Project acronym: eVolution2Grid

Project full title:

Innovative Vehicle to Grid model for electric mobility deployment in Europe

Project start date: 01/06/2018

Title: **D1.2 TECHNOLOGICAL BENCHMARK OF V2G PILOTS PROJECTS**	
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Disclaimer

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List of abbreviations and Definitions

Abbreviation	Definition
BEV	Battery Electric Vehicle
CO_2	Carbon dioxide
AFID	Alternative Fuel Infrastructure Directive
DSO	Distribution System Operator
EC	European Commission
EM	European Member
EU	European Union
EV	Electric vehicle
FCEV	Fuel Cell Electric Vehicle
LCA	Life Cycle Analysis or Life Cycle Assessment
MSs	Member States
PEV	Plug-In Electric Vehicle
PNIRE	Piano Nazionale Infrastrutturale per le Ricariche dei veicoli ad alimentazione Elettrica
RES	Renewable Energy Sources
TSO	Transmission System Operator
US	United States
V2G	Vehicle To Grid

Definitions

- ***Electric Vehicles*****:** (EVs), according to EU Directive 2014 94 UE means "a motor vehicle equipped with a powertrain containing at least one non-peripheral electric machine as energy converter with an electric rechargeable energy system, which can be recharged externally".
- ***Charging infrastructure*****:** supplies electric energy for the recharging of electric vehicles, such as plug-in electric vehicles, including electric cars, neighbourhood electric vehicles and plug-in hybrids.
- ***Smart grids*****:** intelligent interconnected network which allows distribution and exchange of energy in a bidirectional way.
- ***Vehicle 2 Grid (V2G)*****:** describes a system in which electric vehicles, communicate with the power grid to sell demand response services by either returning electricity to the grid or by throttling their charging rate.
- ***Electric Vehicle Supply Equipment (EVSE):*** The equipment able to supply, and recharge an electric vehicle
- ***Rechargeable Energy Storage System (RESS)*** *Include the EV battery and HEV battery*

Summary

This deliverable aim to produce an analysis of the main pilot projects of V2G in Europe and above, identifying the main aspect for every project, limits with the main focus on the V2G concept i.e. the bidirectional energy exchange between vehicle/charging station and electrical network, which is the core subject of study of the "V2G" EME project.

The main objectives of the eVolution2G - V2G project is to develop, test and optimize an integrated V2G solution. The V2G project is currently in its initial phases and this deliverable (D1.2) will be used as guidance to describe the state of the art of technics of V2G in Europe, to be taken into account in the project's activities.

The document also focus on some KPIs definition taking into account the different assets and stakeholders involved: these KPIs are the output of technical and market requirements for all components of the proposed solution and the KPIs acts as a metric for the project pilot and testing facility.

Finally the main technical standards for V2G are listed and described for reference.

1. V2G project

"V2G-eVolution 2 grid" project is a research innovation project funded under the Programme Electric Mobility Europe 2016 and coordinated by IREN. The overall objective of the project is to contribute to a zero CO_2 emissions future, developing testing and optimizing an integrated V2G solution composed by a light quadricycle enabling V2G, a bidirectional V2G-enabling charging infrastructure and an Energy Management and Control System. During the project, the novel integrated solution will be tested in real simulated conditions in two real case studies (public and household), evaluating benefits and obstacles at technological and regulatory level, assessing its business potential and creating awareness about the results of the project, engaging stakeholders, public administrations, car owners, etc. The consortium is composed by 3 companies (1 large company and 2 SMEs) and a research group, all coming from Countries and Regions directly participating to the EME Programme. In particular, the partners are: IREN (coordinator, Large company, ITA), MECAPROM (SME, ITA), CTC (SME, GER) and Aalborg University (research group, DEN). The project activities are divided into 5 complementary and interlinked work packages and 14 Tasks, with a coherent timing, and distribution of roles and responsibilities among all partners.

In particular, WP1 focusses on defining all technical, functional and market requirements (i.e. grid, vehicle, charging stations, integrated system) and analysing the status quo of legislations and regulatory schemes on EM in Europe and the existing pilot testing solutions.

2. The future of e-mobility: the V2G paradigm

R&D and industrial organizations are working to improve and promote V2G paradigm also through the development of several pilot projects, some of which are already close to the commercialization or with high TRLs (Technology Readiness Level). Globally, we mapped 50 V2G projects, of which 25 are in Europe, 18 in North America, and 7 in Asia. In Europe, Northern European states dominate the presence of pilots with the Netherlands, Denmark, UK and Germany (Fig. 3) [24].

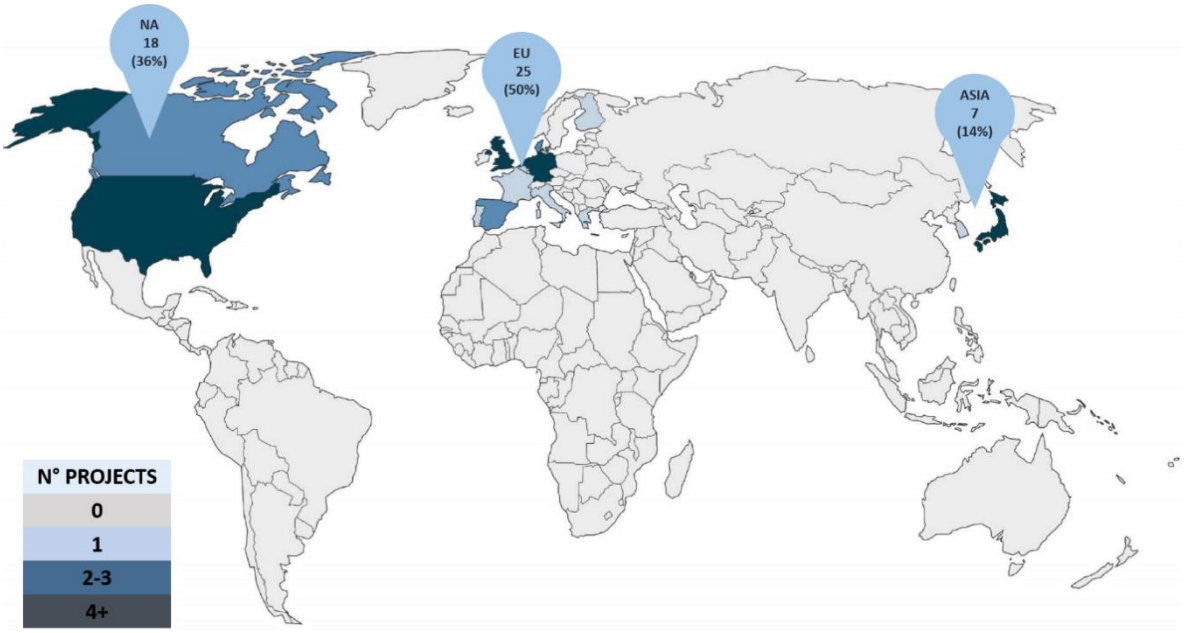


Figure 3: Revised picture from "V2G Global Roadtrip: Around the World in 50 Projects" report

We present here a list of some European pilot projects which have demonstrated to play a crucial role in the V2G development, focusing the attention on DSO services, impact on the customers, with more information on the Country, years of the project, status of development (TRL) and brief description [24]:

- *"Smart Solar Charging"*, Netherlands, 2014-2019: TRL 7. It is a pioneering AC V2G project with 22 chargers installed as part of city car share scheme and solar in Lombok neighbourhood. The core focus of this project, coordinated by Lomboxnet, is developing an AC standard for V2G and developing a system that facilitates and speeds up the rollout of electric vehicle, in particular using the Renault Zoe as vehicle, Stedin as DSO and solar power. Chargepoint will be market ready by end of 2018.
- "City-zen Smart City", Netherlands, 2014-2019: TRL 7. It has a pioneering focus on DSO services and adopts a holistic commercial, social and technical approach, with multiple power sector use cases. The network is composed by the charging station supplier NewMotion (4 chargers installed), the network specialist Alliander, the tech company Enervalis and the innovation platform Amsterdam Smart City.
- *"Parker",* Denmark, 2016-2018: TRL 9. The technology used by the project has been thoroughly tested and validated and it is ready for the commercialization, using high number of charger infrastructures (50). It includes Nissan vehicles (and others), charging infrastructure ENDESA and aggregation software NUVVE. Project sought to test ability of

electric vehicles to provide grid services using real world fleets to identify and address barriers to commercialisation and to compare capability of different cars. Parker builds on two previous projects, the EDISON and Nikola projects, which have already laid the foundation for understanding the electric vehicle's potential in balancing the Danish power system.

- *"Grid Motion",* France, 2017-2019: TRL 9. The project, ready for the market, with 15 chargers installed, is intended to evaluate the savings EV users could achieve under real-life conditions with the implementation of smart charging and discharging. The project uses Peugeot iOn or Citroën C-ZERO vehicles with Enel bidirectional charging stations testing "smart" charging and discharging (V2G services) and NUVVE as aggregator.
- *"Network impact",* UK, 2017-2020: TRL 7. The project aims to understand impacts (negative and positive) and interconnection process for V2G-enabled EVs on the distribution network. Scope also includes investigation of commercial options for connection offers and customer usage behaviour. Northern Power Grid (NPG) monitors the installation of chargers commercially installed by NUVVE, with 16 chargers installed.
- "Re-dispatch", Germany, 2018-2021: TRL 8. Partners of the project are the transmission system operator TenneT, the energy service provider The Mobility House and the automotive manufacturer Nissan. This is a demonstration project proving technical ability to use TSO's own field service fleet in addressing transmission constraints in Germany. Highly distributed chargepoint locations with 10 chargers installed.
- The ACES project [59] is being developed in the Bornholm Island from the insights of the Parker Project. This pilot project will involve up to 50 vehicles (Nissan vehicles) and chargers that will be used to balance the electric system. NUVVE provides technical support an aggregation services for both projects. The local utility Bornholm Energi & Forsyning (former Østkraft) participates into the project in order to provide data and benefit from the analysis and small-scale pilot run in the project.

Although other OEMs participate in V2G projects, Mitsubishi, Nissan and Renault clearly dominate the market and the R&D and piloting efforts, with Mitsubishi iMiev, Mitsubishi Outlander, Nissan Leaf 2. ZERO, Nissan eNV200/Evalia, Renault Zoe.

What is clear from these pilot projects is that the electricity network and market services are underrepresented in the V2G field since the market value is unclear and the service specification and route to market are not normally well understood. This appears to reflect lack of service maturity more than inherent V2G model gaps. Moreover, DC solutions have dominated to date, with DC chargers featured in 93% of projects (Fig. 4) [24] However, there remains significant interest in AC, with more AC compatible vehicles expected to be tested and validated over the coming years. DC chargers use the CHAdeMO protocol. CHAdeMO is a DC charging standard for electric vehicles and it was the first ever global fast charging protocol for EVs. It enables seamless communication between the car and the charger [25].

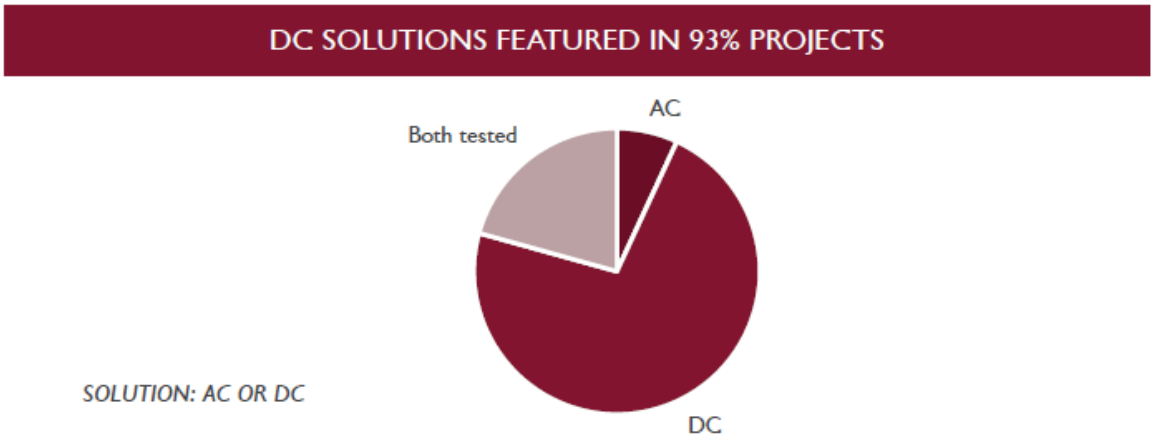


Figure 4: DC solution have dominated to date with DC chargers featured in 93% of projects. However there remains significant interest in AC, with more AC compatible vehicles expected over the coming years.

3. V2G pilot projects in EU

N1 Project name **NewMotion V2G project**

- **Partners** Mitsubishi motors, Enel, NewMotion, Nuvve and TenneT
- **About the project** High-end smart technology optimizes use of renewable energy. NewMotion, one of Europe's biggest providers of smart charging solutions for electric driving - announces the implementation of a bi-directional loading pilot, also known as 'Vehicle to Grid' (V2G). With V2G-technology, peak demand on the electricity grid can be better balanced, by allowing electric vehicles to not just take power from the grid, but also return it to the network. NewMotion joins forces with Mitsubishi, and grid operator TenneT using V2G chargers from Enel and grid services and technology from Nuvve. The pilot features the popular Mitsubishi Outlander PHEV.
- **Project characteristics/Keyword** Electric vehicle as energy buffer. Stability by maintaining supply-demand dynamics, based on request from Grid System Operator
- **Location** Amsterdam
- **Aggregator** NewMotion/NuVve
- **Energy market/Trading** **Frequency** regulation services
- **Incentive/Business model** Not known
- **Scale (Number of V2G charger, EV's, boundary conditions)** 10 EV drivers
- **Running time of the project** Announced 2017 October
- **V2G hardware providers (CCP)** Enel
- **Charging point Operator/ Owner (CPO)** New motion
- **Charging standard/Protocol** CHAdeMO
- **Subsides** Not known
- **Operational environment (Type)** Vehicle-to-Business (V2B)

N2 Project name **Amsterdam Vehicle2Grid**

- **Partners** Alliander, Hogeschool van Amsterdam, Amsterdam Smart City, Engie, Mitsubishi motors
- **About the project** Vehicle-to-grid (V2G) technology enables electric cars to be used as (temporary) batteries, for example to power households. The supply of solar power is growing rapidly. That is a great news as our daily energy demand is increasing too. We could however benefit even more from this growing supply if we would be able to store the generated electricity in times of overproduction. Electric Vehicles offer great storage potential. Additionally, by combining multiple batteries, accumulated capacity can become large enough to effectively prevent unbalance in the electricity grid. In the demo environment in Amsterdam, several bi-directional chargers, needed to charge and discharge the batteries, will be installed to be tested by Alliander.
- **Project characteristics/Keyword** Solar and V2G combination to store and supply electricity as and when required. Energy buffer solutions and societal issues are explored in this project.
- **Location** Lochem
- **Aggregator** Not appointed
- **Energy market/Trading** Investigated different markets: among others frequency Imbalance Market/Energy Storage
- **Incentive/Business model** For the pilot: user receives a financial compensation. Integration of local/household renewable energy.
- **Scale (Number of V2G charger, EV's, boundary conditions)** 2 households in Lochem, Gelderland
- **Running time of the project** until end of 2017
- **V2G hardware providers (CCP)** Endesa/MagnumCap
- **Charging point Operator/ Owner (CPO)** Engie
- **Charging standard/Protocol** CHAdeMO
- **Subsides** Not known
- **Operational environment (Type)** V2H

N3 Project name **SEEV4-City**

- **Partners** 13 partners from 5 cities across Europe (Amsterdam Arena, HvA, UNN, CENEX, AVERE, POLIS, Municipality of Amsterdam, Leicester, OSLO Kommune, KU LEUVEN
- **About the project** The main aim of SEEV4-City is to develop the concept 'Vehicle4Energy* services' into sustainable (commercially and socially viable) business models to integrate EVs and renewable energy in a Sustainable Urban Mobility and Energy Plan (SUMEP)..* - (The implementation of Smart Charging (where the timing of EV charging is controlled to benefit network operation), V2G (where EVs are used as energy stores, enabling a better balance to be achieved between energy supply and demand) and the other 'ancillary' services they can provide are collectively known as 'Vehicle4Energy Services' or V4ES).
- **Project characteristics/Keyword** NSRSmart charging and V2G concept. Operational environments: V2H, V2S, V2N and V2B Reduction in 150 tons of CO2 emissions/annum25% increase in Energy Autonomy Avoid potential grid investments up to 100M Euros in 10 years
- **Location** Amsterdam Arena, Loughborough, Oslo, and Leicester
- **Aggregator** Work in progress

- **Energy market/Trading** Work in progress
- **Incentive/Business model** Not known
- **Scale (Number of V2G charger, EV's, boundary conditions)** 6 operational pilots, 4 countries (50+ EVs) In the Netherlands - Amsterdam (52 Charging poles, smart charging enabled, no V2G yet) Amsterdam Arena (2 V2G units is being installed). In total 5-6 V2G units.
- **Running time of the project** 2016-2020
- **V2G hardware providers (CCP)** (For Amsterdam Arena -Magnup Cap) to be decided for other pilots
- **Charging point Operator/ Owner (CPO)** Not known
- **Charging standard/Protocol** CHAdeMO
- **Subsides** Not known
- **Operational environment (Type)** Vehicle-to-Home (V2H), Vehicle-to-Street (V2S), Vehicle-to-Neighbourhood (V2N) and Vehicle-to-Business (V2B)

N4 Project name **SMART Solar Charging, Utrecht, NL**

- **Partners** Utrecht Sustainability Institute, LomboXnet, Hogeschool Utrecht, Universiteit Utrecht, Last Mile Solutions, We Drive Solar, New Solar, Vidyn, Jedlix, Stedin, ElaadNL
- **About the project:** To develop a sustainable energy system: storing local solar energy in (shared) EV batteries, and supplying to the grid at a later moment.
- **Project characteristics/Keyword** Bi-directional/compact charger (AC) Solar charging. Car sharing. Upscaling to 20 stations
- **Location** Lombok, Houten, Utrecht Science park: De Uithof, Utrecht Central Station Area and Driebergen-Zeist
- **Aggregator** Zedlix, others to be added in the next phase of the project
- **Energy market/Trading** Imbalance market, Local grid congestion
- **Incentive/Business model** Shared vehicles
- **Scale (Number of V2G charger, EV's, boundary conditions)** V2G charging stations in 5 different regions in Utrecht and 70 additional community shared EVs
- **Running time of the project** Ongoing
- **V2G hardware providers (CCP)** General Electric and Last Mile Solutions
- **Charging point Operator/ Owner (CPO)** LomboXnet
- **Charging standard/Protocol** Goal of the project is to develop a standard for AC V2G (15118)
- **Subsides** EFRO
- **Operational environment (Type)** Vehicle-to-X (V2X)

N 5 Project name **Solar-powered bidirectional EV charging station**

- **Partners** Delft University of Technology, Delft- Power Research Electronics, Breda- Last Mile Solutions, Rotterdam. Supported by Nissan, ABB, UT Austin
- **About the project** A first of its kind integrated EV charger that is directly powered by PV panels has been developed. The charger enables direct DC charging of EV from PV without converting to AC. The charger is bidirectional, so energy from the EV battery can also be fed to the grid, via vehicle to grid (V2G). The charger can realize four power flows: EV -> PV, EV -> Grid, Grid -> EV, PV -> Grid. The 10kW modules are modularly built and can be paralleled for fast charging. The charger is based on silicon carbide and quasi-resonant technology, which results in high efficiency and high power density. The integrated EV-PV solution has a lower component count, increased reliability, smaller size and lower cost than using separate EV charger and PV inverter. The charger is compatible with the CHAdeMO and CCS/Combo charging standard and is designed for implementing smart charging.
- **Project characteristics/Keyword** Integrated EV-PV charger, Smart charging algorithm based on EV user, energy prices, PV forecast, multiplexing and distribution network constraints
- **Location** TU Delft, PRE
- **Aggregator** Not applicable
- **Energy market/Trading** Smart charging algorithm based on EV user, energy prices, PV forecast, multiplexing and distribution network constraints
- **Incentive/Business model** Not applicable
- **Scale (Number of V2G charger, EV's, boundary conditions)** Demo with 1 V2G charging station with solar roof (parking area) and Nissan Leaf EV was done in Delft University of Technology in June 2017. 10kW solar powered bidirectional EV charger commercially available via PRE
- **Running time of the project** Completed
- **V2G hardware providers (CCP)** PRE
- **Charging point Operator/ Owner (CPO)** Last mile solutions
- **Charging standard/Protocol** CHAdeMO and CCS/COMBO
- **Subsides** TKI Urban Energy
- **Operational environment (Type)** Vehicle-to-Grid (V2G) with possibility for V2H, V2B

N6 Project name **Grid motion**

- **Partners** Groupe PSA, Direct Energie, Enel, Nuvve, Proxiserve and the Technical University of Denmark
- **About the project** The aim of the project is to evaluate possible savings achieved by real-life electric vehicle (EV) users through the implementation of smart charging and discharging strategies (V2G) for EVs.
- **Project characteristics/Keyword** Shifting charging times from periods when electricity prices are higher to periods when electricity prices are lower.
- **Location** France
- **Aggregator** Direct Energie

- **Energy market/Trading** Grid balancing services
- **Incentive/Business model** Not known
- **Scale (Number of V2G charger, EV's, boundary conditions)** 2-year demo pilot project 50 smart charging cars 15 (B2B) V2G enabled cars
- **Running time of the project** 2017 -2019
- **V2G hardware providers (CCP)** Enel
- **Charging point Operator/ Owner (CPO)** NuVve
- **Charging standard/Protocol** CHAdeMO and CCS
- **Subsides** Not known
- **Operational environment (Type)** Vehicle-to-Business (V2B) and Vehicle-to-Neighbourhood (V2N)

N7 Project name **Parker**

- **Partners** Nissan, NUVVE, Frederiksberg Forsyning, Mitsubishi Motors, Mitsubishi Corporation, PSA ID, ENEL, Insero and DTU Electrical Engineering (PowerLabDK).
- **About the project** The objective of this project is to validate electric vehicles as part of an operational vehicle fleet that can support the power grid by becoming a vertically integrated resource, providing seamless support (i.e. V2G) to the power grid both locally and system-wide. TRL9
- **Project characteristics/Keyword** Experimental validation across several series-produced V2G enabled EV models and brands. Access to the world's first commercial V2G hub of EVs providing FCR.
- **Location** Denmark
- **Aggregator** NUVVE
- **Energy market/Trading** Frequency Containment Reserves (FCR) in commercial pilot, several other services tested at DTU
- **Incentive/Business model** FCR Availability payment
- **Scale (Number of V2G charger, EV's, boundary conditions**) 7 V2G enabled Electric cars 6 Charging stations + data access to 20+ V2G vehicles in the field
- **Running time of the project** 2016-2018
- **V2G hardware providers (CCP)** Enel (subcontractor Magnum Cap)
- **Charging point Operator/ Owner (CPO)** Maintained by MagnumCap and NUVVE
- **Charging standard/Protocol** CHAdeMO
- **Subsides** Research supported by EUDP - no subsidies for commercial pilot although operating under temporarily relaxed market terms
- **Operational environment (Type)** Vehicle-to-X (V2X)

N8 Project name **Integrated Transport and Smart Energy Solutions (ITSES)**

- **Partners** Costain Limited and CENEX
- **About the project** Projects sets out to find new technical solutions and business models for integrating Vehicle-to-Grid (V2G) with two urban systems: energy and transport.

- **Project characteristics/Keyword** Not known
- **Location** Rail stations of Old Oak Common and Park Royal, London, United Kingdom
- **Aggregator** Not known
- **Energy market/Trading** Not known
- **Incentive/Business model** Not known
- **Scale (Number of V2G charger, EV's, boundary conditions)** 2 pilot sites - rail stations in London for V2G application
- **Running time of the project** 2015-2017 (August)
- **V2G hardware providers (CCP)** Not known
- **Charging point Operator/ Owner (CPO)** Not known
- **Charging standard/Protocol** Not known
- **Subsides** Not known
- **Operational environment (Type)** Vehicle-to-Business (V2B)

N9 Project name **Intelligent Transport, Heating and Control Agent (ITHECA), UK**

- **Partners** Cofely, CENEX, European Bioenergy Research Institute (EBRI), Open Energi
- **About the project** ITHECA aims to collaborate transport, frequency response services, energy storage and district heat solutions to establish the potential of Vehicle-to-Grid (V2G) to maximise a combined heat and power (CHP) plant.
- **Project characteristics/Keyword** Integrated energy system (Heat, power and V2G)
- **Location** European Bioenergy Research Institute (EBRI) at Aston University, United Kingdom
- **Aggregato**r Not known
- **Energy market/Trading** Frequency response services, energy storage and district heat solutions
- **Incentive/Business model** Not known
- **Scale (Number of V2G charger, EV's, boundary conditions)** 1 Pilot, 1 Nissan Leaf EV, 1 V2G unit
- **Running time of the project** 2015 -2017 (Currently active)
- **V2G hardware providers (CCP)** Not known
- **Charging point Operator/ Owner (CPO)** Not known
- **Charging standard/Protocol** Not known
- **Subsides** Not known
- **Operational environment (Type)** Vehicle-to-Business (V2B)

N10 Project name **SHAR-Q**

- **Partners** ATOS Spain, bAvenir, UBIMET, ENERCOUTIM, EEE, Basque Energy Cluster, RWTH Aachen, ICCS, HEDNO, Energie Gussing, ATOS CZ relevant to V2G HEDNO and ICCS
- **About the project** Storage capacity over virtual neighbourhood of energy ecosystem: The SHAR-Q project aims to establish an interoperability network that connects the capacities of the neighbourhood and wide regional RES+EES ecosystems into a collaboration

framework, that mitigates the requirement on the overall EES capacities thanks to the shared capacities among the participating actors. Note: Adaptive charging of e-vehicles (EVS) and V2G services.

- **Project characteristics/Keyword** Interoperability to boost the exchange of information between energy batteries from vehicle to power the grid and balance it.
- **Location** Greece
- **Aggregator** None
- **Energy market/Trading** None
- **Incentive/Business model** Focus of the project is on the development of the interoperability adapters, business models for V2G are not explored. Sustainability comes from the use of any battery device to help in network balancing
- **Scale (Number of V2G charger, EV's, boundary conditions)** 4 in Meltemi Greece
- **Running time of the project** 2016-2019
- **V2G hardware providers (CCP)** Not known
- **Charging point Operator/ Owner (CPO)** HEDNO
- **Charging standard/Protocol** Not known
- **Subsides** Not known
- **Operational environment (Type)** Vehicle-to-Neighbourhood (V2N)

N11 Project name **Denmark V2G**

- **Partners** Nissan, Enel, Nuvve, Frederiksberg Forsying and Energinet.dk
- **About the project** World's first fully commercial vehicle-to-grid hub in Denmark
- **Project characteristics/Keyword** Not known
- **Location** Copenhagen, Denmark NuVve
- **Aggregator** Frequency regulation services
- **Energy market/Trading** Not known
- **Incentive/Business model**
- **Scale (Number of V2G charger, EV's, boundary conditions)** 10 V2G units, 10 e-NV 200s
- **Running time of the project** 2016-present
- **V2G hardware providers (CCP)** Enel
- **Charging point Operator/ Owner (CPO)** Not known
- **Charging standard/Protocol** CHAdeMO
- **Subsides** Not known
- **Operational environment (Type)** Vehicle-to-Business (V2B)

N12 Project name **Genoa pilot**

- **Partners** Enel, Nissan, Italian Institute of Technology (IIT)
- **About the project** The first corporate electric car sharing pilot project with V2G (Vehicle to Grid) charging infrastructure in Italy, a system that could allow electric cars to discharge power to the network and contribute to its stability.

- **Project characteristics/Keyword** It is a combination of corporate car sharing, EV and V2G. The project uses the only vehicle ready for bidirectional energy exchange, Nissan Leaf.
- **Location** Italian Institute of Technology, Italy
- **Aggregator** IIT
- **Energy market/Trading** No market trading, energy exchange only under IIT internal grid
- **Incentive/Business model** Due the fact that it is an internal energy exchange ecosystem, there is no business model at the moment. Only in a second phase, car sharing software will be able to allocate cost of service per each single IIT department.
- **Scale (Number of V2G charger, EV's, boundary conditions)** IIT headquarters in Genoa 2 Nissan LEAF EVs: 2 V2G units
- **Running time of the project** 2017 (May) (still in operation)
- **V2G hardware providers (CCP)** Enel
- **Charging point Operator/ Owner (CPO)** Italian Institute of Technology
- **Charging standard/Protocol** CHAdeMO
- **Subsides** ENEL: V2G units NISSAN: 2 Leaf + corporate device IIT: location, car sharing management, reporting results
- **Operational environment (Type)** Vehicle-to-Business (V2B)

N13 Project name **Suvilahti pilot (as part of mySMARTLife project)**

- **Partners** Helen, Virta and Nissan
- **About the project** The vehicle-to-grid (V2G) charging point complements an existing solar power plant and a stationary energy storage, and enables using EVs as energy storages and to stabilize the electricity grid. A public bidirectional electric vehicle charging point is being installed in Helsinki, Finland.
- **Project characteristics/Keyword** Not known
- **Location** Helsinki, Finland.
- **Aggregator** Virta
- **Energy market/Trading** Frequency Imbalance market
- **Incentive/Business model** Not known
- **Scale (Number of V2G charger, EV's, boundary conditions)** 1 public charging V2G unit
- **Running time of the project** 2017- present
- **V2G hardware providers (CCP**) Helen
- **Charging point Operator/ Owner (CPO)** Virta
- **Charging standard/Protocol** Not known
- **Subsides** Not known
- **Operational environment (Type)** Vehicle-to-Neighbourhood (V2N)

N 14 Project name **City-Zen Smart City**

- **Partners** Alliander, NewMotion, Enervalis, MagnumCap

- **About the project** 9 DC V2G chargers will be installed starting December 2017, both in the public domain and at corporate locations. The charging sessions will be operated using varied algorithms, in order to test the value of V2G for grid congestion, power quality, imbalance and energy trading and others.
- **Project characteristics/Keyword** A social research is part of the project, focusing on the appreciation of the technology by the users.
- **Location** Amsterdam, the Netherlands
- **Aggregator** Enervalis
- **Energy market/Trading** **Grid** congestion and balancing
- **Incentive/Business model** To be investigated
- **Scale (Number of V2G charger, EV's, boundary conditions**) 3 corporate and 6 public charging units
- **Running time of the project** 2014-2019
- **V2G hardware providers (CCP)** MagnumCap
- **Charging point Operator/ Owner (CPO)** NewMotion
- **Charging standard/Protocol** OCPP
- **Subsides** Not applicable
- **Operational environment (Type)** V2C, V2B

N 15 Project name **Net-Form**

- **Partners** Encraft, Solihull Metropolitan Borough Council, Costain PLC, Aston University and Western Power Distribution (WPD) and Cenex
- **About the project** The project seeks to assess the feasibility of turning a car park into a MW-scale battery to provide power on demand to the electricity grid. The project will develop secure, dynamic data management platform that collects, aggregates and optimises energy collected by large populations of grid-connected electric vehicle batteries at a single location.
- **Project characteristics/Keyword** Not known
- **Location** HS2 station, Birmingham, UK
- **Aggregator** Not known
- **Energy market/Trading** Not known
- **Incentive/Business model** Not known
- **Scale (Number of V2G charger, EV's, boundary conditions)** Not known
- **Running time of the project** 1 year project
- **V2G hardware providers (CCP)** Not known
- **Charging point Operator/ Owner (CPO)** Not known
- **Charging standard/Protocol** Not known
- **Subsides** Not known
- **Operational environment (Type)** Vehicle-to-Business (V2B)

N 16 Project name **REDISPATCH V2G**

- **Partners** TenneT, The Mobility house (TMH) ,Nissan
- **About the project** Demonstration project proving technical ability to use TSO's own field service in addressing transmission constraints in Germany. TRL8

- **Project characteristics/Keyword** Internal TenneT project , The mobility house provide load and energy management software
- **Location** Substations and HQ TenneT DE
- **Aggregator** Not known
- **Energy market/Trading** **Not known**
- **Incentive/Business model** Corporate funding +TenneT
- **Scale (Number of V2G charger, EV's, boundary conditions)** EVTEC charger 10kW DC , 10 vehicles Nissan LEAF & ENV200
- **Running time of the project** 2018-2021
- **V2G hardware providers (CCP)** EVTEC
- **Charging point Operator/ Owner (CPO)** TenneT
- **Charging standard/Protocol** CHAdeMO
- **Subsides** Not known
- **Operational environment (Type)** Vehicle-to-Business (V2B)

N 17 Project name **INEES (Intelligent Integration of electric vehicles into the power grid for the provision of system service)**

- **Partners** Volkswagen AG, Lichtblick SE, SMA Solar Technology AG and the Fraunhofer Institute Wind Energy and Energy System Technology (IWES)
- **About the project** German 'lighthouse' project which demonstrates the real world technical feasibility of V2G through the use of 20 SMA bidirectional inverters
- **Project characteristics/Keyword** Charging interface not know
- **Location** DE
- **Aggregato**r Not known
- **Energy market/Trading** Frequency response services
- **Incentive/Business model**
- **Scale (Number of V2G charger, EV's, boundary conditions)** 20 Volkswagen UP modified, 40 SMA inverter
- **Running time of the project** 2012-2015
- **V2G hardware providers (CCP)** SMA
- **Charging point Operator/ Owner (CPO)** Not known
- **Charging standard/Protocol** Not known
- **Subsides** SchwarmStrom® bonus
- **Operational environment (Type)** Vehicle-to-Business (V2B)

N 18 Project name **Network Impact**

- **Partners** Northern Power Grid (NPG), Nuvve, Newcastgle univ.
- **About the project** NPG is monitoring installation of charger commercially installed by Nuvve. Scope also includes investigations of commercial options for connection offer and custom usage behaviour. TRL7

- **Project characteristics/Keyword**
- **Location** NPG offices, UK
- **Aggregator** NPG
- **Energy market/Trading** **Not known**
- **Incentive/Business model** Not known
- **Scale (Number of V2G charger, EV's, boundary conditions)** 19 V2G stations , Nissan NV200 and Leaf
- **Running time of the project** 2017-2020
- **V2G hardware providers (CCP)** MagnumCap
- **Charging point Operator/ Owner (CPO)** NPG
- **Charging standard/Protocol** CHAdeMO
- **Subsides** NA
- **Operational environment (Type)** Vehicle-to-Business (V2B)

N 19 Project name **UK Vehicle-2-Grid (V2G)**

- **Partners** Nissan, Enel
- **About the project** First ever vehicle-to-grid (V2G) trial in the UK
- **Project characteristics/Keyword** Not known
- **Location** Multiple locations in UK (mostly in London)
- **Aggregator** Not known
- **Energy market/Trading** Feed-in tariff
- **Incentive/Business model** Not known
- **Scale (Number of V2G charger, EV's, boundary conditions)** 100 V2G units: several Nissan LEAF and e-NV200 electric vans
- **Running time of the project** 2016-present
- **V2G hardware providers (CCP)** Enel
- **Charging point Operator/ Owner (CPO)** Not known
- **Charging standard/Protocol** CHAdeMO
- **Subsides** NA
- **Operational environment (Type)** Vehicle-to-Business (V2B)/ Vehicle-to-Neighbourhood (V2N)

N 20 Project name **Grow Smarter**

- **Partners** 20+ academic and industry partners
- **About the project** GrowSmarter brings together cities and industry to integrate and demonstrate ‘12 smart city solutions’ in energy, infrastructure and transport, to provide other cities with valuable insights on how they work in practice and opportunities for replication. The idea is to create a ready market for these smart solutions to support growth and the transition to a smart, sustainable Europe.

- **Project characteristics/Keyword** The six V2X chargers will be installed inan Endesa Building with Distributed Energy Resources (DER) including a PV Plant, a storage system, chargers (normal, fast and V2X) and a Demand Management System (DMS).
- **Location** Barcelona, Spain
- **Aggregator** Not known
- **Energy market/Trading** Time shift, Power balancing and Power quality support
- **Incentive/Business model** Not known
- **Scale (Number of V2G charger, EV's, boundary conditions)** 6 V2G units: aggregated power of 60kW
- **Running time of the project** January 2015 - 31 December 2019.
- **V2G hardware providers (CCP)** Endesa
- **Charging point Operator/ Owner (CPO)** Not known
- **Charging standard/Protocol** CHAdeMO
- **Subsides** Not known
- **Operational environment (Type)** Vehicle-to-Business (V2B)

4. KPI definition

A List of possible KPI to be taken onto account when evaluating impacts and benefits of V2G solutions are presented above. They are grouped so that to reflect the different assets and/or stakeholders that are or will be involved in the V2G rollout.

Environment

- CO2 emission reductions (if compared to standard EV charging and combustion engines)
- TEP reduction (if compared to standard EV charging and combustion engines)

EV market

- EV selling push due to V2G benefits (economic ones for end users)
- N° of V2G charging points VS normal EV charging points (both domestic and public)
- Customer acceptance evaluations (based on interviews, questionnaires ….)

Local impact on DSO networks

- Power quality parameters monitoring (evaluating improvements if compared to standard slow and/or fast charging solutions)
- Voltage fluctuations evaluation
- Power demand decrease/shift
- Grid congestion evaluation

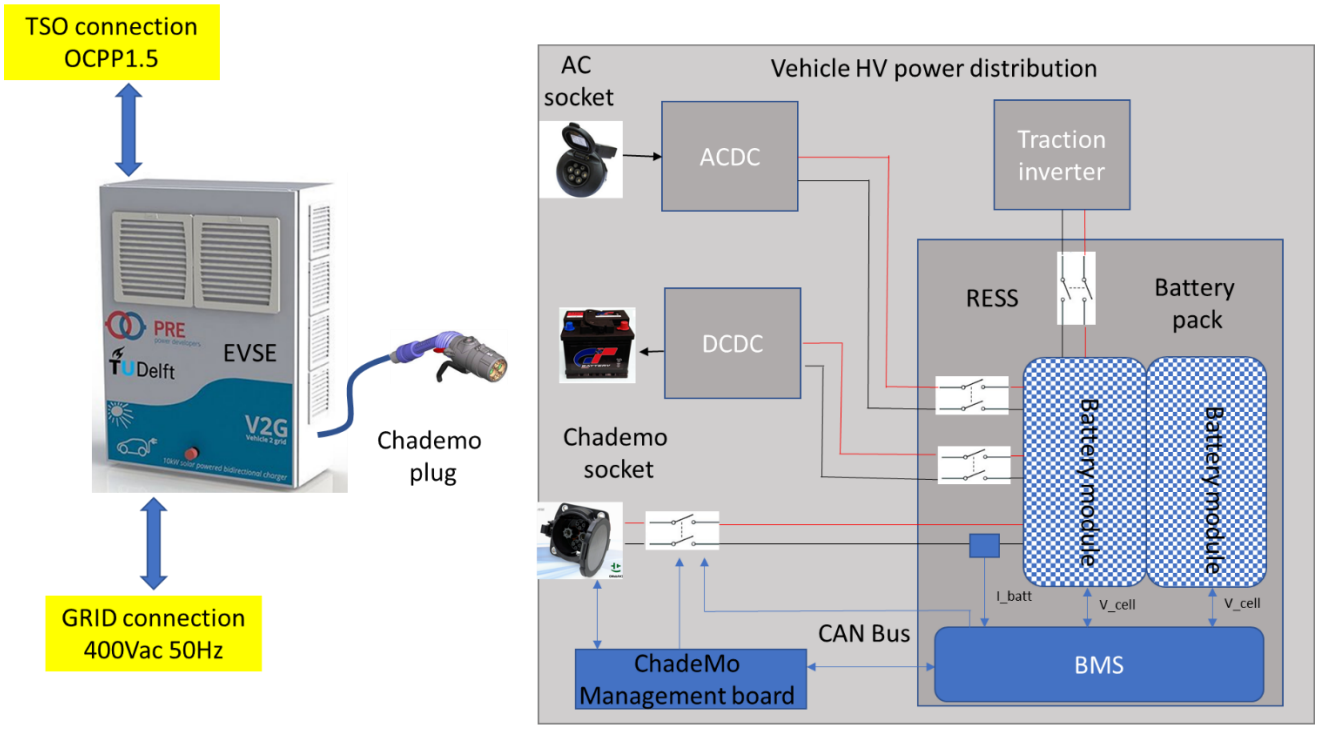
Energy Markets

- Energy aggregation potentials
- Economic returns evaluations for CPOs, EV drivers, aggregators…

Vehicle technologies

- Battery management performances
- SOC, SOH algorithm tested for V2G
- Communication between EV and TSO

5. Main technical standards



At today the main standard to be used in V2G projects are:

Grid to EVSE

The V2G standard allow the EVSS to supply the grid and the standard to be applied will cover the energy generations and micro-grid integration

- Italy CEI 0-21
- DE VDE V 0126-1-1 , VDE-AR-N 4105
- UK G59/3 , G83/2
- Spain RD 413, ITC-BT-40,
- IEC 60364-7-722:2018
- EN 50438
- Denmark TF 3.3.1 (Energinet) (https://en.energinet.dk/Electricity/Rules-and-Regulations/Regulations-for-grid-connection)

TSO to EVSE

- **OCPP** protocol https://www.openchargealliance.org

EVSE to RESS in V2G mode

- IEC 61851-1
- IEC61851-23
- EN 61439-1
- EN 62196-1
- EN 62196-2 (connector AC)
- EN 62196-3

The most used standard in V2G projects is included in IEC61851-23 as CHAdeMO consortium (www.CHADEMO.com)

The CCS standard (CHARIN consortium) don't include a V2G option at today.

Annex1 : References of the document, including legislation

1. Table on EU V2G project courtesy of Amsterdam university of applied Sciences https://www.interregeurope.eu/fileadmin/user_upload/tx_tevprojects/library/file_1541537540.pdf
2. UK power network V2G reports https://northsearegion.eu/media/4308/v2g-projects-in-europe.pdf
3. OCPP standard https://www.openchargealliance.org/protocols/ocpp-15/
4. CHADEMO standard www.chademo.com
5. CCS combo standard www.charinev.org