Super Smart Charging Hubs | Interreg North Sea | Co-funded by the European Union

Task 1.6 Understanding virtual PowerGrid and the profit for parties

October 2025

Summary sheet

Project Name	Super Smart Charging Hubs
Title of the document	**Task 1.6 Understanding virtual PowerGrid and the profit for parties**
Deliverable number	1.6
Programme	Interreg NSR
Coordinator	Province of Zeeland
Website	https://www.interregnorthsea.eu/ssch-0
Author	Super Smart Charging Hubs partners – put together by Kaya van de Grift
Status	Finalised
Dissemination level	With partners, for external use as well
Reviewed by	Project partners
Submission date	October 2025
Starting date	June 2024
Number of months	36

Project partners

Organisation	Abbreviation	Country
Province of Zeeland	PZ	Netherlands
City of Vlissingen (subpartner)	VLI	Netherlands
Gate 21	Gate 21	Denmark
ASTER cv	Aster	Belgium
GreenFlux Assets B.V.	GFX	Netherlands
VUB-MOBI Electromobility Research Centre	VUB-MOBI	Belgium
Flux50	Flux50	Belgium
Agrisnellaad	ASL	Netherlands
Autodelen.net – carshare Belgium	Autodelen	Belgium
Hub Park AB	HUB	Sweden
Free Hanseatic City of Bremen	BRE	Germany
l'Association Européenne de la Mobilité Électrique (inactive)	*AVERE*	*Belgium*
Partenord Habitat	PH	France
ArupHvidt ApS (inactive)	*AH*	*Denmark*
Sustain	SUS	Denmark

Document history

Version	Date	Organisation	Main area of changes	Comments
0.1				
0.2				
0.3				

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Introduction: Super Smart Charging Hubs – Smarter Energy for Growing Energy Demand

With EU electricity demand for Battery Electric Vehicles (BEVs) projected to grow from 9 TWh in 2021 to 165 TWh by 2030, the pressure on energy grids is rapidly increasing—potentially requiring €69 billion annually in grid upgrades. Smart Charging Hubs offer a smarter alternative by combining local renewable energy, energy storage, and Vehicle-to-Grid (V2G) technology.

The Super Smart Charging Hubs (SSCH) project supports 25 SMEs in developing and testing integrated energy solutions. An SSCH is a decentralized energy system that powers the simultaneous charging BEVs using locally generated renewable energy, while also supporting grid stability. A crucial element is the Virtual Power Plant (VPP), which connects and manages distributed energy assets—such as batteries, buildings, and vehicles—allowing them to exchange energy even when not physically co-located.

Through transnational Living Labs, the project will demonstrate how SSCHs can reduce the need for costly grid reinforcements, unlock new business models, and speed up the transition to sustainable mobility across the North Sea Region.

Explanation what a Virtual Power Plant (VPP) / Virtual Power Grid (VPG) is

https://www.next-kraftwerke.com/vpp/virtual-power-plant

A virtual power plant (VPP) is an aggregated network of distributed energy resources (DERs), such as photovoltaic (PV) systems, batteries, wind turbines and electric vehicle (EV) chargers, connected and managed through advanced software to function as a single, coordinated entity.

Virtual power plants (VPPs) are categorized based on the types of assets they aggregate and their operational objectives.

- Supply-side VPPs
  These VPPs aggregate distributed energy resources (DERs) such as solar PV systems, wind turbines and small-scale hydroelectric plants. By coordinating these generation assets, supply-side VPPs can operate collectively as a single power plant, optimizing energy production and participating in energy wholesale markets. In addition, they can provide services like capacity market mechanisms and strategic reserves, which enhance grid reliability.

- Demand-side VPPs
  Demand-side VPPs focus on aggregating flexible consumer loads, including residential, commercial and industrial energy consumers. By managing and adjusting these loads, VPPs can perform demand response activities, for example where consumers are financially rewarded for shifting or reducing consumption during periods of peak demand. This approach helps balance supply and demand, providing value in intraday and day-ahead markets.

- Hybrid VPPs
  Hybrid VPPs combine both supply-side resources (DERs) and demand-side flexibilities, integrating generation assets like renewables with controllable loads and energy storage systems. This combination offers maximum operational flexibility, allowing hybrid VPPs to provide a wide range of grid services, including frequency containment reserve (FCR), automatic frequency restoration reserve (FRR) and reactive power management. Moreover, this versatility allows hybrid VPPs to optimize their participation in wholesale energy markets, maximizing revenue potential by strategically responding to market opportunities and price signals.

  By participating in multiple value streams, VPPs enhance grid stability and facilitate the integration of renewable energy sources, contributing to a more resilient and sustainable energy system.

Advantages / Disadvantages of a VPP

Advantages of a Virtual Power Plant (VPP):

1. Grid Stability: Aggregates resources to provide grid services like frequency regulation and reserve power.
2. Market Participation: Enables small-scale DERs to access wholesale markets and generate revenue.
3. Flexibility: Hybrid VPPs optimize both supply and demand, adapting to real-time conditions and price signals.
4. Renewable Integration: Facilitates higher penetration of solar, wind, and other renewables.
5. Reduced Peak Demand: Demand-side VPPs reduce stress on the grid during peak times via demand response.
6. Resilience: Distributed setup reduces reliance on centralized power plants.

Disadvantages of a Virtual Power Plant (VPP):

1. Complexity: Requires advanced software and coordination of diverse assets.
2. Cybersecurity Risks: Increased digitalization makes VPPs vulnerable to cyber threats.
3. Regulatory Barriers: VPP operation depends on favourable market rules and regulations, which vary by region.
4. Upfront Costs: Investment in communication infrastructure and smart technologies can be high.
5. Data Privacy Concerns: Especially in demand-side VPPs involving residential users.

Why Use a VPP?

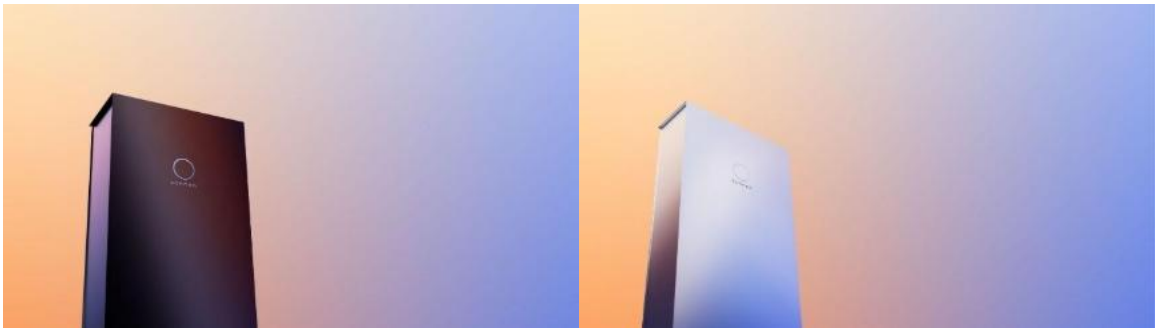
1. To maximize renewable energy use, generate revenue from distributed assets, and improve grid efficiency.
2. Ideal for utilities, aggregators, and energy communities aiming for decarbonization and decentralization.

Why Not Use a VPP?

1. If regulatory frameworks are lacking, or if the cost and complexity outweigh the expected benefits for your scale or location.

Examples in practise (existing ones) and indicative list of what is available on the market

Sonnenbatterie



Sonnenbatterie presents the sonnenCommunity; members can generate their own power, store it and share surpluses online with friends or each other. The sonnenCommunity completely replaces traditional power companies and will soon be available to every household in Germany.

- sonnenCommunity is the first community of producers, consumers and storage operators who can supply each other with self-generated electricity.
- sonnenCommunity members are independent of the established electricity providers.
- Members have significantly lower energy costs thanks to the efficiently controlled, decentralized self-supply of electricity.
- sonnenCommunity members gain affordable access to intelligent storage technology as well as to free surplus electricity.
- The sonnenCommunity actively prevents costly grid expansion through direct marketing of renewable energy even in small residential systems.

Genius project at TU Eindhoven

Genius = Grid Efficiency Network Integration for Universal Sustainability

The TU Eindhoven’s GENIUS project includes the creation of a virtual power plant (VPP) that plays a key role in solving grid congestion. The VPP integrates various energy assets like the 3.4 MWh battery, solar panels, and wind turbines, along with smart software to manage energy flow across the campus and surrounding industrial areas.

The VPP operates as a centralized control system that balances energy generation, storage, and consumption. It optimizes energy use by predicting demand patterns and dynamically adjusting how energy is stored or released. This approach helps alleviate grid congestion by preventing overloads and enabling more efficient use of renewable energy sources.

The VPP also allows for flexibility in energy distribution, enabling the TU Eindhoven to provide grid services and support local businesses in nearby industrial zones. The integration of renewable energy and smart systems is expected to create a model for sustainable energy management that could be replicated elsewhere.

The project also aims to create a sustainable innovation hub, involving local startups and businesses, to solve grid congestion not only for the university but also for surrounding companies. The system has already created 1 MW of grid capacity and is supported by a significant subsidy.

Polestar and Jedlix collaboration

Jedlix offers a Virtual Power Plant (VPP) solution that aggregates electric vehicles (EVs) to manage their charging and discharging flexibility. The VPP allows energy companies and grid operators to monetize this flexibility by providing balancing services to the grid, optimizing energy consumption and reducing imbalance costs. The system takes into account drivers' preferences and mobility needs, automating charge prioritization. Clients can control and dispatch charging commands to thousands of EVs, enabling efficient energy trading and providing a scalable model for renewable energy integration.

The collaboration goes beyond smart charging and includes developing advanced VPP services for unidirectional (V1G) and bi-directional vehicles (V2G). These automated services will leverage the aggregated battery capacity of Polestar cars to support grid stability and renewable energy integration. Customers are then financially rewarded for their participation in demand response programs.

Jedlix will leverage its existing operations of VPP integrations with market access partners across Europe. Jedlix and Polestar invite energy utilities and aggregators to join this initiative to participate in aggregated flexibility services with Polestar cars. Depending on the country and regulatory framework, a range of balancing- and energy services will be enabled.

How a VPP/VPG could be used in a Super Smart Charging Hub (SSCH)

VPPs are solving the "Double Brain Problem". A scenario in which two separate control systems operate independently, leading to potential conflicts in energy management. In bi-directional charging the "Double Brain Problem" can occur when EVs and EMS do not have synchronised communication or control, resulting in suboptimal charging and discharging behaviour, mismanagement of energy flows, or complications in coordinating services like V2G.
For an optimally working SSCH a~~n~~ "Single Brain Concept" is necessary. The Single Brain Concept is based on establishing a hierarchy amongst control devices such that conflicting or inefficient energy management is prevented. Without clear definition of the entity ultimately in control, the "Double Brain Problem" arises.
The definition of a SSCH must include a VPP. To run a SSCH optimally it is best if the VPP is locally operated, it must operate as using a "Single Brain" controller in the area. If the VPP is the one to have the "last word" in the control set up it will lead to a true "Single Brain" control system.

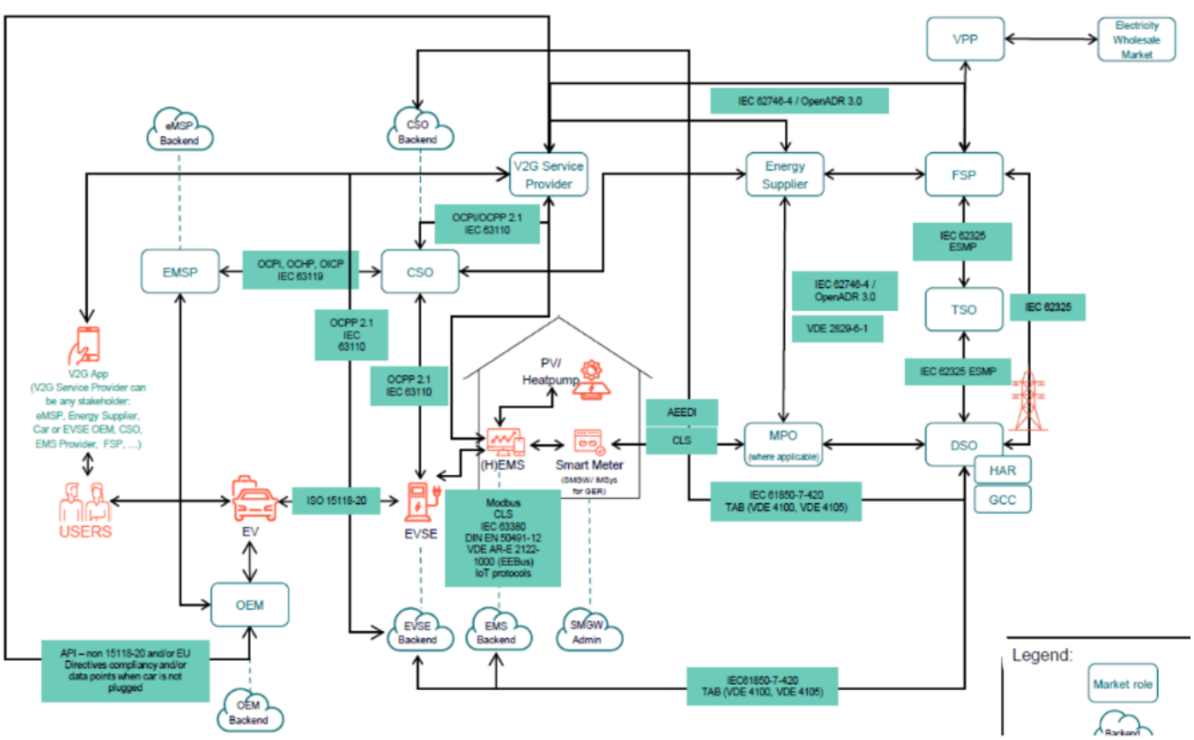


Figure 1: Blueprint with protocols and interfaces

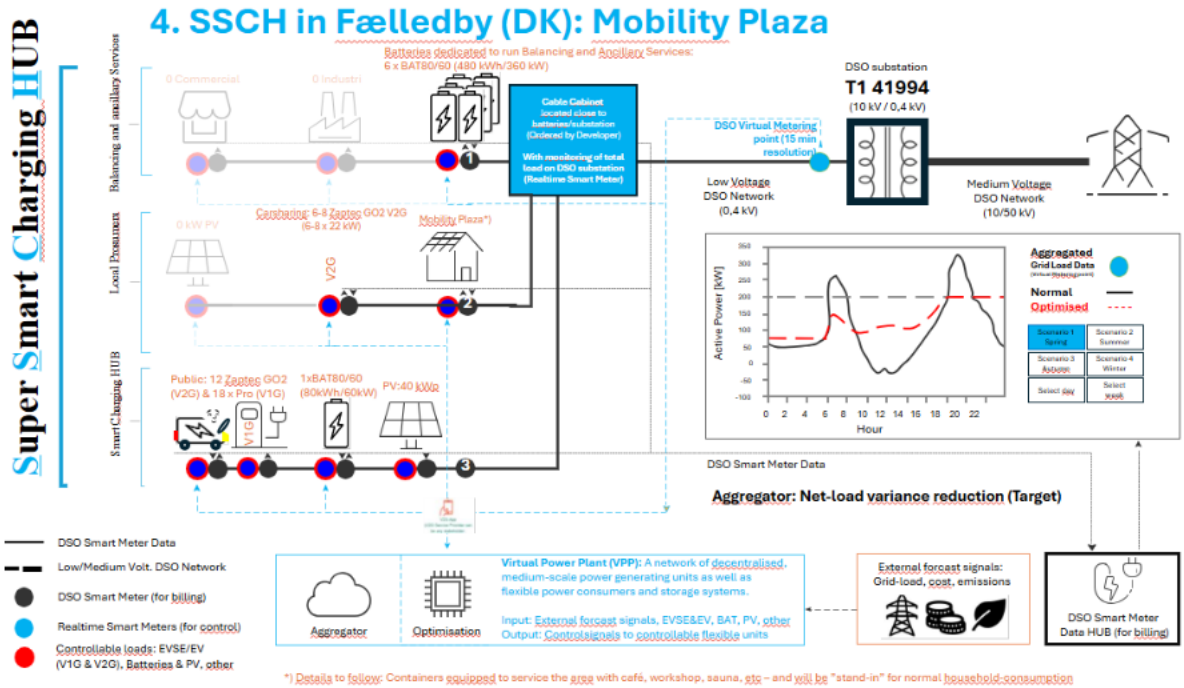


Figure 2: Technical representation of the Super Smart Charging Hub in Faelledby, Denmark

Consortium partner logo's

SSCH Consortium

Living Lab Partners

Provincie Zeeland

AgriShellaad

aster

Gemeente Vlissingen

HUB Park

GATE 21

greenflux

SUSTAIN

Research partner

VUB mobi Electromobility Research Centre

Network and knowledge partners

flux50 Energizing the future

VER

AD autodelen.net

Replication partners

Partenord Habitat

Freie Hansestadt Bremen

For further information please visit https://www.interregnorthsea.eu/ssch-0