



Alternative business models towards the promotion of electric mobility in sustainable smart cities (VALUE+)

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Abstract. The scope of VALUE+ is to support and foster the integration of e-mobility in Sustainable Urban Mobility Plans (SUMPs). Its purpose is to provide to all stakeholders a scalable integration framework that can flexibly support business modelling as well as validation and testing of a wide range of electric mobility scenarios. VALUE+ approaches the concepts of electric mobility and smart charging in urban environments in a holistic way by bringing together methodologies for building and comparing Business Models (BMs) for e-mobility and a service framework to satisfy BM needs and empower scenarios; test bed emulators for the validation of the developed BMs would eventually be implemented by interested communities.. The ultimate results of the adoption and application of the VALUE+ will be a much greater awareness by decision makers about the needs for launching and rolling out an individual roadmap for e-mobility, with justified and verified figures about time, investments and plans for achieving credible results. Coupled to the capacity of running regular simulations, this will give confidence also in the ability to monitor the progress.

1 Background

Besides initial high costs and a limited offer e-vehicles, the still sparse infrastructure of electric charging stations in EU cities constitutes one of the main obstacles in convincing people to switch to the regular use of electric cars. Technology and innovation in this sector have the potential to unlock and promote a significant number of benefits to the public by adopting e-mobility solutions, which are likely to include:

- (i) a more efficient use of energy resources,
- (ii) the integration of energy production by households and
- (iii) environmental protection thanks to large-scale multi-modal e-mobility services enabling people to move using only electric vehicles. In this context, business solutions

for e-mobility and smart power grids will need to be tightly integrated via modern ICT technologies.

2 Objectives

VALUE+ aims to the large-scale roll-out of e-mobility in EU by overcoming existing barriers in terms of building, supporting, testing and validating business models in the field of urban e-mobility. In particular, it focuses on the building and comparison of different business models under real world conditions. VALUE+ approaches the concepts of e-mobility and smart charging in urban environments in a brand new and holistic way by bringing together (see also Figure 1):

- (i) Methodologies for building and comparing BMs for e-mobility (**VALUE-METHOD**);
- (ii) A service framework to satisfy BM needs and empower scenarios (**VALUE-FRAME**);
- (iii) The results form real-world pilot set-ups and testbed emulators for BM assessment (**VALUE-TEST**).
- (iv) VALUE+ will eventually empower, support and expedite the adoption and use of EV (Electric Vehicles) in

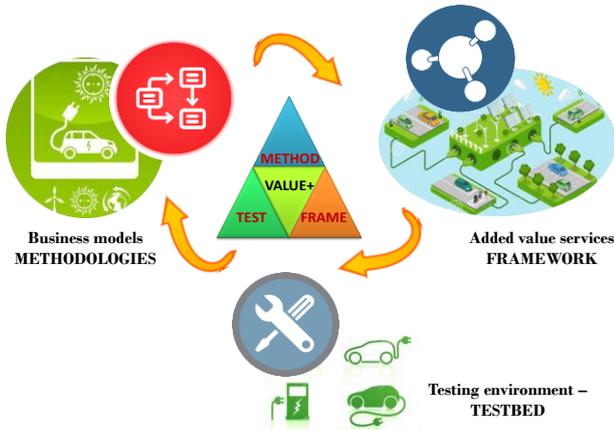


Figure 1. VALUE+ Building Blocks.

European cities.

The VALUE+ meta-model constitutes one of the fundamentals of VALUE-METHOD: it is an ontology framework based on Semantic Web technologies, taxonomies, and BM vocabularies (i.e., concepts and relationships). This upper-level ontology will provide the terminology needed to define the involved players and their interactions, the revenue and energy flows (e.g., types of charging) as well as to formally specify the parameters of a wide range of e-mobility scenarios (e.g., number and type of e-vehicles, configuration parameters, billing rates), etc.

The Domain Specific Language (DSL) will take advantage of the VALUE+ ontology to provide to all users, also those non-expert in Business modelling, simple ways for the specification of e-mobility scenarios even when complex information flows are needed to be defined.

In general, a BM should be revised and refined several times before it takes its final form (e.g., billing rates, charging parameters, battery types, time to charge, costs etc.). In addition, VALUE-FRAME will offer stakeholders an instrument for testing parameters for ensuring the best sustainability conditions. All the above

will require several iterations and tests in the lab before the actual deployment in a real-world setting takes place. The VALUE-TEST emulator will satisfy this basic requirement for the e-mobility stakeholders by allowing non-experts to investigate the viability of different BMs under customized scenarios in terms of number of customers, number of stations, prices etc. before choosing a limited number of BMs that fit well with their needs and goals to be validated in the real-world testbeds of VALUE+.

VALUE+ also accommodates for the upcoming social embracing of the car-sharing services in conjunction to the electric vehicles particular needs. Europe already pioneers the long-term transition to a global economy of shared resources - especially in the automotive sector - with half of all one-way journeys taken worldwide to happen in Germany. Given the increasing public preference to mobility over ownership of vehicles, in conjunction with the electric vehicles benefits, the facilitating of EV mobility will affect deeply the social transition to the new era and generate new business models for the transportation industry. For example, autonomous vehicles in the future will decide whether to earn money by taxiing or as a smart storage for energy by connecting to the smart grid because driving is currently not needed.

A substantial advantage of VALUE+ is the ability to validate business models related to energy management in urban environments. The key concept objective behind that is the introduction of smart grid techniques for transforming the (previously passive) EV into an important (and potentially lucrative) asset.

3 Approach

The practical approach to the building of BM foresees the parameterization of a number factors (e.g., number of participating cars, number of users, supported types energy transfer, parameterization of the billing system, ownership of the batteries used, costs etc.). The emulators and the real-world testbed facilities would come as a triptych consisting of:

- A large fleet of electric vehicles.
- An energy distribution network operating as a smart grid.

- A smart city facility where the e-fleet will operate (including charging infrastructure).

VALUE+ will therefore offer a suite of tools that will allow industries, SMEs, entrepreneurs, municipalities and all actors along the value chain to formally define new Business Models and experiment with several parameters in order to investigate the viability of a proposed business case before its actual deployment and launch on the market.

4 Expected Results

The VALUE+ project aims at achieving a significantly impact on the adoption and deployment of e-mobility solutions in cities, providing ground for the population and businesses to decide for an electric car or other e-transportation alternatives instead of going for a conventional mobility solution. Such impact will be achieved first and foremost by creating a comprehensive, valid business model available to city managers and all actors in the value chain; by providing means to create e-mobility BM, the VALUE+ model will empower stakeholders to represent cities, communities and markets with the highest details, considering their specificities about

- their actual technological progress,
- their mobility needs,
- their readiness to deploy a chosen model for e-mobility,
- their market value and the perceived value of all elements in the value chain,
- the acceptance of the chosen model by the citizens, including recharging possibilities and duration as well as behaviour and ownership, and
- the sustainability of the model balancing CO₂, costs, revenues and social benefits.

By integrating a set of methods which allow the formal representation of cities and communities, not limited to those under study, the business meta-model resulting from the approach will offer a stable, comparable, and objective instrument for evaluating the pros and cons of the possible approaches to the deployment of e-mobility solutions. The ability to identify weak spots, risks, missing elements, revenue streams, hidden costs and inefficiencies of any intended solutions, will positively impact the analysis of possible technological options, energy production/distribution models, areas where investments are needed prior to embark in a full-fledge e-mobility program. More importantly, it will have significant positive effects on the confidence of decision makers and their understanding of the

return of investments (both economical and social) as well as to the capacity of the community to embrace e-mobility. Basically, the VALUE+ business models will identify why currently e-mobility is lacking dynamic development by allowing a better decision making process, ultimately for the go/no-go decision about investing in e-mobility, supporting local/ regional SUMP, see figure 2.



Figure 2. Interlacing business cases.

The business models of VALUE+ will study, simulate, test, and validate the following elements related to energy, making the results also measurable:

- Energy production (full range of sources and production rate, with related CO₂ footprint), considering, feeding, and integrating the most current results of EU funded projects, such as LEARN, of which Fraunhofer IML is consortium partner, while observing and evaluating the CO₂ intensity of the European electricity grid.
- Energy distribution (quantity and positioning of recharging stations, efficiency)
- Self-production of energy (kWh/MWh locally by households and industries)
- Energy transport (including bi-directional charging)
- Energy needs and coverage (average, peak, day/night, demand maps)
- Efficiency of vehicles and battery packs (both for charging/discharging and for mobility)

The ultimate result of the adoption and application of the VALUE+ business model will be a much greater awareness by decision makers about the needs for launching and rolling out an individual roadmap for e-mobility, with justified and verified figures about time, investments, and plans for achieving credible results. Coupled to the capacity of running regularly updated business model simulations, this will give confidence also in the ability to monitor the progress, resulting in a larger number of cities and communities informed about how to plan and deliver a sustainable e-mobility solution suitable for their specific needs.