions on the work package integration

The SMEs in FINESCE integrated a variety of applications and services into the FINESCE trial sites

The integration approach can be grouped in the following categories:

1. The SME application did fill a gap in the trial use case:
    - Developing, verifying and testing a high-speed narrow-band powerline communication infrastructure for Smart Grid applications in the trial site in Terni (Devolo).
    - Integrating Intelligent Automated Metering “IAM” in the e-Market solution in the trial site in Terni (TEAMWARE, ISMB).
2. The SME application enables further services within the trial infrastructure:
    - Including "live” measurements of the produced electricity for users in the trial site in Horsens. (DEVELCO).
    - Developing a Smart Grid interface to the cloud, grid management via cloud for the Smart Grid communication application in the trial site in Ireland (FUNITEC).
3. The SME application offers additional services to customer in the trials:
    - Integrating “Heat monitor”, a web application for customers and prosumers of smart buildings to understand, manage and optimise their electricity and heat energy demand (SEnerCon).
    - Integrating an energy balancing tool that analyses power generation of the VPP and power consumption of the smart factory in Aachen (SOPTIM).
    - Integrating standardized visualisation widgets for the trial sites in Sweden and Germany, and implementing a visualization tool that displays information about the production and power consumption of the smart factory in Aachen (XLAB)
4. The SME application contributes to the dissemination of project results:
    - Developing serious games to disseminate FINESCE use cases and trial results (DunavNET, Yucca).

The variety of integration approaches validates the FINESCE idea of a service-based utility on a process level. The utility is able to collaborate with third parties on several levels, all services can be easily amended, improved and enriched by third-party applications. It is possible for SMEs to offer services directly to the utilities and to the end-customers via the utility (e.g. as white label products).

3.2 Conclusions on the technical integration based on the usage of FIWARE GEs and FINESCE DSEs

The technical implementation of the third party applications is characterized by two approaches that apply to all SMEs that collaborated with FINESCE trial sites:

1. the use of FIWARE GEs and FINESCE DSEs (incl. the improvement of existing and the development of new DSEs)

2. the use of open interfaces to trial data and trial architecture via open APIs (summarised in the FINESCE API)

	DEVELCO	DEVOLO	FUNITEC	SENERCON	SOPTIM	TEAMWARE &ISMB	XLAB
FIWARE GEs							
ORION Context Broker	n/a	n/a		X	X		X
Mashup WireCloud	n/a	n/a					X
Identity Management Key Rock	n/a	n/a	X		X		X
PDP AuthZForce	n/a	n/a					X
PEP Proxy Wilma	n/a	n/a			X		X
IDAS	n/a	n/a				X	
Object Storage	n/a	n/a	X				
FINESCE DSEs							
FINESCE API	X	X	X	X	X	X	X
Sensor2AMI						X	
Temporal Consistency				X			
Hybrid Cloud Data Management			X				

Figure 18: Use of FIWARE GEs and FINESCE DSEs (DSEs developed by SMEs are highlighted)

Depending on the trial infrastructure, the SMEs used the FI-lab cloud infrastructure or integrated the GEs and DSEs into local platforms.

The general conclusion of the SME's GE evaluation is that the GEs have, in general, met FINESCE's requirements very well and have proven to be useful, largely dependable parts on the trial infrastructures.

A further conclusion is that the quality of the individual GEs, while being important, is not the only factor which makes FIWARE attractive to developers: the fact that FIWARE offers a complete development environment means that applications can be developed much more quickly than if the developer has to set up his own environment, which is a huge advantage of using FIWARE.

FINESCE DSEs were usually created in a certain context, often to utilise GEs in a specific environment. The challenge here is to identify general requirements in the energy market (like common interfaces to other energy systems like SCADA) and design and offer it as open source building block. FUNITEC and the TEAMWARE/ISMB team met this challenge by creating DSEs themselves.

The FINESCE API is published as a DSE (FINESCE Mediator), which allows it to be further developed. Already, a second version is envisaged in the API of the FINESCE Data Platform.

The FINESCE API Mediator is easily configured to interact with any Smart Energy Web Service data source that exposes (part of) the FINESCE API. The FAM DSE allows the FINESCE API to be easily extended in future to incorporate data external, non-FINESCE related infrastructures.

A special issue in the FIWARE architecture discussion focusses on the security aspect. Applications in the Energy Market can be divided in two areas:

1. Core applications
   (Core business , limited access, security critical, failure critical
   e.g. energy generation, energy grid operation and water supply surveillance)

2. Smart market applications
   (Many users, open access
   e.g., Demand Response, prosumer contracting, smart home services)

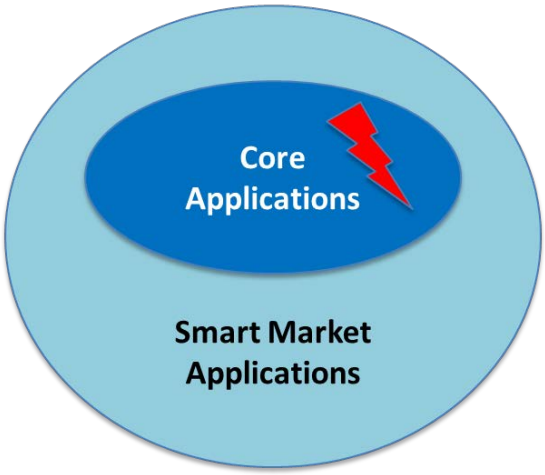

Figure 19 Utility applications: security aspects in relation to the application area (source: own illustration)

The requirements for smart market applications are comparable to the security and privacy requirements for other usage areas like logistics and manufacturing. The FIWARE enablers providing these security features will cover these requirements as they cover the requirements in other usage areas.

The area of core applications is comparable to the usage area of e-Health (FI-Star). Cloud solutions are unlikely to be accepted by the market players. However FINESCE partners like FUNITEC developed a cloud solution for grid management and the success of such solutions are at least imaginable with the experience that companies have made in the project. Instead of rejecting cloud solutions in these areas in general there are now requests for better security solutions in the cloud. This will be one of the big challenges and on the other hand one of the big business opportunities in the future.

3.3 Conclusions on the development of business models

The applications and services provided by the FINESCE SMEs can be divided into 3 categories:

1. **Business applications**, that can be used by customers directly

2. **High Level services** that can enable future business applications to customers

3. **Domain Specific Enablers** that can be used as building block for a variety of smart energy applications within the FINESCE/FIWARE environment.

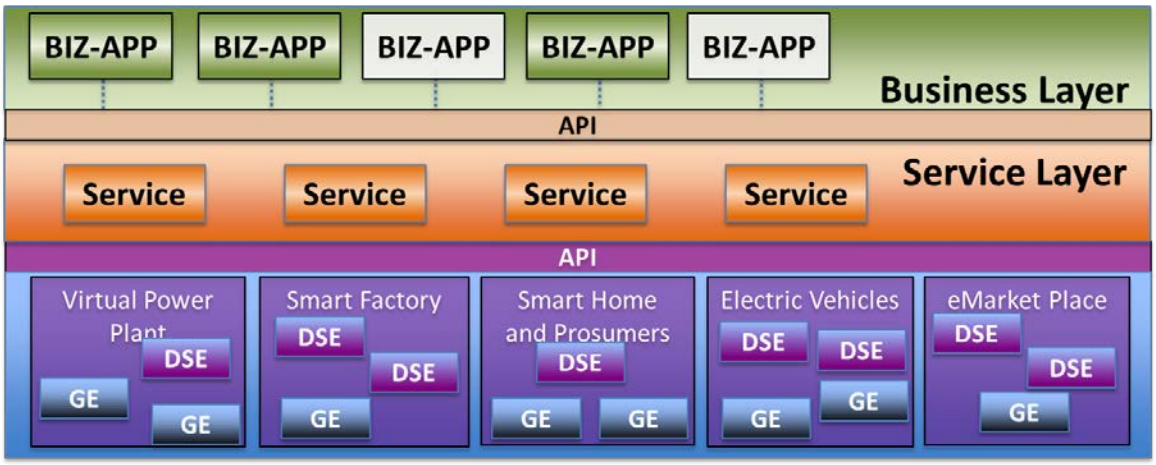

Figure 20: Applications categories (source: own illustration)

Business applications and services can be used by the end-customers directly. There are several business models possible to commercialise the solution, it can be offered directly to the customer (e.g. via an app shop) and paid as license or via transaction fee, it can be used as white label product by other energy market actors (e.g. utilities) and paid as white-label license or via a transaction fee. The utility can use it as a marketing tool and offer it for free, sell a license or offer the service as a bundle together with other services:

- SEnerCon: “Heat monitor”, a web application for customers and prosumers of smart buildings to understand, manage and optimise their electricity and heat energy demand. The target groups are tenants and house owners.

- SOPTIM: An energy balancing tool that analyses power generation of the VPP and power consumption of the smart factory in Aachen. The main target groups are factories and energy suppliers with industrial customers.

- XLAB: visualisation applications for the Smart Factory, the VPP, and the Smart Building, Target groups are factory/house owners, aggregators, utilities

- Yucca/DunavNET: The serious games developed for the FINESCE project can be adapted to the needs of a specific utility, municipality, university etc. The goal missions can be easy (light approach for marketing purpose) or complex (education and training). The target groups are utility customers, students or people who need to get informed about smart energy systems and prefer a playful approach.

High level services are enablers for other services that can be provided to end-customers. They can be purchased by developers from ICT companies or energy market actors (e.g. utilities) and paid as license or via transaction fee:

- DEVELCO "live” measurements of the produced electricity for the users, the target group is utilities

- FUNITEC Smart Grid interface to the cloud, grid management via cloud, target group are utilities.

- DEVOLO: high-speed narrow-band powerline communication infrastructure for Smart Grid applications, target group is grid operators.

- TEAMWARE, ISMB Intelligent Automated Metering solution, target groups are metering companies, grid operators and utilities.

Domain Specific Enablers (DSEs) are building blocks of the FINESCE Smart Energy Platform and can be used for a variety of high level services and business applications and services. They can be paid as usage license or via transaction fee. If they are offered as open source the business model could be consulting services for integration.

- FUNITEC: Hybrid Cloud Data Management: Storage Access provides transparent access to the distributed local storage or cloud storage system Provides transparent access to the Hybrid Cloud (distributed local storage or cloud storage system) infrastructure. Security Service: Provides data encryption functionalities, integrating Object Storage GE and Identity Management KeyRock GE

- TEAMWARE, ISMB: Protocol Adapter AMM (Sensor2AMI) gathers Smart Meters information through DLMS/COSEM protocol and feeds it into an instance of IDAS (Backend) Device Management GE (which then sends it on to an instance of ORION Context Broker GE)

The SMEs provided services and applications on all levels from ready-to use applications for end-customers to high level services provided to main players in the energy market to system building blocks for developers. The results show how flexible and transparent and accessible from all angles the whole system is.

Some applications are in a mature stage and are already offered as commercial solutions by the SMEs others were developed just to serve a specific purpose in the trial site. Most of the applications are in a pilot stage in this regard.

However the business success of DSEs, high level services and business applications depends on how valuable are the business services to the end-customers. The invention of new smart services for which end-customers are ready to pay for will mainly determine the success of the whole ecosystem.

On the other side: the development costs for new applications are very low and the time to market is very short. If prosperous ideas and concepts are born, the open architecture and the FIWARE building block approach will guarantee a fast deployment of applications and an efficient use of resources.

3.4 Résumé and outlook: How can SMEs working in the Smart Energy domain benefit from the SME approach in FINESCE?

The FIWARE/FINESCE ecosystem based on FIWARE software building blocks, open APIs, collaboration of energy companies and ICT companies and the access to open data provide many business opportunities to SMEs which did not exist in the past.

SMEs can develop applications on all levels, as business application, as high level service, as Domain Specific Enabler, even as Generic Enabler in the FIWARE context. The consolidation of legal issues of the whole ecosystem is still in progress, as well as the roll-out of FIWARE nodes throughout Europe to further strengthen the reliability of services based on FIWARE cloud services.

Depending on the success of these efforts the FIWARE/FINESCE ecosystem SME will take up the opportunity on a large scale.

The FIWARE/FINESCE ecosystem with the perspective to be linked to other FIWARE Smart City platforms clearly offers the possibility to be the backbone for the future energy system that needs to meet different challenges compared to the existing energy system.

The “Utility 4.0” concept, describing a service-oriented system of utilities which can make use of the services of SMEs was clearly validated by the SMEs integrated in the FINESCE trial sites.

The main focus of future efforts and projects (like the FEN project which is conducted by RWTH Aachen) is the further development of the Smart Energy Platform:

The Smart Energy Platform (SEP) is conceived as a business-class platform based on an open-source approach using FIWARE technology. It is a cloud-based, service-oriented, open-source middleware platform that is capable of supporting the business models of the different Smart Energy actors. The term “Smart Energy” means making electricity grids, buildings and cities “smart” through the introduction of ICT and automated control, i.e. it covers Smart Grids, Smart Cities, Smart Factories and Smart Buildings.

Actors can carry out their business by means of offering services through the SEP and using the services offered by other actors including, for example, Utilities, TSOs, DSOs, equipment providers, electricity retailers, electricity aggregators, energy service providers, electricity market regulators, electricity prosumers, electricity end-customers, building management firms and ICT companies. Hence, the SEP is envisaged as a hub for Smart Energy business, and must be built to be powerful, robust and secure enough to support real business use cases.

There are several technical pillars upon which SEP is based:

- Use of open source software, to create a dynamic development community;
- Development as a cloud-based platform, to achieve scalability (in terms of geography and size) at reasonable cost;
- Use of a service-oriented architecture, allows simple, extensible APIs between the various actors, which hide underlying complexity;
- Use of a 3-layer platform model (integration of various data sources, middleware and API layer) to allow SEP’s services to address multiple miscellaneous data sources.

In order to support the open source approach, FIWARE open source Generic Enablers will be used as building blocks for the SEP, and it will be hosted in the FIWARE cloud. Hence, the components inside the 3 layers shown in Figure 12 will comprise GEs and DSEs.

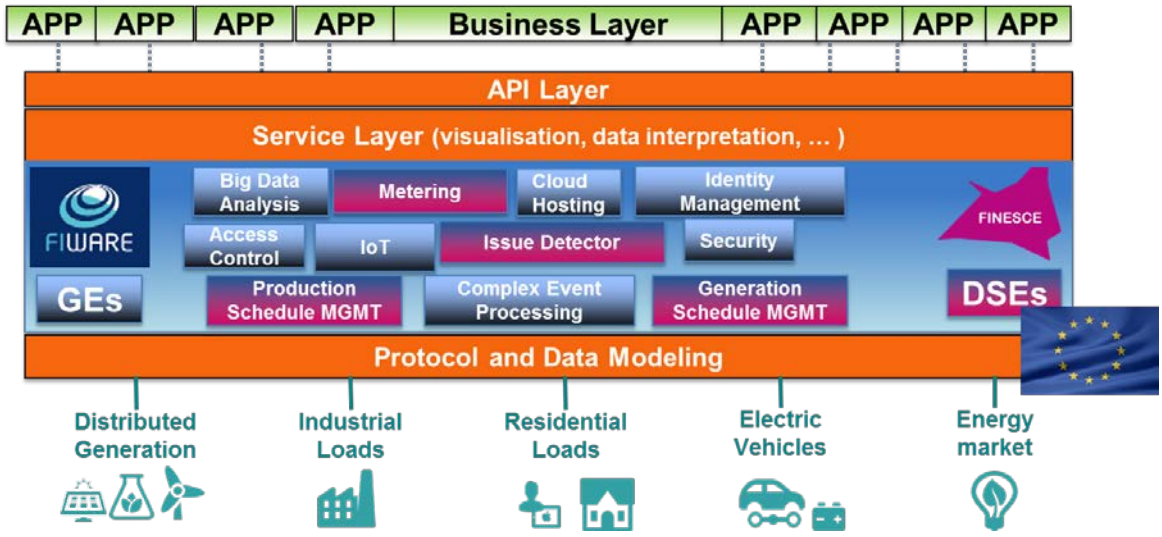

Figure 21 FINESCE Smart Energy Platform (source: own illustration)

Components developed within the Smart Energy Platform will be available under open source licensing agreements as DSEs, thus contributing to the FIWARE offering to developers.

The attraction of the SEP for utilities is that it will allow them to develop business applications based on the Platform infrastructure by adding their own specific service logic, by means of which they can create added-value and develop services which can be made commercially available through the API Layer. It is envisaged that the development of SEP will be driven by developing support for the business use cases required by users such as utilities: such development will mean developing functionality for the basic Platform functions (which will be made available as GEs or DSEs to other Platform users as part of the open source approach) and also application-specific functionality, which would remain the property of the company developing it.

The vision is to develop a sort of Linux of Energy Services. The commonality of interfaces is a winning point for everybody. It is clear though that whenever somebody wants to offer a commercial solution will branch out and offer a supported version: hence, SEP offers a winning combination of shared open source functionality and commercial proprietary functionality.

The open source functionality, comprising FIWARE GEs and SEP's DSEs, will form the basis of individual instances of the SEP, which will be developed and operated by SEP community members to implement their own use cases.

The attraction of the SEP for SMEs is that it provides access to a network of energy companies that in the past often appeared as a closed club, technically and on a business level.

It will be the next step to integrate innovative SMEs in the modern energy system and accelerate the development of new smart energy services.

4. List of Abbreviations

API	Application Programming Interface
B2B	Business to Business
BMS	Building management system
CAPEX	CAPital EXpenditure
CENELEC	European Committee for Electro technical Standardization
CEP	Complex Event Processing
COTS	Commercial off-the-shelf
CPMS	Charge Point Management System
CSA	Cloud Security Alliance
EMS	Decentralised energy management system
DER	Distributed Energy Resources
DMS	Distribution Management System
DMTF	Distributed Management Taskforce
DSE	Domain Specific Enabler
EAC	Exploitation Activities Coordinator
ERP	Enterprise Resource Planning
ESB	Electricity Supply Board
ESCO	Energy Service Companies
ESO	European Standardisation Organisations
ETP	European Technology Platform
ETSI	European Telecommunications Standards Institute
GE	Generic Enabler
HEMS	Home Energy Management System
HV	High Voltage
I2ND	Interfaces to the Network and Devices
ICT	Information and Communication Technology
IEC	International Electro-technical Commission
IoT	Internet of Things

KPI	Key Performance Indicator
LV	Low Voltage
M2M	Machine to Machine
MPLS	Multiprotocol Label Switching
MV	Medium Voltage
NIST	National Institute of Standards and Technology
O&M	Operations and maintenance
OPEX	OPerational EXpenditure
PM	Project Manager
PMT	Project Management Team
PPP	Public Private Partnership
QEG	Quality Evaluation Group
S3C	Service Capacity; Capability; Connectivity
SCADA	Supervisory Control and Data Acquisition
SDH	Synchronous Digital Hierarchy
SDN	Software defined Networks
SDOs	Standards Development Organisations
SET	Strategic Energy Technology
SET	Strategic Energy Technology
SGSG	Smart Grid Stakeholders Group
SME	Small & Medium Enterprise
SoA	State of the Art
SON	Self Organizing Network
SS	Secondary Substation
TL	Task Leader
TM	Technical Manager
VPP	Virtual Power Plant
WP	Work Package
WPL	Work Package Leader