fenix
'… a step towards the future of electricity networks'

Contract Nº: SES6 - 518272

FENIX Deliverable D3.1: Description of scenarios that characterise the electricity markets with ancillary services by DER in the long term

"Northern & Southern Scenarios"

- **Executive Summary**
- **Table of Contents**

Document type: Deliverable 3.1

	Northern Scenario	**Southern Scenario**
Main authors:	Charlotte Ramsay	Jose Oyarzabal
Company:	Imperial College	Labein-Tecnalia
Address:	Exhibition Road South Kensington London. SW7 2AZ UK	c/ Geldo Parque Tecnológico de Bizkaia, Edificio 700 48160 Derio Spain
Telephone:	+44 (0) 20 7594 9313	+34 94 607 33 00
Fax:	+44 (0) 20 7594 9334	+34 94 607 33 49
Email:	charlotte.ramsay@imperial.ac.uk	joseoyar@labein.es
Further Authors:	Goran Strbac (Imperial College) Peter Lang (EDF Energy Networks) Marko Aunedi (Imperial College) Dejan Melovic (Imperial College)	Juan Martí (Iberdrola Distribución) Ana Gonzalez Bordagarai (Iberdrola Distribución) Belén Díaz Guerra (REE) David Alvira (REE) Carlos Madina (Labein-Tecnalia)

Executive Summary

Context

The aim of the FENIX project is to explore the potential for distributed energy systems operated using active network management and a "Virtual Power Plant" (VPP)[1] approach to integration of Distributed Energy Resources (DER) into the system. The purpose of this document is to inform the development of the FENIX demonstration projects and devise a series of future energy system scenarios that illustrate the impact of various levels of penetration of DER on the generation system. These scenario models will be used to facilitate an assessment of the performance of the FENIX VPP approach against a "Reference" model which retains the current (centralised) approach to system operation and development.

In the "Reference" model, a future is envisaged whereby, without technical integration of DER into the system, large penetration of DER may displace the energy produced by conventional plant. However, conventional generation continues to be necessary for provision of system support services (e.g. load following, frequency and voltage regulation, reserves etc.) required to maintain security and integrity of the system. In addition, given that a significant proportion of DER is likely to be connected to distribution networks, maintaining the traditional passive operation of these networks and centralised control will necessitate increase in capacities of both the transmission and distribution networks, increasing overall system costs and reducing the efficiency of system use.

On the other hand, by fully integrating DER (including the demand side) into network operation, using the VPP approach (the "*FENIX future*"), DER will take the responsibility for delivery of system support services taking over the role of central generation. In this case DER will be able to displace not only energy produced by central generation but also its controllability reducing the capacity of central generation as in shown in the figure. To achieve the distribution networks operating practice will need to change from passive to active necessitating a shift from traditional central control philosophy to a new distributed control paradigm, including significant contribution of demand side necessary to enhance the control capability of the system.

The aim of this research is to generate medium-to-long-term scenarios (representing energy systems in 2020) to examine the performance of both the FENIX and the Status Quo approaches. This is being undertaken as two pieces of work reflecting realistic situations and scenarios in Northern and Southern Europe. These "Northern" and "Southern" Scenarios reports reflect the geographic locations of the two FENIX demonstration sites.

Southern Scenario

The Southern Scenario has been developed addressing the future demonstration activities to be performed in practice. Therefore the several potential demonstration sites have been identified as representative of the network in a feasible time horizon taking advantage of the distribution network size and the wide variety of particular situations that are already found.

The FENIX project focuses on the integration of DER into power system operation issues including not only the generation and demand balance but also the ancillary services required to provide a satisfactory security of supply and power quality. In this sense active and reactive power issues deserve a separate treatment; active power is a system problem even when local constraint could appear and call for proper solving countermeasures while reactive power is a more local problem with impact at system level.

As consequence, the general approach in the Southern Scenario development has consisted of selecting concrete distribution networks that have been judged to characterize the expected network in line with the targets about renewable energy penetration, displacement of conventional generation,

[1] A Virtual Power Plant is a flexible representation of a portfolio of DER. A VPP not only aggregates the capacity of many diverse DER, it also creates a single operating profile from a composite of the parameters characterising each DER and incorporates spatial (i.e. network) constraints into its description of the capabilities of the portfolio.

etc. and possibly candidates for the demonstration phase, either on field or partially completed with simulations. These physical network locations are completed with a scenario building tool that enables the creation of network models where different alternatives are assessed in a virtual simulation environment.

The Southern Scenario was initially based on the distribution network of Castellón province where two particular HV/MV substations were recognized as exemplary cases of high penetration levels of DG able to feed a significant part of the local consumption and deferring[2] network investments. STR Onda and STR Alcora substations represent a situation where the local distributed generation resources, mostly industrial CHP plants, contribute significantly (up to 50%) to supplying customers' electricity demand. The installed capacity is thereby lower than the effective peak load. These substations represent a special situation discarded for a field test campaign due to several reasons only enabling the simulation environment: the meshed distribution network topology is a barrier for the scale-up of results to system level; important network upgrades and investments will be put into practice; no renewable resources are deployed; shortage in capabilities of currently installed devices; heat driven DER output limits demonstrations and only enables the simulation environment.

A second Southern Scenario candidate was identified in Álava province. The general layout of the distribution network is stable with well known development plans, maintaining the purely radial exploitation scheme. This provides an easy way for the effect of control actions, and active and reactive power delivered at MV level, to be scaled up to the transmission level by evaluating the impact at a reduced number of frontier transformers. At the same time, the installed capacity of renewable resources is relatively high compared to the peak load and the transformation installed capacity, with an interesting technology mix.

From the point of view of generators' capability to deliver system services, the two larger CHP plants are suitable to handle active and reactive power dispatches without affecting the background industrial processes, while the renewable sources cannot provide this type of service.

In summary, the Southern Scenario has been identified in Álava province based on an average network topology and design while offering an overall interesting mix of renewable/non-renewable distributed generation. This is in line with the expected targets and is deemed suitable to produce adequate local and system effects to be scaled up in order to evaluate the proposed FENIX future and serve as model for the remaining activities within the project.

Northern Scenario

For the Northern report, scenario development has also been approached in parallel to development of the UK FENIX demonstration project (The "Northern" Scenario Demonstration).

The aim of the Northern Scenario Demonstration is to illustrate the potential for multiple DER to be controlled as part of a VPP portfolio and to show how VPP output can be used to facilitate DER participation in the wholesale markets and in system management. The selected location for the Northern scenario is the UK town of Woking. Woking is a small town in the south-east of England, 30 miles to the west of London. Over the last 10 years the Borough Council of Woking has made considerable investment in Distributed Generation Technologies to provide power for the municipal offices, shops and business in the town centre and large numbers of the council owned housing estates and community buildings in the area. Around 4 MW of generation is currently in operation from a range of technologies varying in size, age, controllability and reliability.

Using the Woking DER, the Northern Scenario will illustrate:

- Participation of DER in the wholesale market; the VPP aggregation approach will be used to reduce the risk associated with lone operation in the market, improve availability and give DER

[2] To some extent in the sense that DG effectively supports local demand but the particularities of these locations are implicitly considered when the decision was made, no special contracts are signed. Other combination of industrial/commercial/urban activities could have lead to a different network investment policy irrespectively of the installed resources.

access to economies of scale in market participation.

- Half hourly system management services from DER; the VPP will present the operating parameters and bids and offers for adjustment of a portfolio of DER to the system operator for use in real-time system management after market gate closure.
- Scheduled ancillary services from DER; the VPP portfolio will be used to offer frequency response and standing reserve services to the system operator at scheduled times during the year.
- Real time portfolio balancing; DER in a VPP portfolio will be used to balance the portfolio position after gate closure to avoid punitive imbalance charges.

The identification of DER to participate in the demonstration has driven the identification and characterisation of a local FENIX scenario that has prompted a "bottom-up" approach to defining the wider scenarios and testing the impact of the FENIX and Status Quo futures.

The possible scenarios of development of the overall GB electrical power system until 2020 are presented based on the findings of the SuperGen consortium. The report also provides a review of the UK electricity market operation and structure and framework, outlining the options open to small scale generation and demand in the current market framework. It then reviews the opportunities for DER to provide the system services identified for demonstration (i.e. half-hourly system balancing, scheduled ancillary services and post-gate closure balancing) and gives an indication of the potential size of these commercial markets.

The DER operating in Woking are also described; the report outlines the capabilities of the plant and their control schedules and highlights some of the main operating issues experienced in the daily running of the plant.

Finally, these perspectives are brought together with the presentation of a structure for the Northern Scenario Demonstration project. It identifies the technical and commercial roles that can be facilitated by the VPP and defines the FENIX architecture in terms of this local UK example. These roles are further formalized through developing the transaction schemes describing the interaction between different actors in the Northern Scenario.

The outputs described in this report are derived from the development of a local Northern Scenario, based around the developing demonstration project. It is a definition of VPP services that are envisaged for the UK under a FENIX future and a definition of the local roles and functions derived for individual market actors participating in the demonstration. This grounded definition of the UK FENIX architecture and demonstration structure will be used to inform the high level scenarios and testing of the Status Quo and FENIX future approaches at a national level.

CONTENTS