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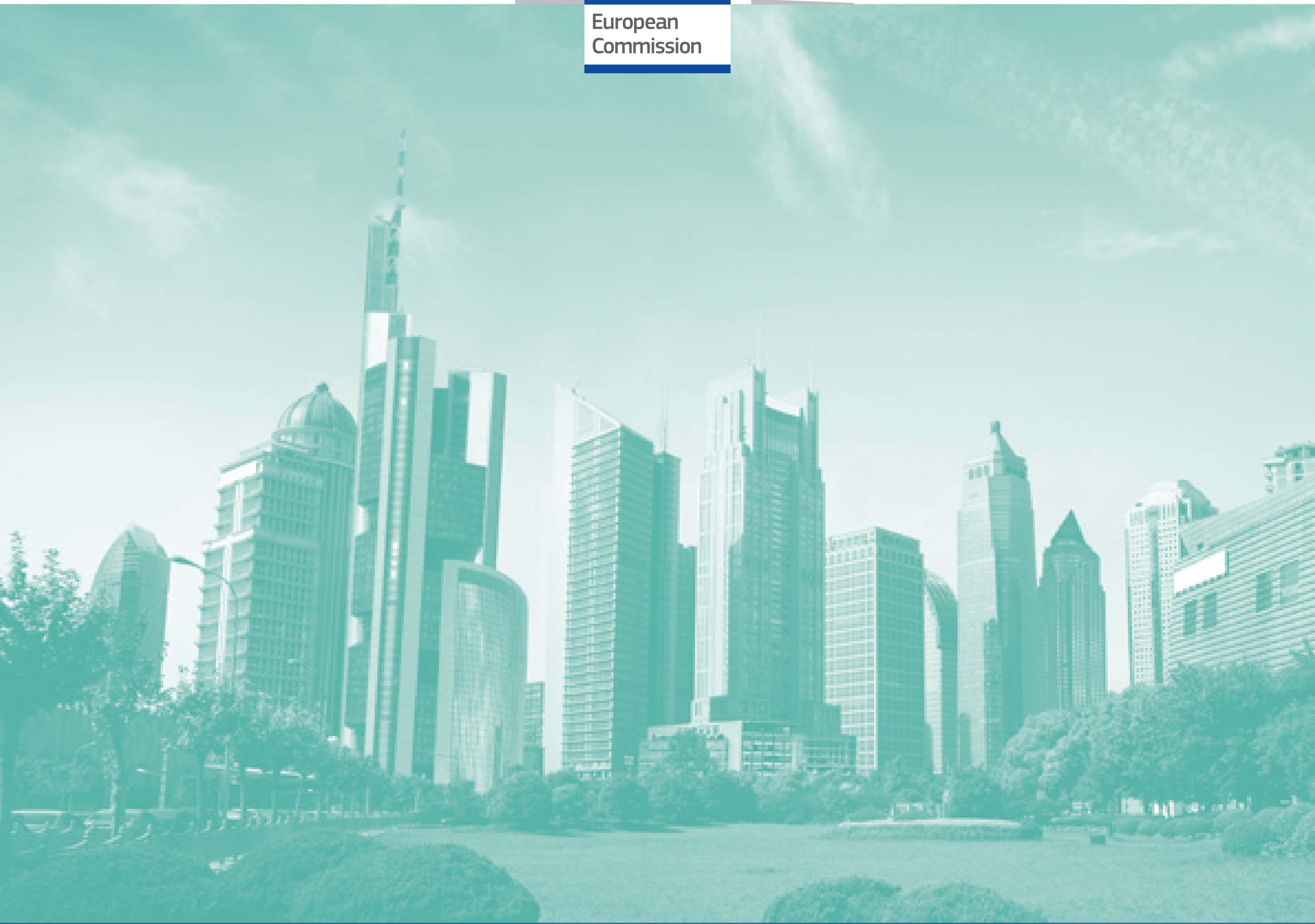

Smart Cities
Stakeholder Platform

Virtual Energy Plan

Key to Innovation Integrated Solution

Virtual Energy Plant (VEP)

Document information	
Prepared by:	Olaf van Pruissen – TNO, Netherlands
Edited by:	Sytze Dijkstra
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INTRODUCTION

The Key Innovations (KIs) are a key output of the Smart Cities Stakeholder Platform. The Platform promotes innovation and is part of the Smart Cities and Communities European Innovation Partnership of the European Union. It aims to accelerate the development and market deployment of energy efficiency and low-carbon technology applications in the urban environment. The emphasis will be on their integration, which is a key challenge particularly for Smart Cities' technologies. The Platform aims to bring together technology providers, financiers and specialists in implementing smart city strategies at local level.

The expert Working Groups of the Platform on Energy Efficiency and Buildings, Energy Supply and Networks, ICT, as well as Mobility and Transport select from the spectrum of Solution Proposals (SPs) submitted by stakeholders[1] the *most promising and fundamental* solutions to accelerate the development of smart cities. The focus is on specific promising innovations, considered pillars or technical leapfrogs for integrated solutions in smart cities, thus promising, but standalone solutions, will not be developed into key innovation files and toolkits.

Regardless, if an SP will be part or not of a key innovation document, all solution proposals will be published in the Platform and linked to city profiles. The Platform is not an evaluation body and is open to all relevant smart solutions, large or small scale for cities and their inhabitants.

The aim is to promote through the preparation of a detailed document, a guide for cities on the performance of the innovation, including in some cases wider impacts on city life (such as change of behaviour, environment, social inclusion etc.). For each innovation, this key innovation document will describe the methodology to deploy it, including the technical requirements and the necessary framework conditions, such as existing infrastructures, technical expertise, regulatory requirements as well as the financial costs involved. The document aims to promote the adoption of the key technology and to identify barriers to deployment to assist relevant authorities in developing solutions to remove them. The document will list the technology providers as well as information of a number of potential financial sources by the EU and other bodies which have supplied information to the platform.

The information in the Key Innovation documents will become an integral part of the recommendations of the Smart City 10 Year Rolling Agenda document the Platform will draft for the European Commission. This document will highlight identified actions at European level required to promote the adoption of key innovations, such as the removal of regulatory barriers or recommendations on the focus of the Horizon 2020.

It is important to stress that this document is not a set of technical proposal or a full evaluation of the innovation, but aims to assist for cities to identify potential solutions and understand their context and implementation needs. It does not exempt or substitute a detailed cost/benefit analysis and implementation plans for cities that wish to introduce the innovation. The Stakeholder Platform cannot take any responsibility for inaccuracies or missing information or specific problems in the implementation of the proposed Key Innovations or other Solution Proposals.

[1] Solution proposals are published on the web site: www.eu-smartcities.eu/ solution-proposals

Description of a Key Innovation

A key objective of the Smart Cities Stakeholder Platform is to identify Key Innovations (KIs) for the development of Smart Cities. The selection of an SP as KI is based on the following criteria: **applicability, simplicity, affordability**, **usability** the extent to which it addresses technology integration and if the potential impact is significant. Selected SPs will then be enhanced by the Platform's technical Working Groups (WGs) to develop KIs, adding the following aspects:

:

- Premises for the technology development and up-take (e.g. problems, what the technology is intended to achieve, other unforeseen benefits for the smart cities);
- Potential integration with other technologies and sectors, including use of ICT;
- If necessary, enhancing the information from the SP on the urban environment in which the technology can be applied;
- Key pre-requisites for the applicability of the key innovation, such as the required enabling environment;
- Instruments and market conditions needed to reach commercial viability.[2]

Completed KIs by the technical WGs will be sent to the Finance WG. This group will analyse the financial needs of the KI as well as their financial viability and bankability. The members of the WG will provide information on funding sources. The result will be published as a Key Innovation Toolkit.

The Toolkits thus provide practical solutions that can create an enabling environment for the application and replication of key innovations in a smart city.

[2] This includes a description of the main EU support instruments, such as the Risk Sharing Financing Facility

1. PRESENTATION OF THE KEY INNOVATION

Submitted to the platform at date:	Body(ies) submitting the proposal(s):	IP right holders:	Maturity of innovation:	City	Parties or stakeholders involved:
1. The Power Matcher					
20-09-2012	TNO	Open-source	Demonstrated at small scale	Hoogkerk, PowerMatching City	TNO, ECN
2. Energy-hub - for Residential and Commercial Districts and Transport					
03-10-2012	KU Leuven	Open-source	Demonstrated at small scale	Leuven	KU Leuven, TNO
3. Dynamic Pricing by Scalable Energy Management Systems					
26-09-2012	TNO	Open-source	Demonstrated at small scale	Den Haag Ypenburg	TNO

Other related projects are given on the Smart Grid map developed by the JRC and Eurelectric: http://ses.jrc.ec.europa.eu/jrc-eurelectric-map

1.1 Description of the innovation and rationale for selection

The recent expansion of distributed renewables – wind, solar, hydro - has resulted in growing local production of energy within urban environments. These new renewables sources of energy are often intermittent raising new balancing challenges within city districts, and requiring new tools to optimally integrate local generation and demand through city grid operation.

This requires the expansion of new Virtual Energy Plant (VEP) ICT and energy management/control technologies to facilitate coordination of distributed energy resources – whether distributed generation, storage or demand-responsive loads.

The solution was selected considering its significant impact on renewable energy integration and energy efficiency as it allows for increasing the amount of distributed renewable generation within city environments, by ensuring that demand is optimally aligned with the availability of these local resources.

The innovative nature of the concept relates to several aspects :

- The underlying model can incorporate a wide variety of energy resources: electricity, heat and cold, several types of distributed generation, flexible demand, and energy storage;
- The platform can incorporate energy network constraints through external data import from network operators, if the platform is operated by a separate market participant;
- It incorporates the latest market-based optimisation technologies into a scalable architecture being able to interconnect millions of distributed energy resources throughout cities;
- It can be integrated into the business activities of different stakeholders, like energy network operators, electricity or gas retailers, city energy managers, and operators of electrical vehicle fleets.

1.2 Level of deployment

Several small scale trials and demonstrations have been achieved so far implying consumer communities not larger than 1,000 consumers typically.

One of the first applications was the PowerMatching City project in Hoogkerk in the Netherlands, virtually connected to the D Dwelling demonstration site at the ECN facilities in Petten. It consists of 25 different homes and buildings integrating various types of distributed energy resources. Each houses has either a heat pump or a micro-CHP system and its own solar PV panel and some have an electrical vehicle charger and a battery system. The PowerMatcher energy management system balances demand and supply by coordinating the generators, batteries and flexible loads, based on the energy system price. The system was first tested in field tests like CRISP. New field tests like Couperus Ypenburg with 300 apartments heated with just heat pumps in The Haque are currently taking place, to demonstrate scalability, cost reduction of network investment for the DSO and reduction of imbalance cost for the energy supplier.

The apartment complex at Ypenburg, part of the city The Hague, Netherlands where the VPP concept is tested

PowerMatching City tested the VEP concept for electricity. The HeatMatcht, a similar system for managing residential heating supply, has also been developed, but has not been tested at such a scale yet.

The Powermatcher technology concept was originally developed out of demonstration projects by ECN and was recently open-sourced to the market. While several vendors adopted the technology, it has not reached industrial maturity yet. The next step being to expand it to a city-wide scale (i.e. typically over 10,000 distributed energy resources connections). This should confirm scalability of the projects, feasibility of the implementation costs as well as end-user acceptance to these new technologies. Larger scale integration projects should accelerate the final industrialisation, and commercialisation could follow within the next 3-5 years.

1.3 Impacts of the innovation: achieved and foreseen

Characteristic	**Impacts achieved**	**Impacts foreseen**
Flexible	Real-time balancing of energy supply and demand in cities	Integration of demand-response in (local) energy markets
Intelligent	Central coordination of supply and demand based on market-price algorithms	

Integrated	Facilitates accessing flexibility of both demand and supply	Integration of electric transport and electricity storage as well
Efficient	Enables most cost-effective use of flexibility	
Attractive	Provides real-time information to end users about own use and related costs	Facilitates end-user participation in (local) energy markets

The main innovation lies into defining a new market-based mechanism to allow the real-time balancing of energy within cities, coupled with energy market prices.

The VEP concept contributes to the integration of SmartGrid ICT with home energy management systems, bringing buildings and end-users into the energy system. This encourages load-shifting according to imbalance pricing and favouring the supply of energy through local energy district balance.

Key potential impacts of the innovation are:

- Facilitating end-user participation and demand response through critical wholesale positive and negative price peak periods – this will reduce volatility in wholesale pricing in the long-term.
- Facilitating the introduction of distributed renewable and electrical vehicles within urban environments
- Offering new sources for providing ancillary service and reserve capability to energy network operators

These impacts remain to be quantified in a global city concept through a detailed cost-benefit analysis.

1.4 Technical feasibility and viability

Concrete adaptations of current A) technologies and B) structures/concepts are necessary to enable VEP concepts to support and drive a smart city development:

A) Technologies

ICT platform

Present status: the use of distributed renewables in urban environments has been increasing. The variable nature of many of these energy sources has created new challenges for balancing supply and demand within city districts, and resulted in complex network flows and bottlenecks. Addressing these challenges requires new tools to optimally integrate local generation and demand through city grid operation.

Emerging Smart City solutions: The innovation is composed of an ICT platform capable to provide real-time pricing information to users having opted for such VEP services. It also includes electronic hardware – like thePowermatcher system - to be installed within residential, commercial and industrial sites. The Powermatcher connects critical energy production/consumption resources such as heating systems, electrical vehicle charging, heat pumps as well as home appliances in the residential area, giving access to their flexibility for balancing supply and demand and solving urban energy network congestion.

B) Structures/Concepts

Real-time pricing

Present status: many end-users currently pay a flat rate for the energy they use, particularly small-scale residential users. Some areas have introduced different price periods over the day (for example peak and off-peak prices), but the price signals that (small) consumers experience normally do not reflect the real-time conditions of the energy system (e.g. supply-demand balance and available network capacity). As a consequence, there is little incentive to shift usage when the system is constrained to solve problems cost-effectively.

Emerging Smart City solution: The VEP concept is based on real-time energy pricing over the day reflecting the real-time energy balance within the energy system supplying the city. The ICT platform embeds multi-goal decision support algorithms calculating the optimum balance of flexible demand and distributed generation within the city environment in real time, while accounting for urban network conditions.

1.5 Financial analysis

The costs and benefits of VEP systems depend strongly on the design and local context, including the local network topology, occupation patterns (i.e. residential, commercial and services), the presence of industry activities in the vicinity and the remoteness of the location. Given the importance of local conditions, cost-benefit analysis needs to be performed at city level, considering several benefits are societal in term of global system welfare.

The PowerMatcher is open source software. This implies that manufacturers of the connected technologies, like whitegoods, heat pumps and all other devices involved can use this technology without paying for the rights to use this software.

Two business cases have been analysed with respect to determine the return on investment.
One is the business case of imbalance reduction using the PowerMatcher for the German electricity system (http://www.smarthouse-smartgrid.eu/). The underlying cost structure of the necessary hardware components are estimated:

- One aggregator / router per household (50 € - 100€)
- Substation aggregator: one per 100 – 200 households (1000 € - 2000 €)
- Controller for distributed energy devices: one chip per device (1 €)
- IT solution to integrate PowerMatcher software in the network operator's IT system (100.000 € - 1.000.000 €)
- Installation at the households: Hourly lavor costs for installation are assumed to be 46 € and four hours installation per household are assumed (total ~200 €)

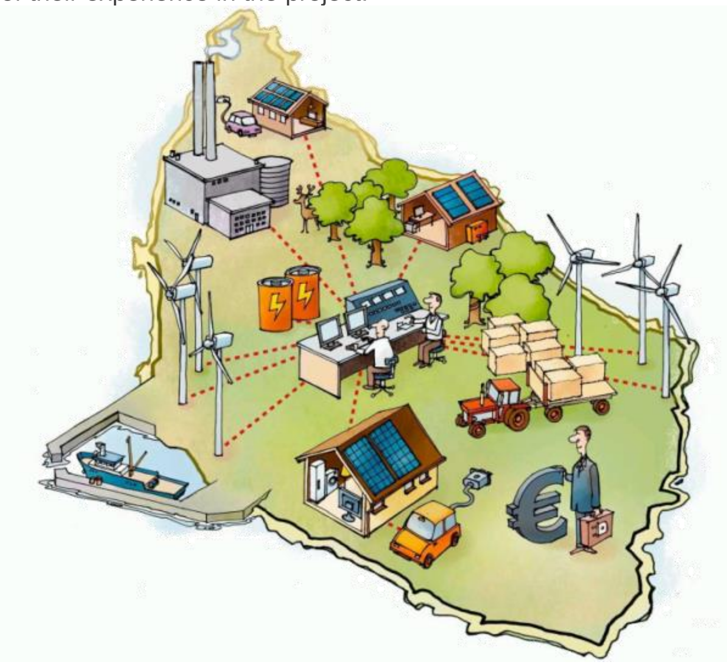
An overview of all key data can be found in the next table:

Structure of the VEP cluster	
DSO	
Total yearly consumption on the low voltage level (1kV)	1,000 GWh
Standard Load Profile customers in distribution grid area	267,379
Average load deviation in balancing area per 15 min. interval	8,021 kW
Households / customers	
Average yearly energy consumption per household	3,740 kWh
Households with controllable micro CHP for local heating	0.5%
Average generation capacity per CHP unit and typical day winter / transition / summer	4.5 kW / 2.5 kW / 0.2 kW
Controllable load of devices per household	246 W, 8h/d
Number of households in PowerMatcher virtual power plant	10,000
Investment Costs	
Per household	
One aggregator/router	75 €
Chip for every smart device (five devices per household)	1 €

Installation per household	100 €
DSO level	
One substation aggregator per 150 households	1,500 €
IT solution for PowerMatcher integration in DSO's IT	500,000 €
Savings	
Costs for deviations per Standard Load Profile customer per year	6.75 €
Total costs for deviations per year	1.81 Mio. €
Maximum balancing potential	63%
Actual savings	1.14 Mio. €

For this reference scenario of the PowerMatcher case, the static payback time calculated to refinance the investment that would result from this cost structure is 3.0 years.

In the project Ecogrid (shown in the picture below) which is related to this key innovation and where VEP systems are rolled out, the DSO Őstkraft is responsible for the installation at the households and a more precise calculation can be made on basis of their experience in the project.



Ecogrid; Bornholm where the PowerMatcher VEP technology is demonstrated

Next to reducing imbalance costs, calculations were made with respect to postponement or avoidance of introduction of certain assets in the electricity grid. The paper “High Concentration of Heat pumps in Suburban Areas and Reduction of Their Impact on the Electricity Network” published in PowerTech 2011, IEEE Trondheim, illustrates the level of costs savings that can be achieved in a residential area with heat pumps. The cost reduction calculated was €220.000 for substations, and €35.000 for MV/LV transformer stations. In the special case of the residential area of Hoogdalem an extra third track for the MV transmission network of about 4 kilometre could be avoided, leading to a cost reduction of another €1.200.000.

Further revenue streams can be anticipated in the following areas:

- Reduced urban energy network costs, avoiding significant grid reinvestments to support integration of distributed renewables, energy storage electrical vehicle charging infrastructure and public transport infrastructure;
- Reduced renewable curtailment during low load conditions, reducing the amount of energy that remains unused;
- Reduced city carbon footprint and clearer carbon cost allocation to end user;

- Automatically generated real-time pricing incentives to leverage urban infrastructure flexibility during grid peak energy demand periods.

Cities and network operators should consider potential for realising additional revenue from these sources, but their exact benefits are difficult to generalise, as local conditions vary and there is limited experience with the benefits that can be achieved by applying VEP systems in different circumstances.

2. EXPECTED IMPACTS

2.1 Energy supplied or savings expected

VEP systems can contribute to energy savings in four main areas. Together final energy savings in the order of 5 to 40% can be achieved.

1. Introducing VEP technology for electricity will **enhance the integration of renewables in the electricity grid**. So energy savings depend on the number of extra renewables introduced than compared to a normal situation. From literature with respect to the US grid it is derived that with conventional technologies up to 20% of PV and wind turbines can be introduced. With this system it is envisaged that penetration of up to 80% is possible, depending on the amount of biogas available for peak production and reserve power. The efficiency also depends on the efficiency gained by the devices, e.g. a heat pump with a COP of 5 is possible when it is designed for smart grid operation and also optimally used. Thus we can arrive at savings which can be 40%.
2. VEP technology **facilitates the uptake and integration of electric transport**, managing the demand from electric vehicles and, in the middle to long term, giving access to vehicle-to-grid storage.
3. Overall, VEP systems can offer **better transparency to end-consumers** on the real-time use of the energy and its costs, encouraging energy efficiency measures and behavior, and load shifting to reduce demand during peak system conditions.
4. VEP systems can contribute to **more effective network planning and operation**. The system will overall reduce the amount of extra grid and back up generation capacity required to achieve the 20/20/20 objective reducing the impact in end user electricity bills. These energy savings from the smart grid itself, without introducing renewable devices are estimated to be about 5%.

When applying the VEP concept to heat, the efficiency gain is highly dependent on the installation. When the heat from a solar collector used for tap water heating, can also be transported to a buffer which can deliver heat to room heating, the smart grid can offer more efficiency gain than when such a connection is not available. It also depends on the efficiency of the conventional system. Furthermore, when the diameter of a connecting pipe is changed, such a system may suffer from a bad performance, whereas with a smart grid it is not. Estimations energy savings vary from 5% to 40%.

Some important business opportunities for the VEP are identified:

1. In home optimization: keeping electricity producing within the consumer's household reduces the amount of import and export and thus the amount of taxes paid.
2. For commercial imbalance reduction: the energy supplier as a balancing responsible party will operate the VEP to reduce its own imbalance. The benefits are worked out in more detail in the next section.
3. For reducing peak loads: distribution network operators can benefit by reducing peak loads low, leading to a longer lifetime of the electricity assets, and deferring investments in new network capacity.

2.2 Expected impact on GHG emissions

The proposed technology will have several impacts in term of city GHG reductions:

- Favoring the integration of renewables within urban infrastructure. Typically, the VEP allows for integration of more renewable energy generation than currently, because it would overcome situations in which that renewable energy generation is curtailed because of limited network capacity or low demand;

- Facilitating the introduction of electrical vehicle through Smart Charging infrastructure;
- Informing end-users of individual carbon footprint, facilitating benchmarking. This helps inform the uptake of active energy efficiency measures, aligning consumption with energy supply and network conditions through the day;
- Contributing to more efficient operation and planning of energy networks in particular, and energy networks and other urban infrastructure in general.

As mentioned in the first paragraph of this chapter, the energy savings depend on the degree of extra integration of renewables and their efficiencies, compared to conventional ways of operating. Likewise the reduction of GHG emissions attributable to these factors is estimated to range from 5-40%, depending on exact design.

VEP systems give potential for additional GHG emissions savings, as the proposed systems minimizes the amount of wasted energy generation capacity as various levels:

- Supporting the use of combined heat and cower at residential and neighbourhood-levels, increasing the overall energy efficiency of energy supply;
- Minimising the amount of standby generation capacity within the system required to balance local renewable intermittency;
- Avoiding unnecessary renewable curtailment of renewable energy production during urban grid low load conditions.

2.3 Wider potential benefits for cities

At a larger city scale the VEP system will facilitate the integrated planning of urban energy infrastructure, as it provides better insight into the real-time condition of the energy system and existing bottlenecks. This helps minimise the spare network capacity required to operate during peak demand conditions. As such:

- Overall, the VEP system can reduce the extra infrastructure Capex investment required to connect with urban scale renewables (roof top PV), Combined Heat and Power and Electrical Charging systems.
- VEP deployment can also support the strong European ICT industry to develop new software in the energy and sustainability domain, contributing to strong job creation overall.

2.4 Additional requirements on deployment

Technology

The demonstration projects have shown the following technical challenges:

- **Layout**: complexity in defining where to locate concentrators and intelligence within the city grid, avoiding duplication of technologies across actors;
- **Standardisation**: how to connect consumers with aggregators and grid operators? What are the communication standards to be put in place to accelerate the industrial roll out? How to facilitate technology plug & play integration on the residential side and ensure the technology roll-out costs do not exceed the system benefits?
- **Privacy and cyber-security**: how to ensure consumer privacy is safeguarded, while allowing for sufficient sharing of data to operate the VEP? What are the datasets to be kept anonymous within the system?
- **User interaction**: how to facilitate end user adoption through a better User Interface design and functionality to match the expectations and needs of end-users?

These areas will need to be further investigated in larger scale integration projects.

End-user acceptance

While acceptance was demonstrated in small early adopter communities, a wider uptake is yet to be confirmed at a city-scale covering all societal profiles. Wide scale deployment will need to be supported by suitable consumer training to raise his awareness towards energy efficiency. This includes further segmentation of end-user groups to define successful roll-out strategies.

Business models

Other questions remain around the associated emerging business model, especially:

- Who should typically own and operate a VEP platform: energy network operators, retailers, independent ICT players or city authorities or agencies?
- What at the main revenue streams, what is their size, and how revenues are distributed between key market stakeholders and end users?
- What new municipal governance structures and institutions need to be put in place to facilitate VEP deployments: who defines the rules, what are the necessary regulatory changes?

Different use cases should be explored in order to quantify the benefits for different actors in connection with different operation strategies. The various cases are manifold as are the varying interests of different stakeholder. Possible examples of these different combinations are:

- Energy network operators delivering network services through the application of VEP systems, like the PowerMatcher;
- Owner-operator of residential or mixed demand sites, who can benefit from balancing demand and supply on-site between local parties;
- Energy retailers acting as performance contractors who could benefit from load-shifting potentials to optimise electricity trading in the intraday or day-ahead spot market.

While these examples are not exhaustive they demonstrate the range of possible applications and their associated financial models for different parties.

2.5 Other expected impacts

The energy-related data collected by the VPP are expected to indirectly provide a wide range of new city infrastructure related data, which can support new cloud-based services, typically around Big Data, Serious Gaming as well as developing new support services to citizens. These services will progressively emerge, as new stakeholders use the data and use cases to will start to develop new services for end-users.

3. ADDITIONAL REQUIREMENTS ON DEPLOYMENT

3.1 Governance and regulation

Integration of VEP systems in energy markets can support their effectiveness:

- Accessing new physical resources for providing flexibility for retailers and balancing-responsible parties to trade in wholesale intraday markets, reducing volatility of the balancing and ancillary service markets;
- Reducing investments for energy network operators in congested networks, allowing for faster development of critical other essential energy intensive investments;
- Generating new revenue streams for consumers from providing energy and ancillary services to the system.

The current energy market structure is however not delivering the proper market signal to facilitate such investments :

- Distribution network operators are regulated businesses, primarily capex-driven, incentivizing large capex investment while keeping opex minimal. VEP investments require the opposite, possibly requiring changes to network tariff regulation;
- Payment mechanisms for intraday energy re-dispatch, ancillary service and voltage support rarely exist, and often remain opaque to market stakeholders;
- Renewable subsidies rarely stimulate balancing of local production and consumption locally, as alternative to investment in physical network capacity.

New SmartGrid regulatory structures are currently discussed to evolve such incentive mechanisms.

The PowerMatcher can provide solutions for different actors. However, these realising would in many cases require access to the electricity market. In 2012 a new market and flexibility premium were introduced to the German renewable energy feed-in tariff. The first experience shows that easier access to electricity trading and incentives to operate distributed energy installations according to the actual demand helped new actors to enter the electricity market[3].

3.2 Suitable local conditions

Local conditions strongly affect the VEP design and benefits, but there are no overall limitations to the suitable local conditions.

3.3 Stakeholders to involve

Stakeholder	Role/ how to be involved
Mayors, politicians	Providing transparency and regulatory framework
City administration	Encouraging introduction of renewables and providing regulatory support
Utilities, energy service companies, network operators (electric, thermal, sewage, etc)	Allocating reserve power, establishing feed in tariff of renewable energy from customers and corporations

[3] Klobasa, Marian et al. (2013) : Nutzenwirkung der Marktprämie im Rahmen des Projektes Laufende Evaluierung der Direktvermarktung von Strom aus erneuerbaren Energien, Working Paper Sustainability and Innovation, No. S1/2013, http://hdl.handle.net/10419/68599

Developers, architects, planners	Incorporating VEP-functionality in design of the built environment
Construction companies	Ensuring buildings are suitable for VEP integration, and offering contracts for (efficient) energy supply
Industries	Providing access to flexible demand, and offering waste heat
Component manufacturers (windows, facades, HVAC components, …)	Adopting standards for smart grids and making their own software for their smart grid devices
Renewable energy industry (PV, solar thermal, heat pumps, …)	Manufacturers offering devices with embedded VEP-agents
ICT companies	Offering services in the new domain
R&D institutes and universities	Research on markets, user comfort, buildings and climate systems
Citizens and energy users (life-long horizon)	Purchasing renewables for a lower energy bill

In other to boost the migration towards smart grid technology next to the traditional stakeholders also a party, which is able to coordinate the stakeholders involved and make the market transparent, would be very beneficial for the process, such an encouraging party could perhaps be the government or a more local representative. Traditional stakeholders like power producers, power suppliers, network operators, consumers and a housing corporation could do the job, but also new energy service companies might enter this new market to fulfil such a role.

3.4 Supporting infrastructure required

The VEP concept is flexible, so it can be shaped to local conditions. Still, some infrastructure that enables its functioning needs to be present or introduced:

- ICT platform for deployment is needed.
- Signals from network operators with information about their substations and cables.
- Signals from energy suppliers representing their imbalance.
- Wireless signals from devices.

3.5 Interfaces with other technologies

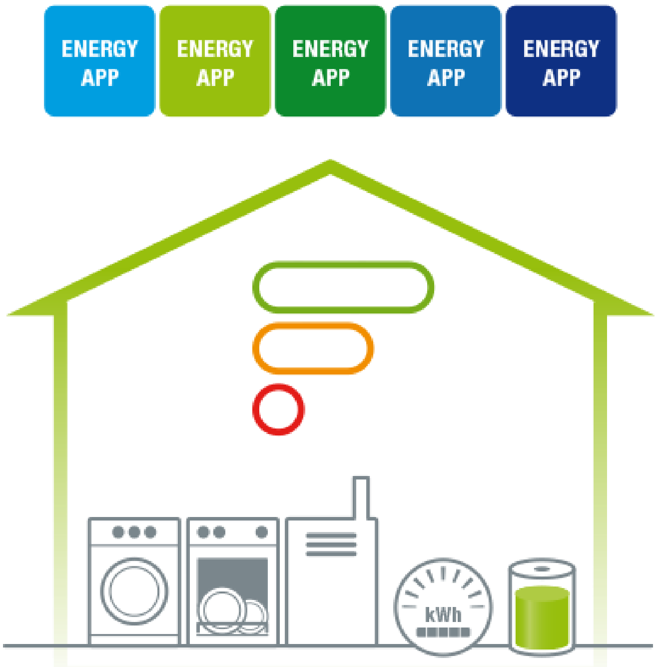
The proposed solution needs to establish links with several critical other technologies:

- Customer Information systems providing energy market information, including the balancing and ancillary services markets;
- Energy management systems and controlling ICT within critical city infrastructures, like homes, commercial and industrial buildings, energy grid nodes;
- End-user ICT systems for communication with consumers, such as telecom boxes, TV, smart phones.

To use VEP-software like the PowerMatcher for smart grid technology interoperability standards are of vital importance. Once a corporate department may have chosen for a certain VEP technology, it should be free to use and test other comparable technology if this is an interesting option for any kind of reason.

An example of such a dedicated platform has been created in the Flexible Power Network (FAN) (more information can be found at http://www.flexiblepower.org/). FAN is an open standard that connects (household) appliances with handy energy apps. Giving users easy control over the energy consumption in their home. FAN thus forms a communication layer between appliances and energy services.

The first energy service to be supplied with the FAN is the PowerMatcher. Other smart grid technologies can connect in near future.



FAN: Flexible Power Alliance Network offering interoperability; see http://www.-flexiblepower.org/.

4. FINANCIAL MODELS AND POTENTIAL FUNDING SOURCES

The Finance Group of the Stakeholder Platform has prepared documents on funding models and the use of EU Funding instruments, either from the EU budget or from the European Investment Bank. The documents are freely downloadable from the Stakeholder Platform's website.

- For funding models please refer to the **"Financing models for Smart Cities"** guidance document.
- For EU supported funding instruments please refer to the guidance document on **"Using EU Funding mechanisms for Smart Cities"**.

This section presents specific recommendations for financing models and potential sources suitable for this KI**"**.

4.1 Financing models suitable for the innovation

As mentioned in 2.2 the return on investment of a typical VEP-application is estimated to be 3.0 years. An estimated timescale for the proposed technology to be available in the market commercially is about 2 years. Certain software components are already available. In the Ecogrid project on Bornholm the goal is to not just demonstrate the components but also to keep tem running after the project is finished.

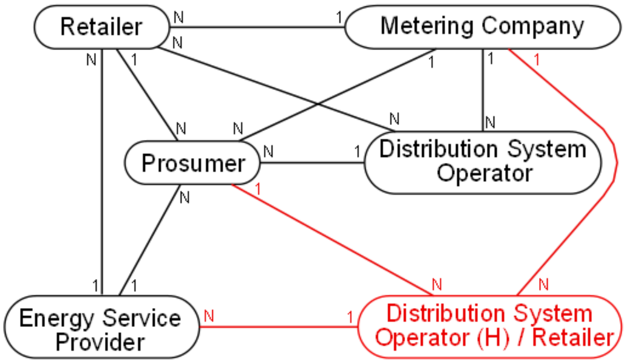
Several other considerations are important when addressing the financing of VEP-applications. The VEP is ideally part of the initial project design and feasibility study. Cities should also consider cohesion with urban planning and permitting procedures. Entering agreements with other organisations that must be involved can help coordinate the different actors that need to be involved. During implementation, it is important that the systems are properly tested, including monitoring of end-user experiences. The Ecogrid project addresses these issues in the analysis of replicability of the VEP application in other locations (certainly not just islands).

The VEP as a solution depend on only little the city type. Software for different type of devices or equipment are available and most of them tested. The PowerMatcher architecture can rather easily adopt the structure of the local grid.

VEP systems are a scalable solution, so that the operation of the smart grid typically will improve with increasing numbers. Wider deployment can support cost reduction of the technology as well.

To define the stakeholder responsible for operating the power plant is not a straightforward process. The outcome might be different: it might be the network operator (example Ecogrid) but also the software company offering the software platform as a service (example Ypenburg).

Some Business models to overcome institutional barriers have been developed. The figure below shows two example of how stakeholders might be involved in the VEP (the stakeholder in red is for heat).



To overcome financial barriers is a challenge for the near future.

4.2 Specific funding by financial institutions for this KI

No specific information at this stage.

Smart Cities and Communities

Smart Cities Stakeholder Platform

…brings together people, industry and authorities from across Europe to make our cities more energy efficient, better to live in and growth-friendly.

…is about developing concrete innovative solutions for cities through tailored innovations.

…facilitates the exchange of knowledge and best solutions across smart cities in Europe.