Alliance for Internet of Things Innovation

Electric vehicles (EV) and electric vehicle charging User Cases driven approach

Towards unlocking the full potential of EVs for European citizens and businesses

April 2021

TABLE OF CONTENTS

1. INTRODUCTION

Transport accounts for 25% of EU GHG emissions[1]. As such, transitioning to cleaner and smarter mobility is a major priority in achieving the goals laid out in the European Green Deal. Rapid innovation in the electric vehicle market promises to be key in this transition. Over the last few years, cost of ownership has declined while both viability, in relation to distance per charge, and acceptability have increased which has helped the number of EVs on the road grow. However, as the market continues to grow one particular market dynamic needs specific focus: electric vehicle charging. By the end of 2019, there were 195,000 public EVC points across the EU or 7 EVs per charging point, however, this number will have to grow rapidly to deal with the projected 30M electric vehicles that will be on Europe's roads by 2030[2]. Ensuring that EV drivers can easily find and use charging stations during a journey is of upmost important. Furthermore, the required growth in EVCs has the potential to have a dual impact on the energy market. EVs could, particularly at the peak, put enormous strains on the energy network through charging requirements facilitated by EVCs. However, on the flip side developing smart charging capabilities as well as battery storage potential of these EVs means that vehicle to home (V2H) and vehicle to grid (V2G) could potentially counteract such pressure while facilitating the integration of renewable energy sources into the grid.

As such, it is an imperative for policy makers to put in place a considered framework that ensures sufficient coverage of EV charge points that takes account of these other important variables. Therefore, the Commission deems it a priority to consider how access to high quality EVC can be expanded in a way that is user centric, interoperable and sustainable (in relation to pressures on the energy system) in order to unlock the full potential of EVs for European citizens and businesses. This is no easy task considering the wide array of actors involved (e.g. EV manufacturers, energy DSOs / grid operators, local government etc.) and the resources required across multiple use cases. At the same time, it is evident that EV drivers will require a combination of critical services, including charging, parking, paying etc. for which many of these services (e.g. sector convergence, wireless dynamic charging) and associated business models are yet to be fully defined or, in some cases, discovered. That said, there might also be a non-disclosed variety of techno-economic challenges that emerge as progress is made.

The aim of this paper is to define principal categories for EV charging points that are illustrated by different use cases and that hint at the major challenges. The proposed categories are below explained as a starting point:

1. Grid Operators
2. Business, Retail, Fleet charging
3. On-the go charging
4. Charging at home, in a commune, housing companies

Categories Description

1 Grid Operators

EV charging may generate strains on the electricity grid and create an imbalance in particular if charging kicks at peak hours. On the other hand, this could be counterbalanced by incentivizing and promoting both off-peak and bi-directional charging where EVs could be charged overnight in order to 'smooth the curve' while residual battery power within the EVs could be fed back into either the home or the grid itself. Nonetheless, increasing penetration of electric vehicles should reduce the overall carbon footprint of grid operators as a

[1] Commission Staff Working Documents: Preparing the ground for raising long-term ambition EU Climate Action Progress Report 2019
[2] Recharge EU: how many charge points will Europe and its member states need in the 2020s

whole. Low-carbon energy sources such as wind farms and photovoltaic (PV) systems turn energy from wind or light into the electricity needed to meet the needs of the emerging electric mobility, including commercial, industrial and residential customers.

2 Business, Retail, Fleet charging

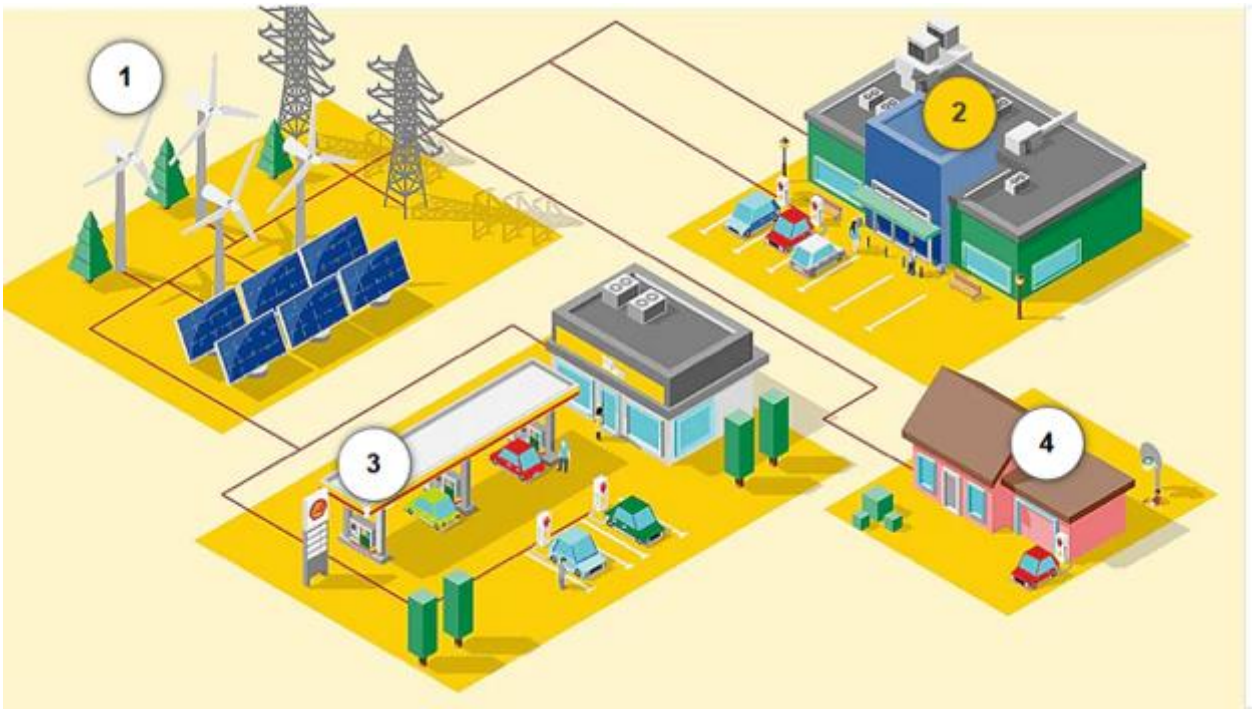
The combination of charging and parking is key to this category which targets private stakeholders that hold a capacity on private parking management, category B2B and B2C. Charging whilst parked at work or during leisure activities like shopping is a convenient way to recharge. From a business point of view, having a charge point at the workplace will become increasingly important as a facility for employees, clients and visitors. Fleet companies with electric vehicles will also seek a financial framework contract and need a reliable charging service as part of it.

3 On-the go charging

This category resembles the standard infrastructure of fuel stations. On semi-public places in cities and along highways, electric fast charging services are developed for drivers who need to recharge their vehicle during their journeys. High-powered fast or super-fast chargers (50kW to 350kW) can charge an electric vehicle in between 10 and 30 minutes, depending on the size of the battery. Apart from relevant fast-charging standards to be agreed between automotive OEMs and grid operators, it is the electricity providers to dynamically fuel the super chargers with energy – in particular during holiday periods and rush hours. In contrast to ordinary fuel stations, those on-the-go charging stations would require the possibility of careful mission planning (incl. reservation, prediction of use patterns, etc.) to provide a minimum quality of service.

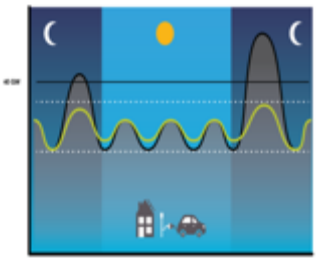
4 Charging at home, in a commune, housing companies

Central to this category is charging the EV close to one's home. Charging at home is often the most convenient and cost effective way for private customers to recharge their cars, as it is where most cars are parked overnight. It is expected that about 80% of charging will be done at home or at work. Regular charging (up to 22kW) units are wired to the central metering unit, but may require severe retrofitting of power lines/cable infrastructure, especially for multi-tenant buildings. [The wallboxes installed are usually on their own circuit for safety and to enable monitoring separate from other electric loads, need to be certified to be linked to a smart meter.]



Source: https://www.shell.com/energy-and-innovation/new-energies/electric-vehicle-charging.html

2. USE CASES



2.1. CAT 1 @Grid Operators

EV capacity for Peak Shaving

The Smart Solar Charging project in Utrecht, which was recently selected as one of five most innovative best practices in Europe of sustainable policy according to the Regiostars Awards and has received over 700k euros of EU funding, aims to store locally produced energy in car-sharing scheme EVs, which can then be fed back into the grid when demand requires. In effect this creates flexible storage capacity, which can be used to flatten the electricity demand curve (as indicated by the yellow line in the visual). The twin goals are to facilitate the transition to a greener energy system (Utrecht aims to be the first world's first city with a bidirectional electricity system by 2030) while delivering new economic activity. The 5 pilots will consider a number of applications each with different demographics and consumer needs and include a residential area, a school complex combined with park and ride, a science park, a transit hub and a railway station. One particular project, We Drive Solar, saw the deployment of 70 EVs that have a range of 300km as well as V2G technology.

More information available here.

2.2. CAT 1 @Grid Operators – Elia Group: A TSOs view

Elia Group, a group of transmission system operators (Elia Transmission Belgium, and 50Hertz Transmission in Germany), considers EV charging to have a strong potential in both increasing the flexibility of the energy consumption and exploiting the storage capacity of EV vehicles, with a strong focus on charging in particular at home and at work. With the proliferation of e-mobility, Elia Group has identified three enablers for overcoming existing barriers to EV uptake and unlocking additional value streams: (1) physical and digital infrastructure, (2) open data access and (3) market rules enabling new consumer services.

In a recently published paper, particular focus was put on the value that can be created by smartly integrating EVs into the power system, both for the EV driver and for society. Elia Group discovered clear economic and grid benefits thanks to the optimisation of the charging process by specialised third parties. Economic benefits where delivered to the consumer by shifting the charging to moments with lower electricity prices on the energy market. By planning the charging session on those moments where the market prices are at the lowest, suppliers are able to minimise their energy sourcing cost and share value with end-consumers in return.

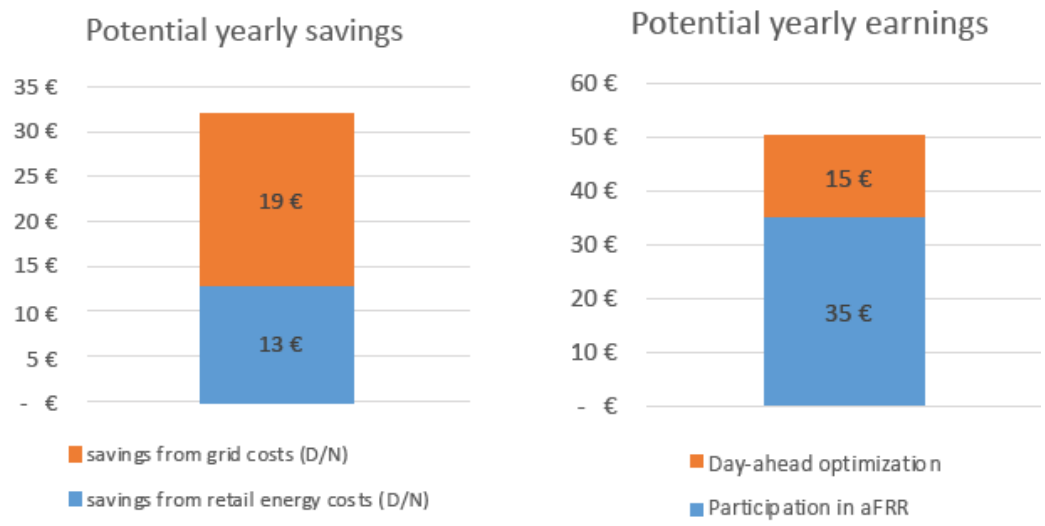
An Ecosystem Approach: 2 years ago Elia undertook a cross-sector call to support the energy transition via the IO.Energy ecosystem jointly with Belgian DSOs Fluvius, Ores, Resa and Sibelga. The approach consists in building a sustainable ecosystem of innovative companies for the exploration of new energy services to establish a consumer centric approach.

This constituted an innovative way of working with start-ups and companies from other sectors to form an ecosystem aiming to address consumer needs in terms of energy services, and to work around the technical solutions. The IO.E Ecosystem is an ecosystem built and facilitated by system operators for market parties to develop the energy services of tomorrow.

These services, the consequent digital tools and market design elements will be developed in an iterative and progressive approach from ideation to sandboxing, through demonstration towards industrialization. Off the back of this Elia together with partner companies CGI, Engie, Fluvius, Jedlix, tiko, and Voltalis, developed the Flexity use case. From a high-level perspective and in their own words, Flexity…

"..investigates which household assets (EVs, boilers,…) can be technically operated and what value can be offered to the end-consumer in return. Moreover, Flexity investigates how the digital meter can be used to facilitate the settlement of new services on residential level."

Within the Flexity use case Elia acted as facilitator to boost the development of residential flexibility offered by technical service providers (such as Jedlix, tiko and Voltalis) and flexible service providers (such as ENGIE and Voltalis). Elia did not establish an interface or a formal collaboration agreement with the automotive manufacturers (OEMs), this was done by the technical service provider (Jedlix). The connectivity that is by default present in the EV (installed by OEMs) was used, while for other type of decentralised assets such as heat pumps and boilers, additional (proprietary) hardware equipment (like a dongle or gateway) was installed. Different options for optimization of electrical vehicles are identified and applied, to manage the charging sessions of EVs, e.g. in function of (1) Day/Night prices or use patterns during the day (2) wholesale prices and (3) balancing services such as aFRR. Further investigations with ENGIE and Jedlix is schedule to understand to which extend the various optimisations could be stacked.



Example: Various optimization strategies for EV charging (Source: Flexity)

It is recognised that in order to deliver the potential benefits to consumers, important aspects such as the requirements related to data access data flows, interoperability and latency need further investigation. This needs to be navigated in a careful way that focuses on consumer-centricity, by ensuring GDPR compliance, (data) security, process transparency but also by alleviating contribution barriers in particular by analysing carefully the cost-efficiency from the consumer point of view. A standardised energy data exchange from and to the consumer via the enabling parties remains a key target.

More information available here.

2.3. CAT 1 @Grid Operators: A European TSO Platform for Millions of Household Devices

As the electricity system increasingly relies to a large extent on sustainable and fluctuating electricity generation, grid operators are looking for new sources of flexibility to keep the grid in balance. Many TSOs are traditionally dependent on fossil fuel thermal power plants to compensate for low peaks in renewable production.

Batteries from millions of households or electric vehicles have the potential to stabilise the electricity grid in the future. A new Equigy platform is being deployed to enable millions of European households and owners of e.g. electric vehicles to actively offer the flexible capacity of their cars, heat pumps and house batteries on the energy markets and as such to be able to offer their free capacity. This is attractive for grid operators to stabilise the electricity system and for consumers to earn money from the energy transition.

The platform uses blockchain technology, is able of communicating with metering devices already embedded in most flexible distributed resources, supports trading of flexibility services and allows transactions from millions of individual systems to be carried out securely, cost-effectively and transparently. Internet of Things (IoT) devices such as smart meters, smart thermostats, connected charging points etc., help to keep track of the data. As an open marketplace, all local/regional flexibility platforms can be connected to the Equigy platform so that as much flexibility as possible can be bundled. Furthermore, the technology and software used will be provided free of charge, open source as to develop secondary applications across the energy value chain.

The Equigy platform aims to both reduce the fluctuations in energy supply and replace some of the fossil fuels used with renewable energy. Through a cooperation among TSOs, they aim to create a standard framework, by which TenneT seeks cooperation with battery suppliers like Sonnen and Vandebron to exploit decentralised flexibility from domestic appliances and batteries as well as with automotive OEMs like BMW, Nissan, Fiat Chrysler et al, through the 'Bidirectional Charging Management'[3] consortium.

"The pilot project demonstrates that we can use electro mobility in the future to flexibly control the weather-dependent renewable electricity production"- Equigy

More information available here

2.4. CAT 2 Business, Retail, Fleet charging

Sonae: EVC as a service in parking and shopping

The retail company Sonai is partner in a pilot in Portugal as part of the Interconnect project that is looking at EVC as a service in parking at a retail complex. Key actors include Sonae, a leading food retailer, and Inesctec, a research institution focusing on scientific and tech development.

The core objectives of the user case are:

- Foster and promote electric vehicle use
- Attract users that already own such vehicles
- Make electric vehicle tariffing simple
- Create and offer other services

Underpinning these objectives are a number of scopes:

1. Integrated Customer Care services incl. EV charging service

Customers can leave their cars to charge while they shop with the option of two charging tariffs. The first is a premium tariff that gives them first DC charging (50 KW) as well as closer access to the front of the store. The second gives semi-fast AC charging (20 KW) and, although not as well as positioned as premium spots, gives better access to the front of the store than normal parking spots (in order to ensure EVs are prioritised as a whole over normal cars).

2. EV charging simplified – be visible as a Charging Hotspot

Customers are subject to EV charging as either a complementary service or 'pay while you park'. There is an ability to charge more or less dependent on quality of service. Furthermore, fleet services aggregate set of EVs to enhance the use of spaces

3. Parking spot operator enhanced by other car services

There is potential to integrate store marketing into the EV charging experience. Additionally, energy sourced can be both local and green courtesy of photovoltaic (solar) power sources. Finally, EVs can be maintained and cleaned by either own or third parties.

3 TenneT's participation in the "Bidirectional Charging Management" (BDL) project. BDL is a consortium led by BMW and sponsored by the German Aerospace Center (DLR) to experiment with electric vehicle batteries as a potential source of energy supply to the grid

4. Uplifting the company's Sustainability Ambition

By investing in renewable energy (solar), the company can efficiently integrate consumption of renewables during daily operations of the shop (HVAC, cooling), feeding EV charging spots.

Below is a photo of the EVC charging pilot in action:

Normal EVC spaces

Premium EVC spaces signified by the red marking

About Interconnect

Interconnect was launched in October 2019 and will receive EU funding under Horizon 2020 of just under €30 million over its lifespan. The project, through a number of large-scale pilots across various EU countries, will contribute to the digitalisation and democratisation of the energy management system through the development and deployment of interoperable technical solutions that facilitate the integration of demand-side flexibility with end-user benefits.

More information on the project is available here.

2.5. CAT2 Bike/Car sharing in Greece - Brainbox

BrainBox S.A. is a leading manufacturer and operator of sustainable mobility offering a wide range of bike sharing and car sharing products. Currently, BrainBox is the largest manufacturer of automatic bicycle rental systems (bikesharing) in Greece and Cyprus, and one of the largest specialist software development companies for machine to machine solutions (M2M), having already international presence and export orientation. Furthermore, certified by the range and quality of technological products it offers but also by the size of the projects continues to undertake and completes successfully.

BrainBox already has the largest market share in the study and implementation of shared bicycle systems. It is the largest company in the sector in Greece, Cyprus and Southeastern Europe, currently operating systems in 45 cities with more than4,500 active bicycles.

In 2018, BrainBox introduces for the first time in Greece the new proposal for the development of sustainable mobility by utilizing detection and protection systems (GPS / GPRS) using a fully automated system of shared electric bicycles for public use without dockless stations, which are controlled electronically via a special application for smartphones.

The first system of electric shared bicycles (dockless) was installed in 2018, in the city of Rethymno with a fleet of 300 bicycles. In November 2018, BrainBox placed 100 electric bicycles in Athens under the sponsorship of the company HERON, the largest electricity company in Greece.

Now, BrainBox manages more than 600 electric bicycles with integrated GPS / GPRS system in Rethymno, Thessaloniki, Kalamata and Athens. Also, BrainBox S.A. has succesfully launched in 2020 the first eCar Sharing in Greece, and more specifically in the Municipality of Vari Voula Vouliagmeni of Athens.

BrainBox SA has developed a series of software applications for mobile devices, smartphones and tablets, with extensive know-how in location service technologies (LBS), augmented reality (AR), virtual reality (VR) and immersion. BrainBox S.A. operates in the field of advanced solutions in the sectors of Telematics and IT with specialization in Sustainable Mobility.

The mobility sector is one of the fastest-growing segments of the shared economy. Part of this dynamism is rooted in creative ways of using and linking different transportation infrastructures and products, many of which already exist. Bike sharing and car sharing systems which are open to the public and serve as a form of public transportation is one of them.

The public perception of shared goods has changed substantially in the past few years. While co-owning properties has been widely accepted for a while (e.g., timeshares), the notion of sharing bikes, cars, or even rides on an on-demand basis has started to gain widespread popularity.

The emerging “sharing economy” is particularly interesting in the context of cities that struggle with population growth and increasing density. Shared modes like bike sharing, car sharing and public transit work best when they complement one another, providing a robust network of mobility options that allow riders to get from point A to point B without needing a car.

Over the past years, mobile technology and electric mobility have driven ebike sharing and more and more ecarsharing services. Even though the term carsharing includes different types of service, the model that has seen the most growth in the last few years in cities like Madrid and Barcelona consists of temporarily using vehicles for brief periods of time (measured in minutes or hours) to travel short distances in cities or their surrounding areas.

Across the free-floating car-sharing landscape, we can see that services adding electric cars to their fleet can be found all across the continent. Multiple analysis shows that overall, about 25% of car-sharing providers worldwide already operate a 100% electric fleet and that this trend is increasing.The increased focus and pressure on zero emission vehicles are one of the reasons why we see more and more carsharing and bike sharing services adding electric vehicles.

2.6. CAT 2 Business, Retail, Fleet charging: Parking and charging at work

With the increasing interest in electric vehicles, a number of necessary changes to infrastructure need to be realized, from retailers introducing EV charging points with customer parking, to electric car charging points for businesses. Large corporate business are determined to offer employees and visitors a smart charging solution to satisfy a growing need and are engaged in managing fleets of EVs. (see Newmotion website)

- Large office complexes may need to think about employees who require electric charging points for vehicles they drive to work
- Businesses or public sector with an electric commercial fleet – such as a logistics company, for example – will require commercial electric car charging stations to accommodate large numbers of company-owned vehicles
- Companies based around individuals driving a fleet of electric cars that are individually owned – such as a taxi firm – could benefit from offering electric vehicle fleet charging on the premises
- Leasing firms with electric vehicles on offer will need to ensure that there is sufficient charging so that models from electric car companies can be tested and demonstrated

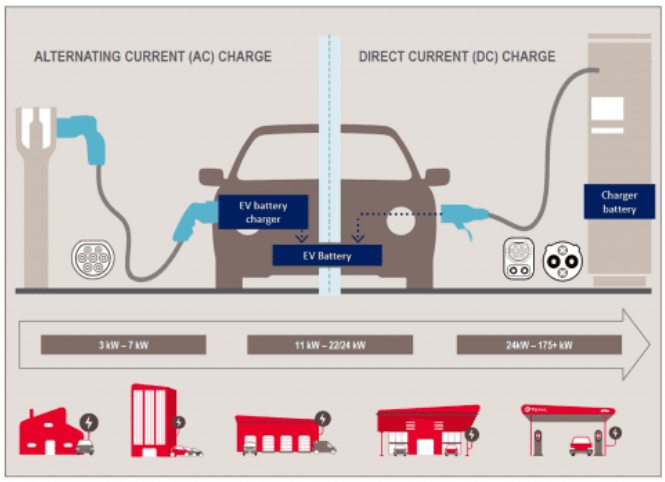
Deployment of EV charging infrastructure for fleets or corporate use will bring opportunities to run that equipment in a collective mode more efficiently and cost effectively. Corporate users might be interested in a business package, e.g. a package bundling mobility and charging services that includes consent for data access and processing. This case helps fleet operators to optimize energy and vehicle use by setting driving schedules and routes, charging intervals, and vehicle maintenance in alignment with customer demand, power prices, traffic conditions, and charging-station availability. For utilities, EV fleets represent a particularly promising segment of community charging, which may include V1G and V2G services to reduce strains on grid balancing and provide economic incentives for procuring energy services for a bespoke community of EVs or EVCs. In practice, charging points are connected to the internet – the corporate or the fleet operator has knowledge about the average use pattern of the EVs, e.g. related to office hours and habits. Practical experience has been gained that it is technically feasible to provide FCR (Frequency containment reserve) different types of actions that can be taken to balance the grid power at 50 hertz.

2.7. CAT Using electric vehicles to accelerate energy transition

BovLabs from France is offering solution to optimize every charging cycle.

- **Objective:**
  - Optimize energy management on local auto-consumption grids especially using smartcharging and V2G
- **Partners:**
  - A consortium has been created to carry out this project gathering SNCF Gares & Connexions, the startup Bovlabs and Nissan
- **Context:**
  - This pilot project has been realized on one of the biggest mobility hub of the Region Sud, the AIX TGV train station that was seeking for innovative solutions to optimize its energy consumption and to prevent from potential blackouts. The train station offered a perfect experimental field with a local auto-consumption grid composed of several distributed energy resources (DERs): V2G EV charger + V2G car, solar panels and ground batteries storage
- **Solution:**
  - The startup Bovlabs proposed a set of energy services and functionalities through its software platform using smart agents distributed and connected to all DERs of the station local grid.
  - This platform is using a scalable secure blockchain network to:
    - Record peer to peer distributed energy transaction
    - Track and record every kWh of energy produced and consumed, certifying the source of energy
    - Verifying transactions using smart contracts linked to DERs
  - A smart charging algorithm based on machine learning models is used to derive a unique charging profile based on user inputs (a user mobile application allows EV's owner to define their time of arrival/departure/minimum energy level required…), energy arbitrage, demand charges and demand response programs
  - V2G flows were tested for auto-consumption and demand response services
  - Energy transactions tokenization has been tested to incentivize EV owners in the future using loyalty points for participation and thereby reduce their parking fees
- **Results:**
  - This successful pilot has lasted 2 years recording 3 million energy transactions and provided the train station with the best approach towards the scaling of charging infrastructure and how EVs in the long term parking segment could be a backup strategy for grid resiliency.

2.8. CAT3 @ On-the go charging with Total



Total is a French multi-energy group, with 100.000 employees, producing and distributing fuels, natural gas and electricity. Total is committed to more sustainable energy, being more affordable, safer, cleaner and accessible to a wide range of private and professional customers. Present in more than 130 countries, Total's ambition is to become the major provider of sustainable energy.

At workplace: 40% of charging sessions happen at workplace. Employees charge their electric vehicle rather it is a personal car or a company car. On the road: 15% of charging sessions are made on roadways or when visiting commercial locations. At home: 40 % of charging sessions take place at home. Total provides a charging solution for your private driveway or for your residential parking lot. You will be able to plug either your personal vehicle or your company vehicle.

At service station: charging in service stations represents 5% of electric charges. Drivers mainly use this option when travelling long distances on the highway. Total ambitions to deploy 150.000 charging point In EU till 2025. For drivers to access reliable EV charging service anywhere at any time, TOTAL is building a network of high-power charging stations across western Europe.

Two technologies exist in the field of charge points for electric vehicles: alternating current (AC) chargers and direct current (DC) chargers.

AC chargers meet the most frequent charging needs: charging at the workplace, at home, or at destination (commercial sites). The user takes the opportunity to charge their electric car while it is parked. We offer a range of charge points featuring shared and distinctive characteristics.

DC chargers can provide up to a 175kW charging power, such as the charge service offered in Total's service stations. Depending on the EV technology, DC charging can be used to to-up the battery quickly if needed, for example for long journeys or between rounds.

Total offers the AC 7kW suitable solution for charging vehicle remaining parked for a long period of time (at least ½ day). For charging in a shorter time, like 1 or 2 hours, the AC or DC 22 kW chargers are available and for fast charging requirements the 50 kW+ DC models.

2.9. CAT 4 @Home – the commune takes an initiative for local parking management

Toronto: EVC for residents without their own parking space

Problem: “How do I charge my EV overnight without a driveway?”

Solution: The commune may adapt its policy for parking lots in residential areas. Toronto city has partnered with an energy supplier and an EV charging provider and installed a number of EVCs around residential areas in the city. The trial will last a year, through which the effectiveness of the solution will be determined. This is an important trial at 71% of residents suggested they were likely to buy an EV in the next 5 years, with the rate increasing if more charging points were available.

Benefit: Through the use of a special permit, the EVCs will give locals access to the overnight charging that will cost only $3. However, recognising the fact that a lot of locals will use their cars for commuting during the day, they will be available for unfettered access to anyone throughout the day at a cost of $1.50 per hour. What’s different about this solution is that instead of lots of standalone, bespoke EVC units having to be installed, the provider attached the charging points to existing utility poles.

More information is available here.

2.10. CAT 4 @Home – A City’s Approach for Smart Park and Charge

VMZ supports the Berlin Senate Department for Environment, Transport and Climate Protection (SenUVK), providing services on traffic automation and city-friendly mobility in Berlin

As part of this VMZ runs the editorial office of the Berlin Traffic Information Center and operates the corresponding websites information services. Location and accessibility of publicly accessible charging infrastructure is a basic topic of this information platform.

The info platform provides information on more than 1000 charging points in public street space which are usable for EV-Drivers. With this, the state of Berlin operates a high basic range of charging infrastructure for electric vehicles in public street space to make the entry into e-mobility sufficiently attractive. In addition, the number of publicly accessible charging points on private space is growing continuously - a process that will continue in the future and make charging points in semi-public spaces and residential areas more important. Current studies (including that of the SenUVK) show that the future share of demand for charging infrastructure will increase more for private (at home or at work) or publicly accessible areas in the private sector (in customer parking lots, at gas stations).

Associated with the growth of e-mobility and the use of charging infrastructure in public and semi-public space is the increasing need and possible reservation of parking spots at charging stations. Accordingly, VMZ explores new concepts and information services on "boosting and facilitating the collaboration of charging point operators, e-mobility providers, housing companies and the city, in designing and implementing new business models that combine parking and charging services in public and semi-public space".[4]

In line with this ambition, some of the questions that they are looking to answer are as follows:

- How can the provision and usage of public EV stations on public ground be increased?
- How to optimize the number of public charging stations in a city - be relocated to private and semi-public areas?
- How to optimize the use of charging infrastructure on publicly accessible private space by reserving charging station parking spaces?

The information service that help evaluate the impact of reservation of parking spots at charging station in semi-public areas is presented here

2.11. CAT 4 @Home – An economic model for Housing Companies for EV Charging

Gewobag

Gewobag is a German municipal housing company that at present manages around 70,000 housing units and 120,000 tenants in Berlin. The company recognises the role of mobility in the lives of its tenants and, as such, is motivated to consider how mobility solutions can be integrated into their living and housing offering to enhance tenants' lives in Berlin. This is particularly relevant in relation to the EV and EVCs, where for housing companies (i) there is not a reliable, clear and simple legal framework for implementation; (ii) investment requirement in EVC infrastructure is considerable, while payback path is unclear (lack of clarity around business model) and (iii) in particular for Gewobag and equivalent for other German housing companies, to comply with tenant's claims for a EVC installation.

[4] E.g. see EU Horizon2020 funded e-mobility project MEISTER www.meisterproject.eu

Actually, recent German legislation has facilitate the installation of charging infrastructure in multi-family houses for the benefit of the tenant of an apartment. For a housing company such as Gewobag it is the ambition to comply with the legal claim of the tenants to get access to a EVC point and find a scalable and sustainable solution to up-grade its existing electricity infrastructure; this creates a challenging environment where they run the risk of a mushrooming of technical solutions in building complexes that hinder the delivery of a cost-efficient and resilient operation of its infrastructure with regards to electricity and parking space. Gewobag considers solutions (i.e. integration of parking and charging into a combined service) for residents without a parking space as one of upmost importance. Addressing the business model challenge, Gewobag has suggested two basic economic approaches:

- Rental fees for parking spots equipped with EVC (i.e. single user of a parking spot, TCO with tenant) that enable the recouping of investment. This can be done in new buildings and major renovations of residential and non-residential buildings. The electricity infrastructure would have to be gradually up-graded with the usage cycles of EVC
- Public charging on semi-public grounds that enable the recouping of investment through electricity sold. Opening up the parking space to a wider audience like residents living in the area or even to the wider public has the beauty of increasing the duty cycle of the EVC and as such be economically feasible through a commercial offer. A rental fee for the ground and/ or the overhead of energy service provision (booking, charging, identification and billing) may be supported by the city or the commune while the adaptation cost of the electricity installation would need to be covered by the housing company

2.12. CAT 4 @Home – TESLA's mobility platform tapping on flat energy prices

Manufacturers of EVs aim at extending the user experience through a platform approach, including the provision of integrated mobility services, such as special parking arrangements in cities, charge point reservation, navigation/trip planning, integrated payment or special charging tariffing. Digital-native companies like Tesla provide those incentives to be granted access to user data, their profile, use pattern, preferences and habits – as known from other digital platforms like Apple or Google. For providing additional platform services and nurturing a vibrant ecosystem around these services OEMs need to engage with partnerships and make technical and economic arrangements outside their sector, e.g. with electricity grid operators.

A multi-sided marketplace

The bespoke platform for user data gives Tesla a unique position to bundle mobility and energy services and to tailor its services to the context and use pattern of its users. Tesla, traditionally known for their focus on the development and manufacturing of EVs, is planning a move into the decentralised power sector in cooperation with Octupus Energy. Homeowners that have a Tesla Powerwall and an installed solar system can be part of the Tesla Energy Plan. This gives customers access to a very low, flat rate electricity tariff (£0.08 p/kWh for those who have both a Powerwall and a Tesla EV vs £0.12 p/kWh for those who have a Powerwall without a Tesla EV) that Tesla claims can save customers 75% on their energy bills (vs the 'Big Six' with consumption of 8000 kWhs). Tesla can offer this, by customers giving Tesla management and control functions of the Tesla Powerwall, which it then uses to "draw, store or feed electricity back into the grid as required". Normally, the Tesla Powerwall acts only as a temporary storage unit for locally generated solar electricity that is then subsequently used to power the home within which it is directly located. Even if a customer has signed up for the Tesla Energy Plan, the Tesla Powerwall still retains 20% capacity as and when it needed for the primary home.

More information is available here.

2.13. CAT 4 @Home – A magic box to link solar and charging

EEBus is a solution provider in the area ofhome automation, home appliances and energy management. The company is currently looking at a number of grid and e-mobility user cases, including one that looks at bidirectional EV charging or vehicle to home (V2H). At the core of this user case is the ability to enable the battery of the EV to power the household. Using EEBus communication protocols and energy management system (EMS) the EV will be applied to (i) temporarily store PV energy, (ii) make PV energy available after sunset and (iii) ease strain on DSO at peak time. This will ultimately increase user 'self-consumption'.

An energy management system (EMS) is installed together with a wallbox and/or the acquisition of solar panels, which links both solar power generation with EV charging.

In line with the EEBus user case described, the UK's OVO Energy is currently running a V2G trial where, in partnership with the government and Innovate UK, they have installed bi-directional EV chargers in 300 homes. The trial triggered consumption in a household at hours when the sun is shining through flexible energy tariffs. It has been deemed a success, demonstrating significant cost savings for EV drivers of up to £800 p/y delivered through smart charging / electricity price optimisation. Their focus now moves onto how to roll the technology out, which they stress will be heavily influenced by policy and standards.

EEBus is a non-profit association in the energy management sector. Working across industry, EEBus has the aim of creating a "standardised language for energy" that will facilitate the move towards a more intelligent, digitised, interconnected, integrated and sustainable energy system. In this system, real time information is exchanged between the grid (supply) and components (demand) in a way that helps modernise the system to cope with new sources and storage of energy as well as changing consumer needs.

More information is available here and a video overview (courtesy of the BBC) is available here.

3. e-Kinesis use case: Technology and methodology for efficient EV charging

e-Kinesis is a Greek start-up specialized in battery electric powertrain technology. Since 2017, the company develops innovative technologies to support:

- conventional vehicles electrification through retrofit
- eV charging and
- eV fleet deployment

Nowadays, electric vehicle charging optimization is becoming increasingly important to efficiently deploy electric vehicle fleets. Charging a fleet of electric vehicles is a complex task, requiring consideration of multiple factors ie. vehicle model and battery capacity, vehicle routing, available charging power, energy consumption by vehicle's auxiliary loads etc. Thanks to e-Kinesis competence in computational engineering, the state of the art electric vehicle simulator *ARCHIMEDES* has been developed in-house, allowing for modeling and simulating performance of the complete eV, as well as for depicting performance characteristics of the vehicle's subsystems, such as the electric motor, battery, transmission etc. Instead of employing statistical or empirical correlations, *ARCHIMEDES* is based on fully physical models, which enable phenomenological prediction of eV performance.

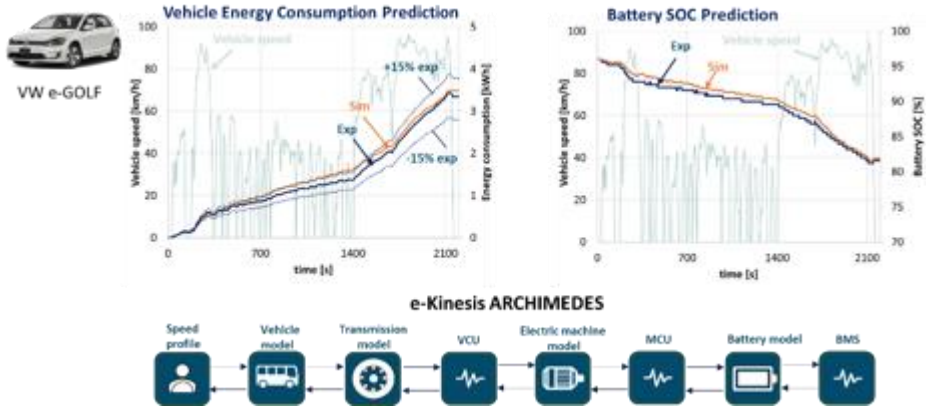


Figure 1. Benchmarking between ARCHIMEDES simulation results and experimental data regarding energy consumption & battery SOC during driving cycles on a VW e-GOLF.

Employing the vehicle simulator *ARCHIMEDES*, e-Kinesis has developed an innovative approach for eV charging planning. According to the proposed methodology, *ARCHIMEDES* is combined with geographical information system (GIS) software, traffic data, as well as data bases related to electric vehicles and chargers specifications, allowing for defining charging locations, designing charging infrastructure and proposing optimum eV charging planning. The aforementioned workflow can be customized in order to be applicable to various vehicle segments and vehicle use cases, hence covering a broad range of applications.

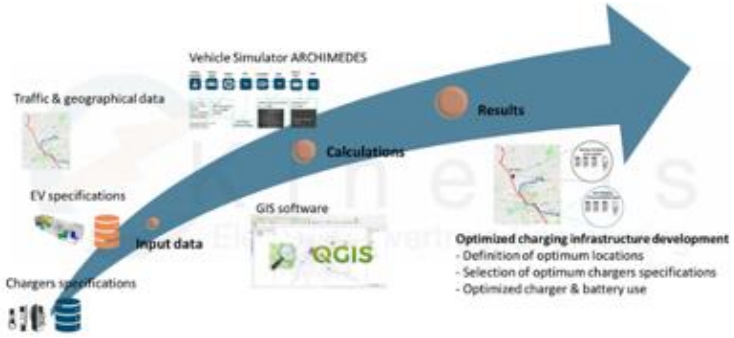


Figure 2. e-Kinesis workflow for optimized eV charging planning.

The proposed methodology has already been demonstrated for real use cases. In 2020, e-Kinesis eV charging planning workflow, was applied for defining charging points to serve eVs owned by the Municipality of Vyronas in Attica, Greece. First, locations of charging points were defined employing GIS software. Subsequently, using *ARCHIMEDES* it was possible to properly size respective charging stations, in order to meet requirements of daily charging events corresponding to municipality's eVs.

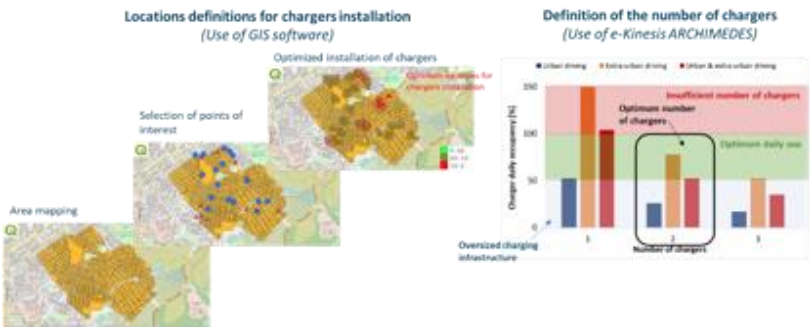


Figure 3. Application of e-Kinesis eV-charging planning for the Municipality of Vyronas, Attica.

Recently, e-Kinesis charging planning has been demonstrated for planning charging of electric van fleets. In this use case, the Nissan e-NV200 light duty commercial vehicle has been selected. Accounting for traffic data and daily vehicles' routes and employing e-Kinesis *ARCHIMEDES* it was possible to analyze various charging scenarios and evaluate different charging solutions, leading to a combined optimization of both charging infrastructure and vehicles routing.

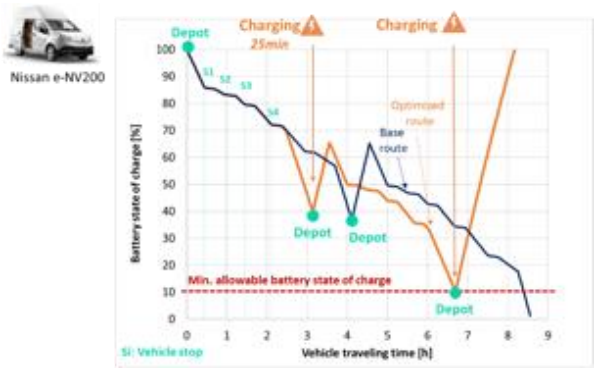


Figure 4. eV charging application for e-vans fleet charging.

4. CONCLUSIONS

Smart energy management

The goal of optimal energy management in the context of EV charging is related to two concepts, the first one is optimisation of RES resources utilisation for EV charging, the second one is optimisation of overall charging process and the flexibility services provision to the market.

Off-peak charging can avoid peak energy demand spikes and enable price optimization that delivers lower costs for consumers as well as grid operators through lower hourly day ahead rates on the wholesale energy markets.

Charging based on carbon intensity and within available regional flexibility markets or contributing towards the available flexibility markets while adding flexibility resources. If the smart energy management adequately addresses carbon neutrality, the stakeholders are positively contributing to the UN's sustainable development goals 7, 11 and 12

Key takeaways:

- Promotion of smart energy management by grid operators to consumers
- Multisided participation in services provision from prosumers side
- Clear demand signals are needed from the grid operators as well as market signals

Bidirectional charging

Energy management systems (EMS) and bidirectional charging will enable EVs to play a complimentary role in the energy system where residual power can be used to (i) power household appliances (V2H) and / or (ii) be fed back into the grid which taken together can help maintain grid power balance contributing to system flexibility and evolving demand response evolving models.

Key takeaways:

- Represents a fairly complex value chain. Promotion of agreements of bidirectional charging with grid operators, business like taxi, retail, large corporates and consumers
- Interoperable solutions should be priorities
- Harmonisation

Usability

Requirement for user experience to be seamless in relation to the way to reserve, the tariffs (e.g. pay as you go) and charge options available (e.g. fast AC vs slower DC) and the payment methods.

Key takeaways:

- Sharing of best practices
- Barriers removal for multisided participation in services

Incentives and other services

Opportunities to promote usage (e.g. through positioning of parking places in the shop), other value-added services (e.g. marketing offers) and transition to a green economy by enabling charging through local renewable energy sources.

Key takeaways:

- Sharing of best practices

Local infrastructure

A high priority is residents without driveways. Local municipalities should work across sectors to consider infrastructure (e.g. integration into existing utility network or roll-out of bespoke stations) and soft (e.g. permits) solutions in both public and semi-public areas.

Key takeaways:

- Raising awareness of need to address this particular use case with urgency
- Creation of a fora across municipalities

Investment, business models and legalities

In the case of Housing companies, they want to serve the EV needs of their tenants but currently face deterrents such as the investment required, an unclear business model as well as legal uncertainty.

The evolving market design will impact business models evolution and demand response models.

Key takeaways:

- Support cooperation across the value chain, supports pilots and trials in sandboxes to experience on business models

Cross cutting issues

Digitization (e.g. smart meters, thermostats, connected charging points etc.) **and data essential**.
Data governance and consent to data sharing remains to be a blocking factor for innovative energy services

- Creation of a European Data Space for Energy
- Establish transparent and replicable standards for data semantics, security and trust
- Horizon Europe and Digital Europe programmes funding of research and innovation actions

Standardized data communication protocols and interfaces across the actors / different sectors involved is instrumental, open access to SMEs and innovators desirable

- Standards put in place
- Validation of emerging interfaces and protocols through pilots / experiments with further outlook on scaling up

All user cases require strong collaboration across key stakeholders involved including OEMs, grid operators, local government etc.

- Creation of an open platform to agree on interfaces and a governance model
- IO Energy to support open APIs

The co-existence of different e-vehicles, including LEVs (light electrical vehicle) requires every time more, a Standardisation in terms of the e-charging points

- The increase of electric vehicles should be supported by infrastructures able to offer charging solutions for all of them

Electrification is a significant prospective contributor to shared passenger mobility with potential positive benefits in terms of efficiency improvements, cost reductions, and reduction of carbon emissions. That is especially the case in the last mile solutions and in an urban environment.

- Complement other modes of mobility of transport in the sharing economy
- Work towards increasing user acceptance of shared goods through demonstration and promotion
- Deliver one-stop-shop solutions

Regulations and usage schemes
A real deployment of electrical vehicles should be supported for the regulations that make possible a real usage of the infrastructures (common card to access to the charging points, maintenance requirements, etc).

About AIOTI

AIOTI is the multi-stakeholder platform for stimulating IoT Innovation in Europe, bringing together small and large companies, start-ups and scale-ups, academia, policy makers and end-users and representatives of society in an end-to-end approach. We work with partners in a global context. We strive to leverage, share and promote best practices in the IoT ecosystems, be a one-stop point of information on all relevant aspects of IoT Innovation to its members while proactively addressing key issues and roadblocks for economic growth, acceptance and adoption of IoT Innovation in society.

AIOTI's contribution goes beyond technology and addresses horizontal elements across application domains, such as matchmaking and stimulating cooperation in IoT ecosystems, creating joint research roadmaps, driving convergence of standards and interoperability and defining policies. We also put them in practice in vertical application domains with societal and economic relevance.