Orchestration of Renewable Integrated Generation in Neighbourhoods

Grant Agreement Number: 314742

D7.3 Options for Interfacing Community and National Supply

WP7 – Community Energy Business Models and Commercialisation

Delivery Date : MONTH 34, August 2015
Updated Version: December 2015

Dissemination Level : public

Nature of deliverable : Report

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The work is part of the project ORIGIN (Orchestration of Renewable Integrated Generation in Neighbourhoods) supported by the European Union and its 7th Framework Programme. The sole responsibility for the content of this publication lies with the authors.

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1. Executive Summary

Besides local electrical demand coverage, available load and generation flexibilities (e.g. controllable RES generation and consumption) in communities can generate additional financial and systemic benefits by offering services and products to the national grid or other third parties. Prerequisite for this is the technical coupling to the national electricity supply system, islanding solutions cannot profit from those concepts.

A part of these services is being traded or negotiated via standardised and mostly liberalised market places, allowing free competition of registered service providers. For the countries under special consideration within the ORIGIN project, such markets exist for:

- Energy (all countries, spot trade, intra-day OTC, …)
- Primary Reserve / Frequency Response (Germany, UK)
- Fast reserve /Secondary Reserve (Germany, Italy, Portugal, UK)
- Tertiary Reserve / Short Term Operating Reserve (Germany, Italy, UK)
- Regulation Reserve / Replacement Reserve (Italy, Portugal)
- Switchable Loads (Germany)

An analysis for the communities Findhorn, Tamera and Damanhur revealed a number of technical opportunities for participation in the system services markets, but showed at the same time obstacles for implementation. The main obstacle is the relatively small nominal powers and amount of flexible energy being available compared to lower power limits defined for the most market products. Additional challenges arise for generation/load flexibilities with limited predictability and local community operation demands being in conflict to requirements from the grid services. So, for example, integrating the Findhorn wind turbines in balancing services might require a temporary powering down while the community seeks for maximization of the wind power output. The absence of exporting electricity for Tamera and the geographical and contractual splitting of the separate units at Damanhur are specific aspects setting high barriers for accessing the markets.

Pooling of a number of smaller generation units and flexible loads can help to overcome market barriers and to meet technical limits for the market product. Already today a number of service providers exist accepting smaller generators in their pools. Still it has to be considered that the provision of market products and system services requires corresponding metering and communication equipment being a critical cost factor for very small single units.

From the perspective of the ORIGIN project philosophy the ORIGIN energy management system could in future take over monitoring and management tasks and might interface the single generation or storage units in the communities to the markets and service providers. This approach would improve the profitability of investing into the ORIGIN technology and give a win-win situation for all parties involved.

2. Motivation

Key focus of the project ORIGIN are technical solutions and business models to establish innovative energy management solutions in communities allowing them to match local energy demand with decentralised energy generation capacities, like Photovoltaics (PV), Wind or Combined Heat and Power generators (CHP) delivering both heat and electricity. Often the foremost intentions of the communities are a high level of self-sufficiency and a maximum local consumption of renewable generation to implement a “green self-supply”. The ORIGIN energy management system contributes to this goal by forecasting generation and consumption profiles, scheduling the operation of flexible generators, loads or storage systems and providing information for flexible tariff systems allowing the inhabitants of the communities to adjust their personal energy consumptions profiles to the momentary availability of natural resources.

In most cases the communities stay connected to the national electricity supply grid because of the need to import deficit power and the option for exporting excess power and selling this to the grid operator or third parties. This interfacing to the national grid opens up a broad variety of technical options to contribute to the national grid operation and national transitions efforts for replacing conventional (CO_2 emitting) generation by a more sustainable energy supply system.

At a first glance technical contributions from rather small communities to the “big grid” might seem negligible. There are two main arguments against this “pessimistic view”:

* A significant number of RES installations are smaller and distributed systems, adding up to relevant total powers. So, for Germany an accumulated total of 39.4 GW PV installations are expected for 2015[1] with (for the last years) more than 40% power originating from installations <100 kWp[2], being typical for decentralised installations. Numerous studies show significant potentials for household energy management with accumulated flexible powers in the GW range (for example see reference[3]).
Aggregated smaller DG and flexible loads can in some cases generate impacts on the national grid even today.

* Regulations and technical standards in the past were tailored to a system of big centralised power plants providing both power and system services for the grid operation. With the increasing share of DG RES and the systematic shut-down of nuclear power plants and old CO_2-emitting conventional power plants regulations and standards are more and more changing for a smooth integration of smaller size DG RES and the creation of free markets for power and system services allowing even smaller actors to participate. A cornerstone for this participation is the option to bundle a larger number of small systems (“aggregation”) in order to meet required power limits or to secure save supply of the service (e.g. by balancing fluctuating generation).
Aggregated smaller DG and flexible loads are more and more accepted for participation in power and system service markets on the basis of adjusted regulations and standards.

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[1] http://volker-quaschning.de/datserv/pv-deu/index.php

[2] Bundesnetzagentur Deutschland

[3] Palmer, J., Terry, N., Kane, T., „Further Analysis of the Household Electricity Use Survey: Early findings - demand side management“, 2014, London: DECC/DEFRA

Providing power and/or grid services for the grid is **a win-win situation for each party involved** (leaving out old central power plant operators …):

- the grid operators acquire decentralised flexibilities allowing cost efficient grid operation and partly avoiding grid reinforcement

- the national energy supply system receives higher shares of RES or sustainable generation

- supplying the national grid opens up new business concepts for the Communities making their investments more profitable.

During the course of the ORIGIN project a survey has been conducted to identify services and business options for Communities operating DG RES systems or controllable loads, which can be forecasted and controlled by the ORIGIN energy management solution. Markets, technical requirements and practical examples have been collected allowing decision makers and technical experts in the communities to understand the existing options and to identify most promising market options. The most promising services and business options have been compared to the existing technical flexibilities in the communities Findhorn, Damanhur and Tamera, and an assessment about the current and future relevance of those options together with further recommendations is given.

3. Interface options for the Findhorn community

The Findhorn Foundation Community owns/operates "The Park" and Cluny Hill College in Forres, Scotland. The ORIGIN project dealt only with the Park with the following parts: 27 bungalows / 51 caravans / 58 houses on private land called 'Field of Dreams' which consist of Eco-houses and Barrel Eco-Houses / Community Centre Kitchen. The Park consists of around 300 people, 200 of which are staff.

There are four wind turbines installed with a total nominal power of 750 kW (for an equivalent of 2,500 hours of full load/year this would equal 1,875 MWh/year). The number of kWh per year exceeds the aggregated consumption of the settlement, so there is a relevant volume of electricity export to the public grid. About 50% of the electricity produced is used on-site and the remainder is distributed to the main grid. Total local grid load is up to about 250 kW. The wind turbines supply in total more than 100% of the community's electricity needs. The wind generators are owned and operated by "Findhorn Wind Park Ltd." (FWP), the electricity is bought by Scottish and Southern Energy (SSE). Circa 15 kW of installed solar-PV in participating buildings is feeding into the private wire grid. Findhorn owns two electric vehicles and a charging station

The customers at the Findhorn settlement (which includes Findhorn community and all other Findhorn settlers / park people) buy their electricity from New Findhorn Directions (NFD) Ltd., who acts as retailer. NFD is buying the electricity from FWP, which operates the substation being the link between the public electricity grid and the local grid in Findhorn. Local infrastructure (including meters) at Findhorn is installed and maintained by NFD. FWP purchases electricity from SSE, if the wind generation is not sufficient. Figure 1 visualizes the contractual and financial relations between the different actors at Findhorn.

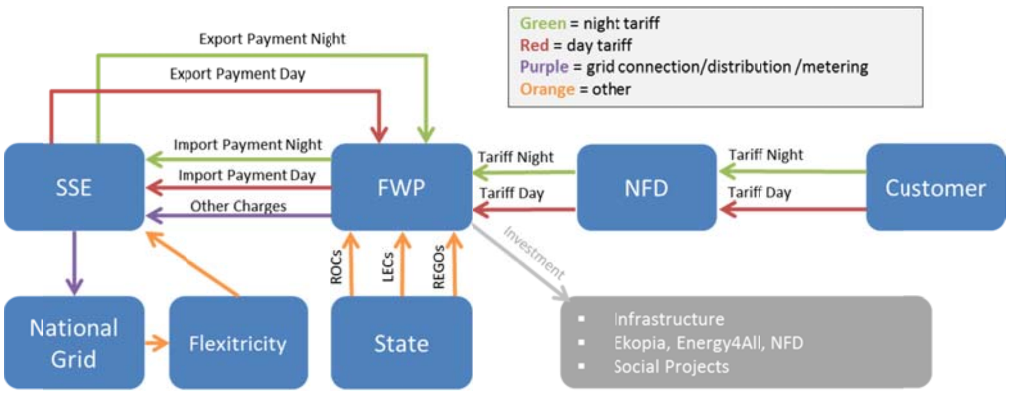

Figure 1: Actors involved in the electricity supply of the Findhorn community and payments between the actors. Day and Night Tariff systems exist both for energy imports (purchase) and exports (excess energy from wind power).

One special feature at Findhorn that extends the electrical energy management options is the coupling of electrical and thermal supply systems. Table 1 shows some typical examples for Findhorn buildings showing flexible space and hot water heating options that could be operated according to external optimization requirements.

Table 1: Examplary thermal supply concepts for single Findhorn buildings (source: ORIGIN Deliverable 4.1)

Space heating system	Hot water heating system	Example of related applications
Thermal store / solar thermal / electric backup / radiators.	Thermal store / solar thermal / electric backup.	Findhorn Centini
Heat pump / electric backup / underfloor.	Thermal store / solar thermal / heat pump / electric backup.	Findhorn East Whins
Thermal store / heat pump / electric backup / local PV / underfloor.	NA	Findhorn Arts Centre
Biomass district heat / central thermal store / radiators.	Biomass district heat / central thermal store / solar thermal / local thermal store / electric backup.	Findhorn Soillse Damanhur Magilla Damanhur Crea

Based on this technical situation Table 3 summarizes the existing flexibilities (orchestration opportunities) that could be relevant for business opportunities related to the grid interface. Since only a part of the community participated to ORIGIN field tests some of the quantified figures are estimations.

Table 2: Orchestration opportunities in Tamera

Orchestration opportunity	Flexibility parameter	Quantification	Remarks on flexibility
Load shifting of electrical space heating and domestic hot water supply	Power, Energy	about 75 kW	Because of the thermal inertia of heating systems and the availability of alternative supply options electrical heating technologies offer excellent short/medium/long-term flexibilities for load management.
Appliance load shifting (fridge, freezer, washing machine, small loads)	Power	In the range of up to about 50 kW	Mostly short and medium term load shifting. Some appliances allow long term shifting (washing machines). "Hard switching" concepts possible if not interfering with users' requirements. Rather small flexible energy quantities.

Water pumping in sewage treatment plant (“Living Machine”)	Power	5 kW	Limited flexibility because of biological requirements
Load shifting of electric car charging	Power	10 .. 40 kW, only small energy amount (negligible)	Short and medium term load shifting easy to realise, multiple hours load shifting possible with sound prediction/planning of mobility requirements. “Hard switching” concepts appropriate. Load controller might be able of providing extra functions (e.g. reactive power).
Informational load shifting	Power	only few and energy efficient appliances available (negligible potential)	Response to informational load shifting is hard to predict and less useful for providing grid services. Lowering of peak power demand might be achieved in certain cases.
Wind Turbine Energy Management	Power, Energy	750 kW	Under normal circumstances fluctuating RES generation can only provide downward regulation. This, however, would counteract the community’s interest to harvest maximum energy output from the wind turbines. For situations with excess wind power generation, the operation of restrained wind generators under the perspective of selling system services might become an option.

Altogether the flexibility potential for Findhorn (relevant for grid services) is estimated to be in the range of up to 100 .. 120 kW, thus being about half of the peak demand. Because of the high share of flexibilities originating from thermal/electric heating systems a good part of this flexibility could be available both very quickly for short term (and low energy volume) balancing services and for long term (and higher energy volume) management options requiring revised operation schemes for all thermal/electric system components.

Markets for grid and ancillary services

“National Grid”, in its capacity as National Electricity System Operator (NETSO), ensures that electricity generation and demand are balanced across the U.K. transmission system on a second by second basis.

Electricity can be purchased in the U.K. via different market platforms, like APX power spot exchange or Nord Pool Spot AS – N2EX. One remarkable aspect about these energy spot markets is the reduction of minimum clip sizes for the continuous UK power market from 1.0 MW to 0.1 MW some years ago. The smaller clip size lowers the barrier to entry by allowing members to trade smaller positions. Even though not being an ancillary service it should be mentioned here that flexible provision of energy imports taking into account variable market prices can be one option to transfer local flexibilities into economic benefits. Intra-day market trading might be of special importance because of higher forecasting quality for fluctuating RES.

As for the market based grid services, “Frequency Response” is one relevant service in the UK that is comparable to “Primary Reserve” and “Secondary Reserve” in other EU countries. There are two major types of Frequency Response: Dynamic Frequency Response and Non Dynamic Frequency Response. Dynamic Frequency Response leads to an automatic change in active power output in response to a frequency change. The service is needed to maintain the frequency within statutory (49.5Hz - 50.5Hz) and operational limits (49.8Hz - 50.2Hz). Non Dynamic Frequency Response is a discrete service triggered at a defined frequency deviation. A mapping of these two types of services to “products” is shown in Figure 2. It is worth noticing that National Grid implemented services allowing smaller parties to access markets open only for providers of large flexible powers (like 10 MW for firm frequency response or 3 MW for frequency control by demand management).

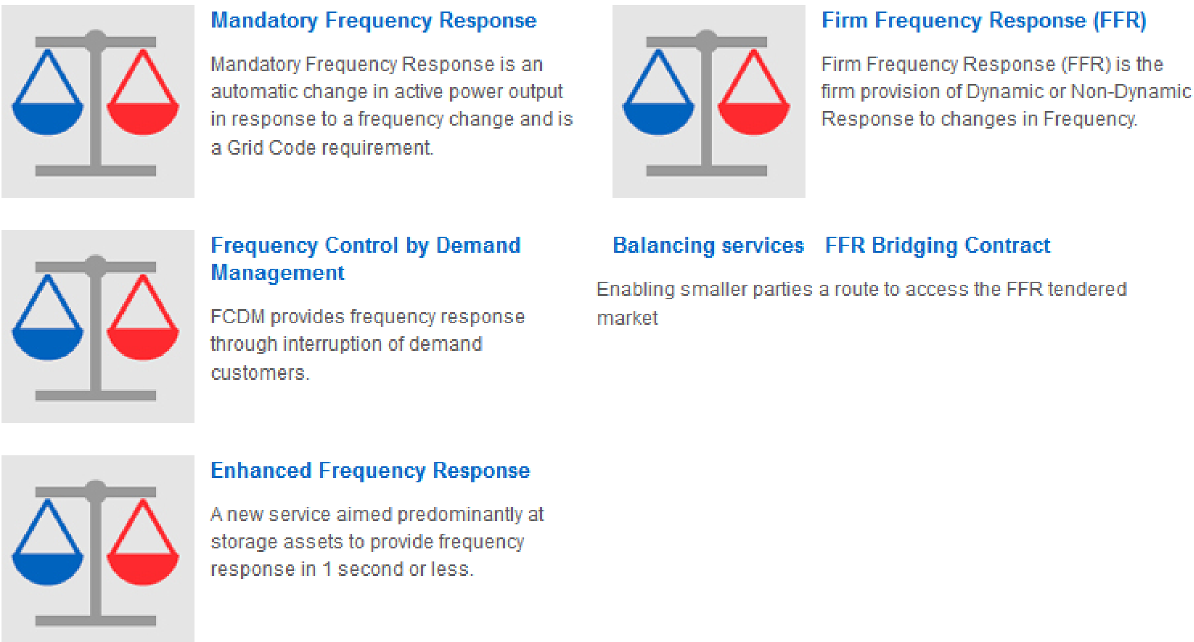

Figure 2: Frequency Response Services in the UK (source: National Grid)

On a longer time scale (which is covered by tertiary reserve in other EU countries) services are procured in the U.K. via the "Short Term Operating Reserve STOR". STOR is a service for the provision of additional active power from generation and/or demand reduction. Requirements for STOR are:

- Offer a minimum of 3 MW or more of generation or steady demand reduction (this can be from more than one site);
- Deliver full MW within 240 minutes or less from receiving instructions from National Grid; and
- Provide full MW for at least 2 hours when instructed.

STOR is procured via competitive tender with three tender rounds per year. All the interested parties have to fulfil the pre-qualification by signing onto the Framework Agreement before participating in tender.

Besides Frequency Response and STOR there exist BM Start Up service products, which are procured through generic contract terms. These are not relevant in the present context.

Today there already exist a number of larger service providers aggregating smaller flexibilities on the basis of standardised contracts. They do accept comparably small singe unit sizes of down to e.g. 100 kW. To give an idea about requirements and revenue potentials Figure 3 shows two services for aggregating CHP units and load management options provided by the U.K. service provider Flexitricity (www.flexitricity.com).

Combined heat and power (CHP)	
Asset description	Natural gas or biogas powered electricity generator with heat recovery, heat storage, and possibly absorption chilling
Example sites	Hospitals, public and office buildings, district heating, horticulture, manufacturing
Example asset profiles	Small: <500kW Medium: 500kW to 3MW Large: 3MW+
Typical revenues (after operating costs)	Small-to-medium: £35,000 to £240,000 per annum Large: £241,000 to £400,000+ per annum
Large assets can participate very flexibly. Smaller assets are more constrained. Consult Flexitricity to discuss your site.	
Running regimes	Subject to heat load, heat storage, and "normal" CHP operational schedule, Flexitricity normally targets 100-150 calls per annum, with 1-2hrs running per call.

Load management	
Asset description	Multiple types such as air conditioning, pumping, refrigeration and heating
Example sites	Chilled distribution centres, office buildings, retail premises, pumping stations, factories
Example load profiles	Small: 150kW to 1MW Medium: 1MW to 2.5MW Large: 2.5MW+
Typical revenues	Small-to-medium: up to £40,000 per annum Large: £41,000 to £100,000+ per annum
Expected load reductions per annum	Low: ~50 calls per annum, ~1hr running per call (max 2hrs per call) Medium: ~100 calls per annum, ~1.5hrs running per call (max 4hrs per call) High: ~200 calls per annum, ~1.5hrs running per call (max 4hrs per call)

Figure 3: Previous examples from the product portfolio of Flexitricity (www.flexitricity.com)

Recommendations for the Community

Key advantages for the community Findhorn to provide grid related system services are the availability of (compared to the other ORIGIN communities) relatively large generator powers and flexible loads, and the centralisation of all energy supply and distribution grid related matters in the companies "NFD" and "FWP". Nevertheless, participation of the large wind generation capacity in the balancing service markets certainly is no realistic option because of the intention of the community to harvest the maximum of the energy that can be generated. As of today there are only very few examples in Europe of restraining the actual output power of fluctuating RES to offer voluntary grid system services (which should not be mixed up with the occasional need to shut down of wind turbines because of grid dispatch requirements!). So, at the end, there is only the about 100 kW flexible load power left which is clearly below all thresholds for direct market participation and even critical for participation is most pools (see the minimum power limits in Figure 3). Besides the problem about the minimum power limits the forecasting and activation risk impose additional challenges. The requirement for hard control of the technical units providing the service together with the operation of necessary communication and monitoring equipment produces significant O/M costs making it hard to devise paying concepts in situations with multiple small units providing the service. The technical and financial prospects would improve, if the available maximum power of controllable devices (like CHP or EV charging stations) would significantly increase.

One way for a future entering of the service markets would be contracts to other neighbouring communities with alike generation and consumption portfolios, especially those operating CHP or larger switchable load units. For such aggregations, load shedding or power adjustment on frequency changes might allow entering service product pools.

Besides such market related service products there is some other grid related services that could be provided by the existing infrastructure. So the inverters/converters in most wind turbines are able to provide reactive power which could mend local grid voltage problems (i.e. grid congestion problems) by flexible adjustment of the type and quantity of reactive power injection at the grid connection point[4]. The same is possible with the inverters of the PV installations.

Another aspect is the curtailment of maximum peak power demand for the community. The current tariff structure at Findhorn foresees capacity payments between SSE and FWP as well as FWP and NFD. Since the individual customers have no capacity payment, capacity reducing behaviour of the customers would have to be honoured by alternative financial measures.

For more information about the balancing services in the U.K. please refer to: http://www2.nationalgrid.com/uk/services/balancing-services/ .

[4] More information about that can be found here: http://electrical-engineering-portal.com/how-reactive-power-is-helpful-to-maintain-a-system-healthy

4. Interface options for the Tamera community

The Portuguese community of Tamera comprises a number of residential and community buildings (e.g. communal cooking and eating area, assembly hall, bar and conference areas) loosely spread on an area of 1.4 km². They are working to re-introduce water courses to the land and currently use approximately 30 % of their electricity consumption for pumping. The community operates a grid connected island power network with one joint electricity meter. PV systems totalling 20 kWp provide about 20 % of the electricity consumed in the community. The generated PV is used instantaneously by the community or is stored in batteries (2x48 V Storage / 2x3500 Ah) for use later. Some electricity is discarded (see Figure 4) – no export arrangement exists with the grid operator. Community imports are above 50 MWh per year. About 23 MWh per year are used for pumping water for irrigation, remaining consumption is about 65 MWh. A charging station for EV allows charging powers of about 10 .. 40 kW.

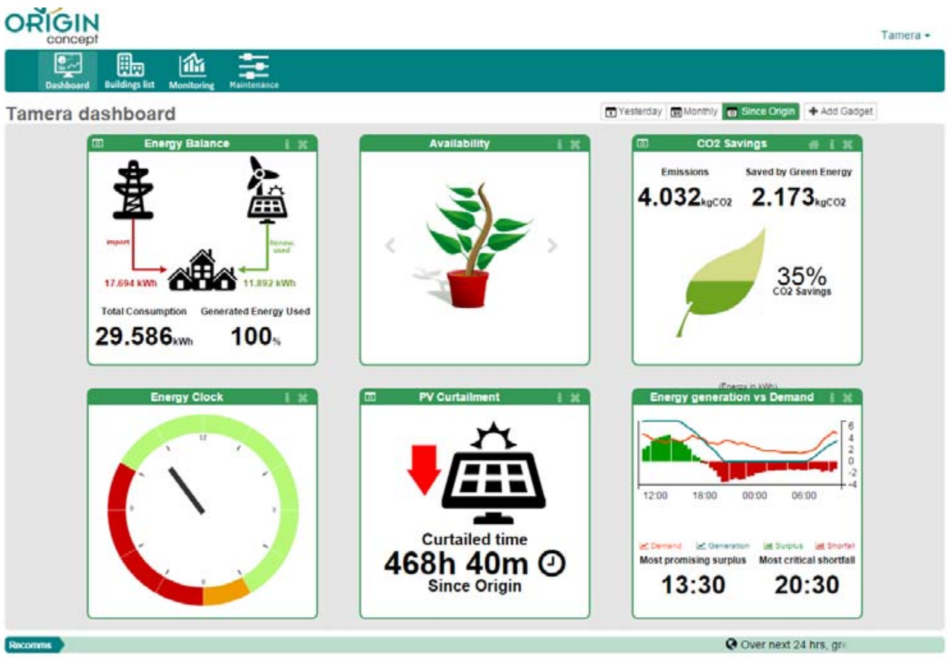

Figure 4: ORIGIN Dashboard for the Tamera community showing among others the relation between consumption and generation as well as energy curtailment at Tamera.

The community experiments in other innovative electricity generation technologies, which however have negligible nominal powers (like a 1.5 kW Stirling Engine).

The contract with the grid operator involves a maximum peak power for consumption of about 40 kW and electricity is being billed using a triple tariff “Tariffa tri horario” with peak, day and night prices being different for summer and winter time (for more information: http://www.edpsu.pt/pt/tarifasehorarios/BTN/Pages/HorariosBTN.aspx). Payments add up to about 700 € per month.

Based on this technical situation Table 3 summarizes the existing flexibilities (orchestration opportunities) that could be relevant for business opportunities related to the grid interface:

Table 3: Orchestration opportunities in Tamera

Orchestration opportunity	Flexibility parameter	Quantification	Remarks on flexibility
Load shifting of electric car charging	Power	10 .. 40 kW, only small energy amount (negligible)	Short and medium term load shifting easy to realise, multiple hours load shifting possible with sound prediction/planning of mobility requirements. “Hard switching” concepts applicable. Load controller might be able of providing extra functions (e.g. reactive power).
Appliance load shifting (fridge freezer, washing machine, small loads)	Power	2 .. 3 kW, only small energy amount (negligible)	Mostly short and medium term load shifting. Some appliances allow long term shifting (washing machines). “Hard switching” concepts possible if not interfering with users’ requirements.
Water pumping	Power, Energy	< 40 kW, 23 MWh	Short and medium term load shifting easy to realise, multiple hours load shifting possible with forward-looking irrigation concept.
Battery storage	Power, Energy	30 kW, abt. 300 kWh	Positive and negative flexibility depending on state of charge situation. Alteration of regular battery management might result in additional curtailment of locally produced PV power.
Informational load shifting	Power	only few and energy efficient appliances available (negligible potential)	Response to informational load shifting is hard to predict and less useful for providing grid services. Lowering of peak power demand might be achieved in certain cases.

Summarizing this technological basis, the following flexibilities could be utilized in the context of providing services for grid operators or service market places:

- Fast and short duration load changes (positive or negative): up to about 100 kW
- Longer duration load changes: up to about 70 kW
- System services provided by power electronics (e.g. reactive power): up to about 70 kW

Markets for ancillary services

In Portugal, ancillary services are provided by the system operator REN – Rede Elétrica Nacional, S.A., as a National Electricity Transmission Network (Rede Nacional de Transporte – RNT) operator (Figure 5). Throughout 2013, the ancillary services market represented an average weighted cost of approximately €2.88/MWh sold in comparison to the weighted marginal price in the daily and intraday market of approximately €42.91/MWh.[5] Mandatory services are voltage regulation, frequency regulation and maintenance of stability. Additional services are synchronous and static compensation, regulation reserve, secondary regulation, quick interruptibility, black start and remote start. **Currently, only secondary regulation and regulation reserve are remunerated under the competitive market. Remaining services may be subject to bilateral trading.** Regulation reserve is split into “minimum reserve of tertiary regulation” and “additional reserve”.

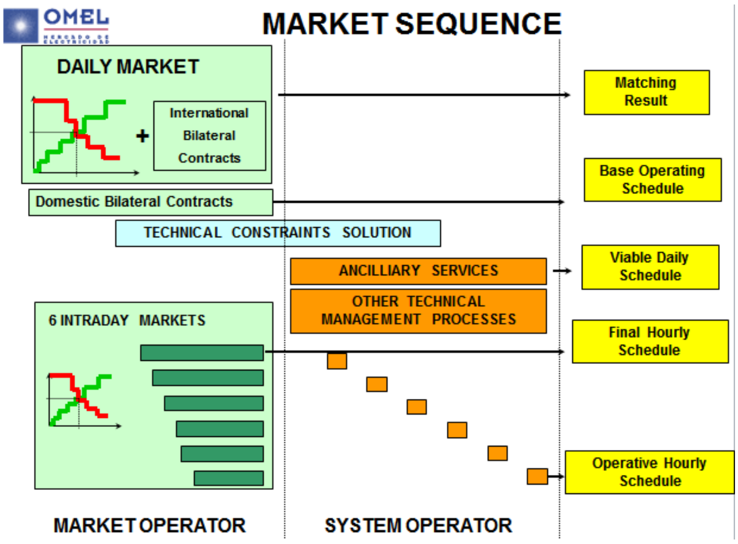

Figure 5: Energy and system services markets in Portugal. Ancillary system services are provided by the system operator REN. (source: OMEL)

The value of the service “secondary regulation” is composed of two parts: the secondary regulation, valued according the top marginal price of the secondary regulation, which goes up or down every hour; and the secondary regulation energy, valued according to the price of the last offer to sell for mobilized regulation reserve energy each hour. Market begins after day-ahead market closes. For “regulation reserve” the market agents submit upward or downward regulation reserve offers for all

[5] ENTIDADE REGULADORA DOS SERVIÇOS ENERGÉTICOS, Annual Report to the European Commission 2013 Portugal, July 2014

enabled balancing systems and for each schedule period for the following day between 6:00 pm and 9:00 pm. Service provision must be possible for at least two consecutive hours.

Recommendations for the Community

The absence of possibilities to export electricity is one key obstacle to provide services to the national grid. There might be the theoretical opportunity to be allowed delivering balancing services (like positive reserve) without energy export contracts, yet this seems in this constellation an unprecedented legal challenge if physical feed-back of electricity would be involved (and the community of Tamera actually does not want energy exports). For some services pure load variation might be an option not involving grid exports.

Taken aside this basic problem about energy exports, participation in the ancillary service markets requires a minimum electrical power in the Megawatt range. So the community cannot participate in the markets alone. Contribution to pooling solutions would be possible from the technical point of view, but due to the small individual size of the single loads/battery/generators and the inevitable efforts for communication and metering equipment this will hardly be reasonable both from the financial and the technical perspective.

The community should focus on the aspect of maximum peak power payments and organise the energy management (provided by the ORIGIN system) in a way of reliable peak load shaving. It also should be aware about the opportunities resulting from the triple tariff scheme allowing to purchase cheaper energy during some times of the day.
In cases of voltage problems of local grid wiring the community could try to use intelligent inverters/charge regulators for voltage management by reactive power injection.

For more information about the ancillary service market in Portugal refer to http://www.mercado.ren.pt.

5. Interface options for the Damanhur community

The Italian community of Damanhur has approximately 500 members and occupies a geographically disparate region of Northern Italy, centred near the village of Vidracco, some 60 km north of Turin. The Damanhurian people live together in family units of between 15 and 25 in communal buildings known as nucleos. These are typically two storeys with communal living areas on the ground floor and single bedrooms on the second floor. There are also a number of administrative and educational buildings and they also own a 4000 m2 two storey office building called the Damanhur Crea which has 21 zones and multiple uses.

The community operates a number of smaller PV plants (about 3 kWp each) on the living buildings belonging to them and a 120 kWp PV installation on the Damanhur Crea building. The PV system of the Crea building serves about 28 % of the total annual demand generating about 90 MWh/a (see also Figure 6). The Magilla Nucleo has 28 kWp building integrated PV and also a storage system for the 24 V light circuit (Morningstar TRISTAR 60 A battery), providing a high level of self-supply.

Figure 6: ORIGIN Dashboard for the Damanhur community showing among others the relation between consumption and generation at Damanhur.

Each of the single parts of the community organises energy purchase and metering/billing solutions individually. Currently there are no plans for centralising the contracts with one energy provider.

Based on this technical situation Table 3 summarizes the existing flexibilities (orchestration opportunities) that could be relevant for business opportunities related to the grid interface.

Table 4: Orchestration opportunities in Damanhur

Orchestration opportunity	Flexibility parameter	Quantification	Remarks on flexibility
Appliance load shifting (fridge, freezer, washing machine, dishwasher)	Power	Up to 11 kW per building, only small energy amount (negligible)	Mostly short and medium term load shifting. Some appliances allow long term shifting (washing machines). "Hard switching" concepts possible if not interfering with users' requirements.
Air conditioning	Power, Energy	35 kW (Crea building)	Short and medium term load shifting easy to realise, multiple hours load shifting possible with forward-looking air conditioning concept.
Battery storage	Power, Energy	1.44 kW	Positive and negative flexibility depending on state of charge situation. Because of being a 24 V system not relevant for grid interfacing.
Informational load shifting	Power	only few and energy efficient appliances available (negligible potential)	Response to informational load shifting is hard to predict and less useful for providing grid services. Lowering of peak power demand might be achieved in certain cases.

Markets for ancillary services

In Italy the TSO (TERNA) is responsible for balancing and acquires the balancing energy on the Ancillary Services Market (MSD) that is managed by GME (Gestore Mercati Energetici) as Market Operator. The MSD consists of a scheduling stage (ex-ante MSD) and of the Balancing Market (MB). For details refer to Figure 7.

Mandatory services are primary frequency and voltage control, load rejection, black start capability and secondary voltage control. Regulated contracts exist for interruptible customers. The Dispatching Services Market (MSD) addresses aspects of congestion management, secondary reserve (f / P control), tertiary reserve and real-time balancing. Products with high market relevance for operators of distributed flexibilities are "Secondary Reserve (FRR)", "Tertiary Fast Reserve" and "Tertiary Replacement Reserve (RR)". Italy saw a significant increase in the revenues resulting from the ancillary services markets during the last years, which is explained by the impact of RES generation (Figure 8).

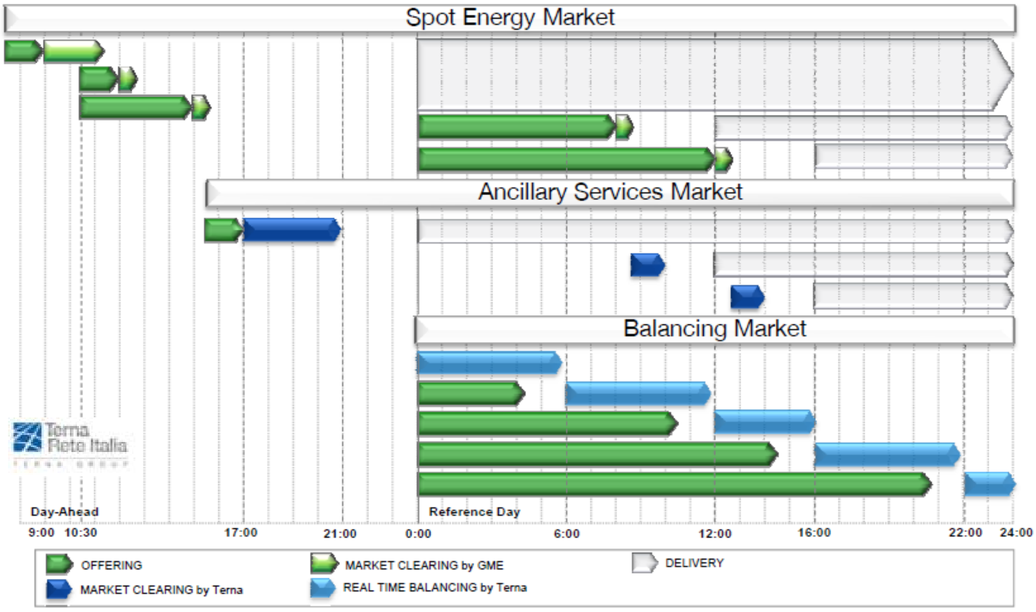

Figure 7: Structure of the Italian Energy Markets (source: TERNA)

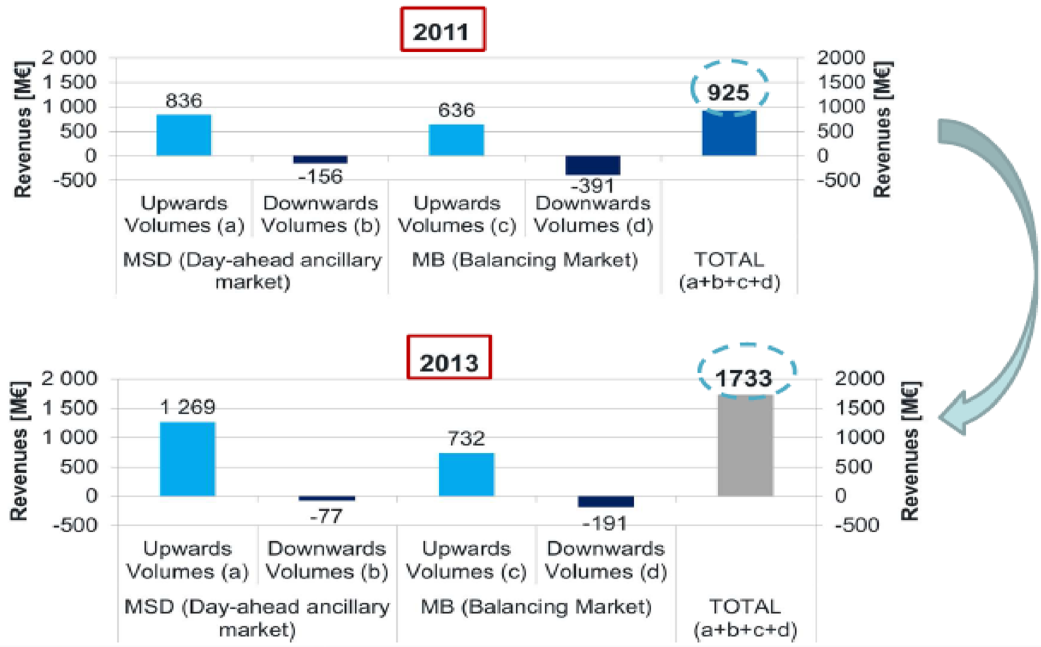

Figure 8: Impact of RES generation on the Ancillary Services Market (Source: Workshop Greenpeace – Terna „Power30“, Rome, October15 2014)

Recommendations for the Community

In Italy Secondary and Tertiary Reserve markets are interesting opportunities for business concepts using (distributed) flexible generators and loads. Rising market volumes show increasing business opportunities for the upcoming years.

The most serious problem to make use of these business opportunities in the community Damanhur clearly is the small available power volume of the individual loads and generators linked together with the geographical and contractual splitting of energy consumption and generation between the "Nucleos". This prohibits approaches of economically viable and technically reasonable services to be provided for the grid operator or to other external service providers. Seen on a long term perspective the community might consider to become member of a larger network of communities bundling their energy purchases and contracting one (innovative) service provider who could seek to aggregate single flexibilities in order to achieve advantages for the energy procurement (e.g. shifting maximum load to low tariff times or curtailment of peak power demand) or add these flexibilities to a much larger service pool.

In case of grid problems in the distribution network near the Damanhur Crea building, the inverter of the 120 kW PV installation might be able to provide a flexible share of reactive power thus stabilizing the local voltage level and lower stress son grid components. This, however, would be a local service not requiring intervention by the ORIGIN energy management system.

For more information about the ancillary service market in Italy refer to http://www.terna.it/en-gb/sistemaelettrico/mercatoelettrico.aspx.

6. Outlook

A successful transition of the national and European energy supply system towards a high share of sustainable energy resources involves the empowerment of smaller size distributed generation systems. Because of their closeness to the consumers and the distribution grid they offer excellent technical options for systems services needed in the corresponding regions or grid segments. To motivate owners and operators of flexible RES, loads and storage systems to contribute to requirements and services of the national grid, solutions and regulations need to be worked out which are

- easy to understand
- easy to implement
- reliable regarding technical and legal requirements
- allowing reasonable profitability.

Currently we are just at the beginning of processes opening up markets for smaller participants and redefining the requirements of system services in a way allowing new service providers to enter the competition. This process will continue and intensify during the next decades and current differences between “front running countries” and “conservative countries” will diminish.

Integrating the provision of smart services in products like the ORIGIN energy management system will lower the technical and motivational barrier for smaller actors to participate the big markets.

For the communities Findhorn, Tamera and Damanhur the participation in the grid system services markets today is hardly conceivable, acknowledging the currently existing technical and economic barriers. But on a longer time scale all actors willing to contribute to a stable and sustainable electricity supply will be integrated in revised system of grind management where even smaller flexibilities will find an appropriate role.

Note on Complementary Document

A more general survey about Options for Interfacing Community and National Supply has been compiled and prepared in the form of a Power Point presentation available on the ORIGIN website as well. This document indicates additional services and business opportunities that were not relevant for the Findhorn, Damahur and Tamera communities but might be applicable for other types of communities.