Key note lecture:
"Third Industrial revolution & Energy (US + international context)"

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Theme 1: Energy connects people

Invited lecture:
The role of different actors in the German E-energy programme on smart grids

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LINEAR: towards a Breakthrough of Smart Grids in Flanders

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ABSTRACT:
Smart grids refer to electricity networks that enable a more efficient (both economical and energetic), reliable and sustainable energy production and distribution. Such networks integrate innovative tools, technologies, products and services throughout the value chain — starting from production through transmission, distribution and supply completely to the devices and installations of the consumers — by the use of monitoring, communication and control technologies. Smart grids support bidirectional real-time exchange of both energy and information. As a result the end users have access to more accurate and timely information regarding their energy consumption and to several options regarding different tariff structures, which enables demand side integration and an improvement of the energy-efficiency.
To implement the new structure for sustainable energy supply on a large scale in Flanders by 2020 (and beyond), a transition is necessary with short term action points, that are however based on a mid and long term strategy.
The "breakthrough" project Linear (Local Intelligent Networks and Energy Active Regions) is a first crucial step in this transition towards Smart Grids. The project focuses on the realization of a technological and implementation break-through by innovative technological research and a large scale pilot in a residential area. All this in close collaboration with industrial partners and associated Flemish innovation platforms.
The project has a budget of 9,5 M€ for the research institutes (ESAT/Electa-KULeuven, IBBT, VITO and IMEC) during a period of 5 years starting from may 2009. Besides this, the industrial partners invest a budget of more than 32 M€.
This paper presents an overview of the project, with a focus on its specific short and long term goals and objectives.

INTRODUCTION
Despite many efforts to improve energy efficiency, global energy consumption still rises. With respect to electricity, it is generally acknowledged that improving overall energy efficiency inevitably leads to rising electric energy use (e.g. plug-gable (hybrid) electric vehicles PHEV). Moreover a large part of the total energy is consumed by households and other small energy users (small industrial and service companies). With increasing dependency on electrical appliances and with growing demand for heating or cooling, their energy use is even expected to rise during the coming decades. As a consequence, small energy users are a strategic stakeholder when shaping the energy future.

In the electricity and gas market with respect to the individual customer, there is no pronounced (r)evolution towards

smart grid concepts yet: some small price reductions are the only element available for the time being. However, it is generally recognized that active demand side participation, by which the energy user really gets involved in the system, is the only way ahead. Furthermore, the energy system should be developed in such a way that the user gets incentives to actively pursue energy efficiency in every possible way. Also, there is a clear need for controlled integration of different energy sources, often renewables, available at local consumer level and exhibiting a variable, non-controllable nature. Successful adoption of such smart grid concepts will require to take into account the expectations of and acceptance by the end users — which can be steered by appropriate incentives and raising awareness.

Therefore, the Linear project aims looking at a full system approach of the problem. It aims at developing concepts, products and services that will allow residential energy users to get the most out of their renewable sources integrated locally, to take advantage of the integration of different energy sources and to optimise their demand in an economic and energy efficient way. This challenge is in accordance with the ideas put forward by the RP7 Smartgrids Technology Platform [1]. By doing so, the local grid (gas and electricity) will be used far more efficiently both in an energy and investment way. By doing so, it becomes feasible to include the energy demand for (hybrid) electrical vehicles.

To warrant a successful elaboration of the future energy grid, first an innovative and relevant pilot implementation and associated demo projects are required. To go beyond the level of a purely technological show case — and also obtain quantitative information, crucial to assess possible business cases — Linear starts with an intensive measuring and monitoring campaign to acquire actual data on the present and future use of electrical energy (for example after the introduction of plug-in hybrid or full electrical vehicles) and the complementary potential of local generation of electricity. Next, it will be studied how an optimal portfolio of distributed resources together with control equipment can be realised. Initially this will concern development of concepts and testing them in a laboratory set up and setting up models and guidelines. In a later phase, this acquired knowledge can be applied to concrete projects and a real residential pilot will be implemented.

LINEAR targets, objectives and methodology

Transition towards an intelligent electricity network in Flanders

In the recent SET-plan (Strategic Energy Technology Plan) of the European Commission [2], energy networks are defined as one of the technological priorities. Besides this, in order to obtain the 20-20-20 objectives for 2020, a large scale implementation of smart grids by 2014-2015 seems to be necessary. Hence, only a few years are left to gain experience with large scale pilots, to ensure the eventual large-scale deployment will be as efficient and effective as possible.

In Flanders, for this transition several steps have been suggested (see figure 1). In a first round the listing and integration of existing knowledge and technology is crucial, including the preparation of the first pilot. In a second round the realisation and analysis of the 1st pilot project and preparation of more pilots is necessary. This includes the realisation of innovative breakthroughs in the field of flexible and intelligent grid connected energy systems (building management, plug in hybrid vehicles, micro-cogeneration, photovoltaic systems combined with storage) that can offer services to the grid. In the third round the implementation trajectory will be expanded to multiple pilot projects in both urban and rural areas in Flanders and a further development of breakthrough technologies will be done. In the final round the large scale implementation of smart grids can be realised.

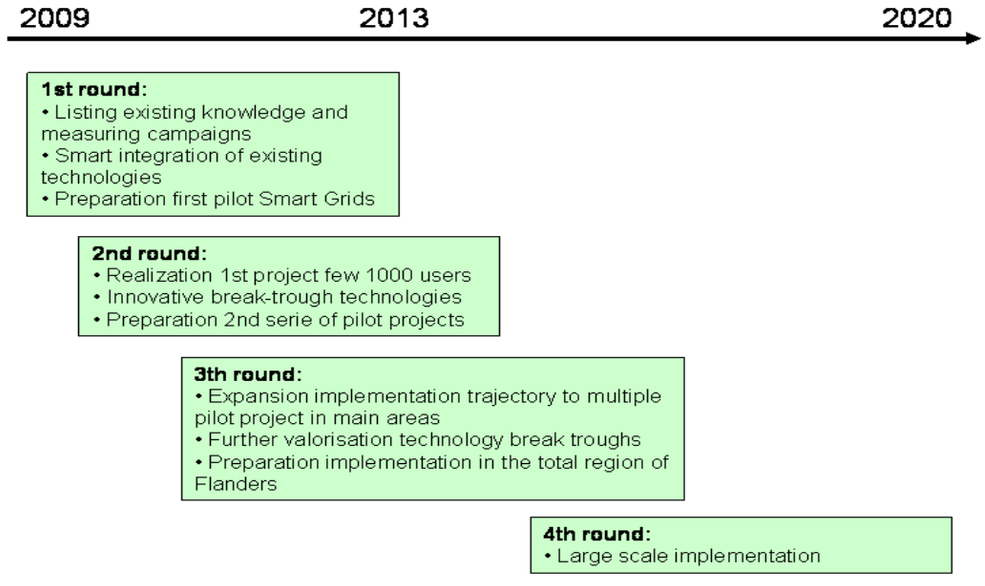

Figure 1. Timeline for the transition to smart grids in Flanders

In the Linear project both a technological and implementation breaktrough is aimed at, so it's is situated within the first and second round of the proposed transition. Linear is a 5-year large-scale research and development project that started in May 2009 and that receives a partial funding of 9.5 M€ for the research institutes (ESAT/Electa-KULeuven, IBBT, VITO and IMEC from the Flemisch Government (IWT/090800). Besides this, the industrial partners Eandis, Infrax, Laborelec, SPE-Luminus, Telenet, Belgacom, Alcatel-Lucent and Fifthplay invest a budget of more than 32 M€ in the project.

Technical and scientific objectives

The aim of the project is to activate households and small industry (SME), businesses and services in order to boost retail energy markets and increase efficiency and sustainability in an economically feasible and societal acceptable way. The research and implementation activities consider technical innovations (both on electrical network technology as the controlling ICT infrastructure, architectures and protocols), but also incorporate business modelling and user acceptance analysis. The objectives can be summarized as:

- To gain insight in the pattern of electricity and gas usage of a small region (typically fed by a single electrical substation) with as much as possible houses, service buildings and SMEs with the view to use this information for intelligent demand side participation. This project wants to analyze the pattern on the level of the building as on the level of the most important consumer equipment.
- This project works out the needs which stimulate small consumers to participate actively in the market both via local generation and demand side participation by the identification of the barriers and formulation of solutions which take the technical, social and economic aspects into account.
- To propose concrete concepts where the energy supply and demand can be tuned in an intelligent way taking into account:
    - the needs of the different energy networks (electricity and gas);
    - the fast fluctuation of the energy price in a liberalized market;
    - the application of smart metering and the required communication infrastructure;
    - the integration of smart household appliances
    - the integration of renewable energy and decentralized electricity generation;
    - the integration of storage means, both electrical and thermal
    - the integration of energy demand for mobility by the introduction of plug-in hybrid and fully electric vehicles.
- The implementation of these guidelines in a concrete residential pilot project and a virtual power plant (VPP) in Flanders.

Structure of Linear

The methodology used in Linear to obtain the objectives mentioned above is shown in figure 2. Basically there are two

parts: one focusing on research and development — which aims at technological breakthroughs — and one primarily focusing on an implementation breakthrough by the preparation and set-up of a residential pilot and a VPP.

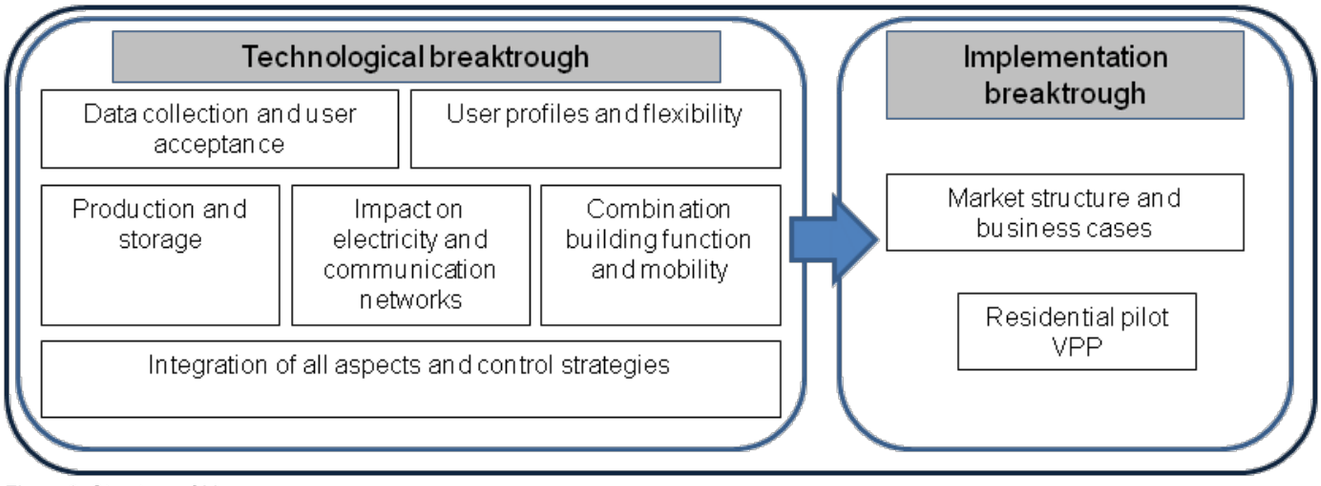

Figure 2. Structure of Linear

The research part has to lead to the definition of concrete technological concepts for a smart energy supply. Standardisation of smart energy architectures is a very important topic in this part. Further on, simulation tools (such as [1]) will be developed and a research infrastructure coupled between the research partners of the project will be elaborated. This will be done in several work packages, each focusing on a specific aspect: 1) User and device profiles will be gathered by a full scale monitoring and the profiles will be linked to different types of users. This will be done based on results of enquiries with end users to study user acceptance for active demand and smart grids. 2) Profiles of devices will be linked to the energy use of the building and the flexibility of the different users and devices will be studied. 3) Another research topic is the combination of distributed generation units, such as photovoltaic systems, and storage, also in combination with the type of user and devices that are present in the building, each with its own typical flexibility. 4) The impact on related networks – electricity, communication, gas- will be studied, including the potential of micro-grids in Flanders. 5) The application of plug in hybrid electric vehicles as either a load, a storage means or a producer is also an important aspect that will be studied in detail. 6) All the knowledge about these different aspects will be combined in order to define optimal combinations and control strategies of loads, storage and production units and to integrate these in an estimation of the potential for the measuring sites and to formulate general advices for other projects.
To stimulate the implementation breakthrough, a demonstration of the smart grids philosophy in an existing typical Belgian residential area is foreseen. This pilot-site will be operational starting from 2012. Active demand management of 1000 buildings will be realized within the project with many non-predictable energy resources as a part of it, as well as micro-cogeneration, heat-pumps, thermal and electrical energy storage and plug-in hybrid electric vehicle concepts.

CONCLUSIONS

The paper presents a possible transition path towards smart grids in Flanders. Within the first two steps of this path, the Linear project aims at the stimulation of both a technological and an implementation breakthrough of smart grids in Flanders. An extended research part focuses on the exploration of competences in Flanders in this field which has to lead to the definition and development of concrete technological concepts for a smart energy supply. Besides the research, a VPP and a residential pilot demonstrating active demand will be set up with 1000 buildings.

ACKNOWLEDGEMENTS

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