Energy Transition as the driver for Innovation

EnTranCe – the Living Lab for Innovation

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Introduction

Given the background of European energy policies of reducing CO2-emissions and import dependence, business as usual is not an option for the energy sector. Add to this the policy that aims to create a single well-integrated European energy market, and the pressures indeed becomes steep. This is all the more the case for the gas industry, as many regard the transition to a renewable energy system inextricably connected to an electrification of that system. This creates an environment unique in the world, one where the gas industry can only survive by becoming highly innovative.

In this paper we argue that gas industry can meet its challenges by successfully developing the notion of open innovation. We illustrate how this notion can be put to practice by describing the Energy Transition Centre, which is currently being built up by a coalition of industry and research and education institutes. We explain how EnTranCe functions as a Living Lab, a highly adaptable environment where new technologies are combined in constantly changing settings that aim to spark new thoughts. As a flag-ship activity, we describe the iBalance project. It is a project that combined innovations in gas technologies with elements of smart grids, and real demand, showing that gas can play a pivotal role in balancing energy demand at a local level. Finally, we end by some conclusions on the way forward.

The need for open innovation

Europe has set itself the target of becoming the leading continent when it comes to innovation. At the same time, targets for CO_2-emission and the contribution of renewable energy systems present a challenging environment for the energy sector. With the wide-spread notion that renewable energy systems are inextricably electrical in nature, this holds even stronger for the gas sector. Outside of the gas sector, in Europe there is only seen a diminishing role for gas, and the question is not if gas is replaced by electricity, but when.

Of course, within the industry, this view is different. Gas is seen as the ideal partner of renewable energy, as it is clean, abundantly available and highly flexible. Yet this story does not come across, as CO_2-emissions are seen as dirty, recurring conflicts upstream of Europe's major gas supply route put question marks over the abundance and an over-supplied

existing electricity infrastructure appears to be sufficiently flexible to cope with an increasing share of renewable energy.

A possible way forward for gas lays in open innovation. In this concept, businesses with various backgrounds together work on developing innovative technologies and concepts. By partnering up with businesses from outside the gas industry, working together on innovative concepts, we can bring across the notion that gas can play a central role in the energy system also in the future. At the same time, for people from outside the gas industry this future role of gas is all but given, and convincing them in participation in gas-related innovative research constantly requires the industry to rethink and rephrase the arguments of why there is such a role.

Maybe even more important, the proposition of gas is in essence one of physical and financial reality. Yet the political discussions are mostly emotional in nature. Therefore the gas industry not only has to find new technological answers, but also has to come up with social innovations. For this, working together with others is crucial.

EnTranCe: a Living Lab for innovation

With the idea in mind that open innovation is the way forward for the gas industry, GasTerra has allied together with Hanze Applied University and a number of other companies to set up an environment where we illustrate that the Energy Transition and the pivotal role of gas therein may become a driver for Innovation in Europe. This is the Energy Transition Centre, or EnTranCe for short.

EnTranCe is embodiment of an approach to energy innovation that is unique in Europe - based on the philosophy of combining research, education and innovation in a business setting. It creates opportunities for graduate and post-graduate students to be educated, to learn and to work inclusively. EnTranCe thus aims to develop technologies and people equipped for the global challenges associated with securing energy for the future. At the very core of this development is the notion that this is best done through an open innovation environment where R&D/innovation and new to develop education go hand in hand. In all this, multidisciplinary cooperation between the Sciences and the Arts and with close involvement of private companies is a central element.

The research at EnTranCe focusses on the system function of natural gas – that is, the pivotal role that natural gas can (and should) play in an increasingly low-carbon system. For this to materialize, it is essential that at the site several elements of the current and future energy system are present. In particular, as we believe that open innovation is an essential element, such elements are introduced in a modular way (Fig. 1). Various technologies can be connected or interconnected as needed, in such a way that both their individual behaviour as well as the interplay between can be studied.

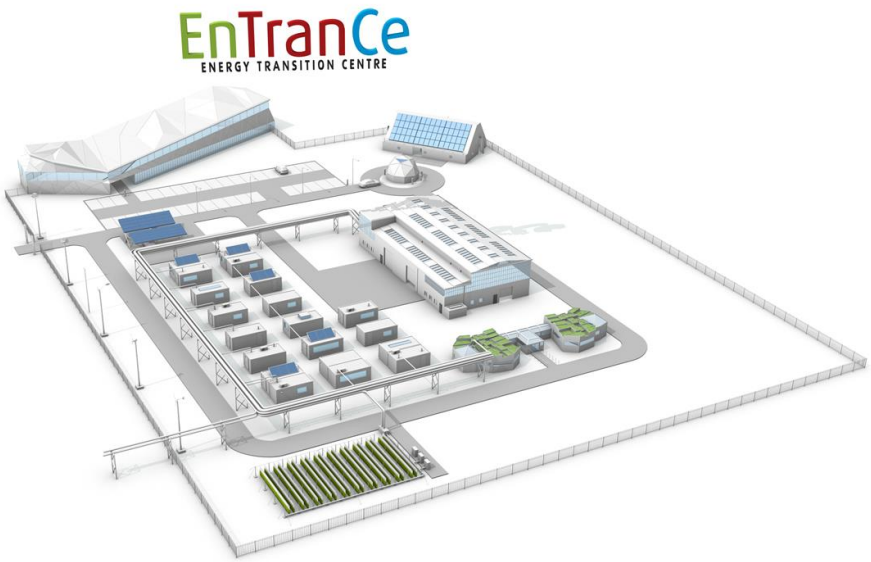

Figure 1. EnTranCe at a conceptual level

An essential element of EnTranCe is that it is basically a facility for researchers and industry to define and do relevant research. This implies that a multi-fuel infrastructure is an important part of the set-up of the Centre. As we principally are interested in questions related to local integration, these are laid out as loop systems. Of course, the covers an AC distribution grid as well as a natural-gas grade gas grid. It also consists of a heat grid, and as the facility expands it will incorporate a separate gas grid that can cope with a broad spectrum of gasses. The gasses will range from low grade biogas through to pure methane, and possibly it will also accommodate hydrogen. As regards the electricity grid, a separate DC grid might be worth considering, particularly when studying the concept of an all-gas district.

Aside from being a laboratory environment where new technologies are illustrated, we have the ambition that EnTranCe also becomes a venue where can give a feel for mthe possibilities that a low-carbon future with gas entails. Therefore, the facility is going to house new building concepts such as the Energy Barn (see Fig. 2) as well as existing houses turned into low-energy buildings.

iBalance: first step towards People in Power

If local balancing were only a question of technological ingenuity, there would be little that an open innovation environment like EnTranCe could add to already existing research on this topic. However, as the consumer in the on-going energy transition more and more transforms into an active agent in the energy system, there is a need for technologies and systems that help putting people in power. This is not merely a question of introducing new

technologies, or ICT-systems that enable the communication between these technologies, but also of social innovation. Developing and integrating these technological and social innovations through the intelligent use of the existing gas infrastructure in Europe is at the heart of EnTranCe, as it finds its first manifestation in the iBalance project.

In order to balance decentralised production and consumption of energy we first have to establish energy profiles of non-controllable sources of energy. Solar and wind resources are predictable to some extent, but not controllable. While following the concept of open innovation, the final configuration in the project is not yet fully determined, there is already a combination of a number of solar panels together with several small wind turbines installed on the EnTranCe site. The output of these determine part of the intermittent generation as used in the project. This is added to the generation from solar panels installed in the residential area in Hooghalen, with about fifty households which are participating in the project.

The smart meters installed at the households in Hooghalen are also used for measuring the demand patterns which are used in the project. Using smart meters, high time resolution measurements are possible. Thus, the constantly changing gap between supply and demand on a simulated yet real-life local level can be determined. Here enters the final piece of the puzzle: balancing power from highly modulating BlueGen ceramic fuel cells. The aim is to analyse how a range of fuel cells can best be modulated to achieve a higher or lower output. In particular, we look how modulation of a single fuel cell compares to a similar modulation by a number of fuel cells simultaneously.

Ten fuel cells are installed in two barracks at the EnTranCe facility (see Figure 2). They are operated following a simulated demand that requires the fuel cells to modulate up and down on a regular basis. A layer of ICT will be added to do the planning, with computer models predicting consumer behaviour and with access to real-time data flows. This layer will be developed in such a way that the local community can decide how it wants to run the local energy infrastructure. One option is that they choose to try to produce and use as much renewable energy as possible. Alternatively, they can opt to find an optimal combination of decentralised energy and energy from the main grid. Or they can set up the system so that it reacts to financial incentives, if and when energy pricing will become dynamical over the day.

Figure 2. Set-up of two CFCL BlueGen fuel cells at EnTranCe

Currently, the project does only involves the balancing of electricity demand. For households in the Netherlands, energy demand for heat demand typically is some five times higher than electricity demand. Thus, looking at the electricity balance clearly is only part of the story. Therefore, in the longer run the aim is to have the fuel cells also supply the heat according to some simulated demand, or preferably the measured demand from the same village as is used for the electricity demand. However, as the fuel cells provide insufficient heat to meet this demand, we will also involve micro-CHP. The micro-CHP is primarily controlled in such a way that heat demand is satisfied, while it of course at the same time produces electricity. Thus, the inclusion of the micro-CHP adds another boundary condition to the operation of the fuel cells.

The project does look beyond the mere technicalities of the integration of renewable energy systems on a local level. The resulting ICT infrastructure provides people with options to react according to various strategies. This presupposes active involvement of people, quite unlike the current situation where consumers are only interested in having a certain comfort level, generally quite irrespective of how this is met. Therefore, alongside with or following the development of the physical system, we will have to investigate how consumers can be transformed into active participants. Here enters the element of cooperation between the sciences and the arts. Together they will develop the technical and social instruments to put People in Power.

Concluding remarks

The Dutch gas industry together with other companies and research and education institutes builds a facility for open innovation at EnTranCe. In line with the notion of open innovation, we wholeheartedly invite other companies to join us here to further the case for gas a pivotal fuel in the transition towards e renewable energy system.