ultra E

ULTRA CHARGING STUDY EUROPE

MARKET AND BUSINESS MODELS FOR ULTRA CHARGING

KEY FINDINGS STUDY 1

Co-financed by the European Union
Connecting Europe Facility

PARTNER

allego Audi RENAULT bayern innovativ HUBJECT MAGNA SMATRICS Strom gibt Gas. Verbund

EXECUTIVE SUMMARY ULTRA-E STUDY 1

Ultra-E Study 1 provides a near-future outlook for all necessary technical, economic, customer-related and policy requirements to ensure an effective and coherent planning of a pan-European Ultra Charging (UC) network that can accommodate the charging needs of both existing Electric Vehicles (EVs) and the next generations of long-distance EVs.

Within ultra-E, "ultra charging" or "UC" is defined as DC charging at 150–350 kW

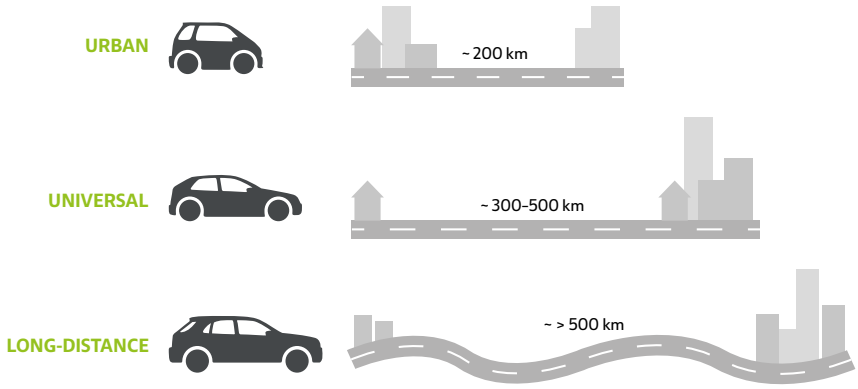
This study was jointly edited by the partners Allego, Audi, Bayern Innovativ, Verbund & SMATRICS. The main findings and recommendations of the study are summarized below.

The ultra-E project, co-financed by the "Connecting Europe Facility" of the European Union, has deployed, for the first time in Europe, a network of 25 Ultra-Fast-Chargers with a charging power of up to 350 kW on TEN-T core network corridors. This network connects the Netherlands, Belgium, Germany and Austria.

E-MARKET

Long-distance EVs will coexist with lower-range EVs

A closer look at the EVs announced by the OEMs for the upcoming years shows the development of EV models that support longer driving ranges, coexisting with EVs with lower ranges. Three typical vehicle types will emerge, categorised by their driving range and charging power, each of them covering a particular use case.



Electric buses outlook

Mini and city buses are the main application scope for electric vehicles in the transport section at the moment (disregarding rail-bound transport such as trains and subways, which are out of scope). Their mobility usage is limited to inner city or metropolitan areas and their charging needs can be easily accommodated in the bus depots or at dedicated bus stops. Electric long-distance buses, aka inter-city buses, could become a market with the expansion of a UC network and further developments in the charging technology.

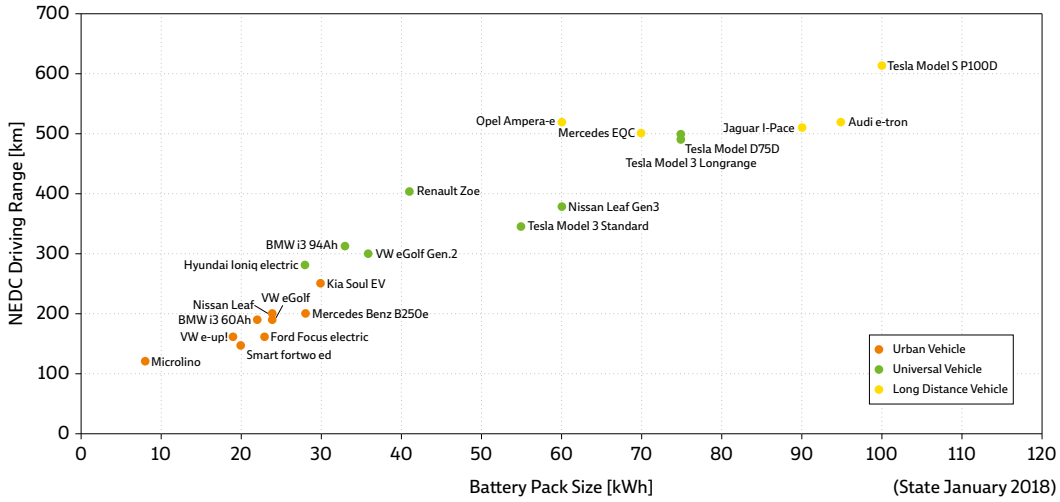
Electric commercial vehicles outlook

A strong uptake in the electrified commercial vehicles market, especially in mini vans and urban commercial delivery trucks, is expected some time soon.
Long-distance trucks will have a lower uptake due to their high battery performance requirements. New demands for UC are likely to emerge due to this vehicle segment, not only on the design of the charging interface, but also on the charging station and its location, the charging technology, and the power output.

BATTERIES & CHARGING INFRASTRUCTURE

Larger batteries and higher power density will allow higher driving ranges

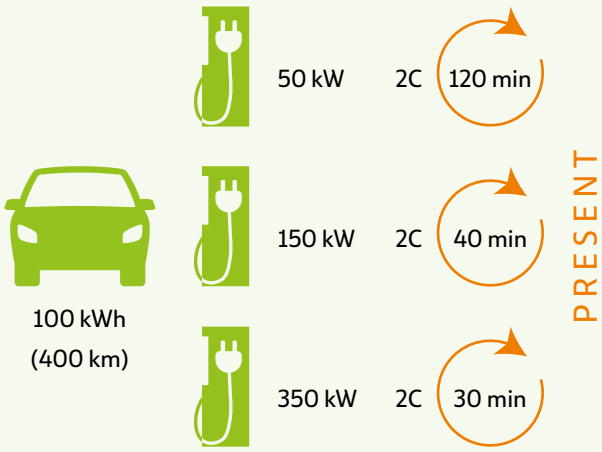
The evolutionary development of Li-Ion batteries will continue through to 2025, bringing reduced cost and increased power density. This will lead to typical battery capacities between 80 and 125 kWh in universal vehicles or long-distance vehicles, resulting in 500-700 km of nominal range.



400 kW will be the maximum charging power for UC until 2025

Next generation Li-Ion battery technologies will extend present charging rates, resulting in possible charging power levels between 150 kW and 400 kW. Therefore, a maximum of up to 400 kW can be seen as the future-proof requirement for UC (for passenger vehicles), at least until 2025.

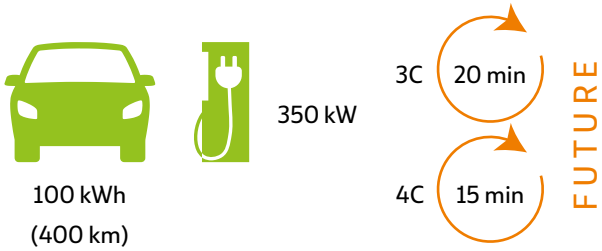
The possible charging performance of EVs depends highly on the **charging rate** that a manufacturer allows for the battery. Today's maximum allowed charging rate is typically 2C (meaning twice its capacity per hour) in order to not damage the battery or limit its lifespan. To reduce charging times, automotive manufacturers are working on extending the charging rate up to 3C (or even beyond), e.g. by using optimised cell cooling.



Shorter charging times can only be achieved with higher charging rates, supported by new generations of EVs and an according UC infrastructure

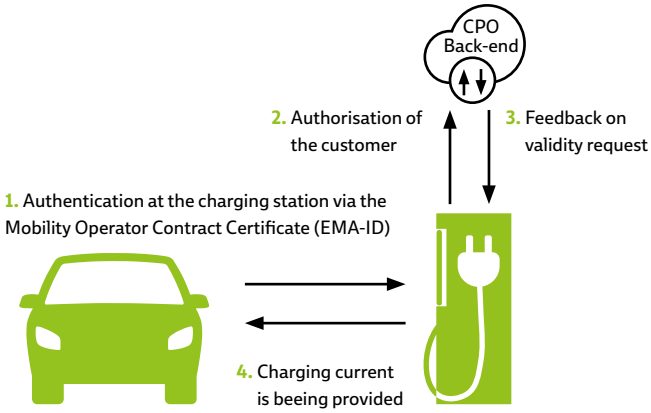
The customer target of a "less than 20 minute stop" can only be reached with:

- large battery capacity in the car (e.g. 100 kwh)
- extended charging rate (e.g. 3C)
- powerful UC Infrastructure (e.g. 350 kW)



Charging standards need to be adapted to UC

Ultra charging with 350 kW requires voltages up to 1.000 V and currents between 350 A and 400 A, even up to 500 A could become reality. This results in temperature increases and brings new requirements for safety and temperature monitoring. Future standards must focus on safety measures and must offer new technical descriptions for cooled charging cables and connector systems. Additionally, standards for ICT, such as the ISO 15118 Plug & Charge, must be tested and implemented in a coordinated effort.



ISO 15118 Plug & Charge standardizes the communication between the electric vehicle and the charging station. This standard will allow for automatic vehicle owner authentication, as well as seamless payment, and will provide a much user friendlier charging experience.

BUSINESS MODELS

Several business model options for UC guarantee a competitive market

A well-functioning business model for UC is driven by the openness of the network, stimulate the development into a competitive market, and ensure a high-quality service level to the customer. Additionally, the coexistence of the different existing business models will support the pan-European UC rollout since it fosters competition, provides customers a wider choice, and shares risks for investing parties.

BUSINESS MODEL	DESCRIPTION	EXAMPLE	ADVANTAGES	DISADVANTAGES
Energy companies or utilities as CPO (ultra-E use case)	CPO invests in the charging infrastructure and refinances it by selling electricity or services with a margin.	SMATRICS, E.ON, Allego	Existing know-how of electricity industry (production, transmission, distribtion, trading, sales)	High financial risk
OEMs as CPO	One or more OEMs invest in the development of a charging network and operate it themselves.	Joint venture IONITY, Tesla, Inc.	Market power and financial possibilities of the OEMs accelerate the entire process Location advantage (own dealerships)	Strong influence on market deviation Potential risk due to propertary technical solution
Gas&oil companies as CPO	Investment and operation of own charging network.	Royal Dutch Shell, MOLGroup	Location advantages (can build on own grounds)	Strong influence on market deviation
CPO operating as white label service to third parties	A third party commissions a CPO to install and service charging stations and bears the costs for this.	Allego, Royal Dutch Shell, SMATRICS	Splitting the financial risk Strong partnerships/ cooperation help shape the market	More complex coordination processes

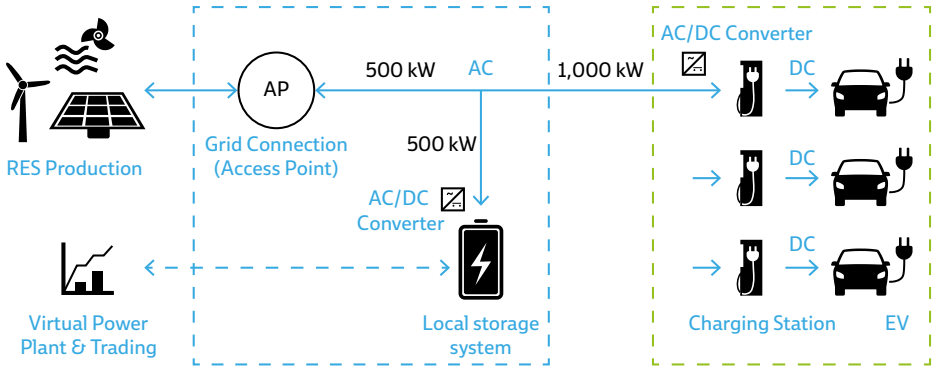
High investment and operational costs make UC business case challenging

The business case for UC (ultra-E use case) is an investment in the future due to high capital and operational expenses and a still slow growing EV market, that will significally turn with the imminent greater availability of EV models.

- **High hardware and installation costs** due to new technology.
- **High grid connection costs** due to large grid connections needed at UC locations. High variation depending on grid operator and country, which leads to uncertainty.
- **Grid fees/Energy costs**, beyond the energy consumption itself, also the utilization of the grid causes costs which are linked to kWh of consumption and kW of used capacity. This means, when mass adoption of EV happens, grid operational costs will grow tremendously and will have a main impact on UC costs.
- **Moderate revenue**, rooted in the fact that the UC infrastructure investments will precede the growth in EV sales and associated charging demand.

Local battery storage systems can contribute to a positive business case

The use of energy storage systems in a UC location can help to lower investment and operational costs for the CPO by reducing power peaks from the grid and by providing additional revenues trough grid serices.



Source graphic: © VERBUND, SYNERG-E project.

Further synergies in the use of local battery storage at UC locations will be studied in the Synerg-E project

USER PREFERENCES

The following findings are the result of the ultra-E survey, conducted in the four ultra-E countries (Sample n=2,977).

UC is a key enabler for EV uptake

A UC network is one of the key factors to create consumer confidence to purchase EVs and to have a network to serve their travel needs. According to the ultra-E survey, e-mobility without UC is only acceptable for 23% of participants.

77 % YES

Ultra charging enables the charging of 300 km range within 15–30 minutes. Assuming there was an extensive UC network, does this option make e-mobility more attractive to you?

23 % NO

52 % Especially because I can be more spontaneous and flexible.

24 % Especially because I need to do fewer breaks during long-distance drives.

UC public stations are also interesting for commercial fleet operators

City bus operators and logistic companies with large trucks require dedicated UC stations at their premises or on their routes (for example, the end station of a bus line). Car sharing companies, city logistics using small trucks or vans and taxis, for which UC is an option instead of a must, may prefer to make use of publicly accessible UC stations.

Business travellers as key users for UC

Business travellers can be identified as the main user group for UC. Especially if they have time pressure, they show a strong tendency towards very high charging speeds. Highway UC with 350kW stations seem the best option for this specific target group to satisfy their preference on saving time rather than saving money.

You have to charge 300km – which option would you choose?
(Time and cost assumptions: 50 kW: 75 min, 21.75 €; 150 kW: 30 min, 28.20 €; 350 kW: 15 min, 38.25 €)

50 kW
43 %

150–350 kW
57 %

26 % of business travellers choose DC 350 kW

only 8% of private travellers choose DC 350 kW

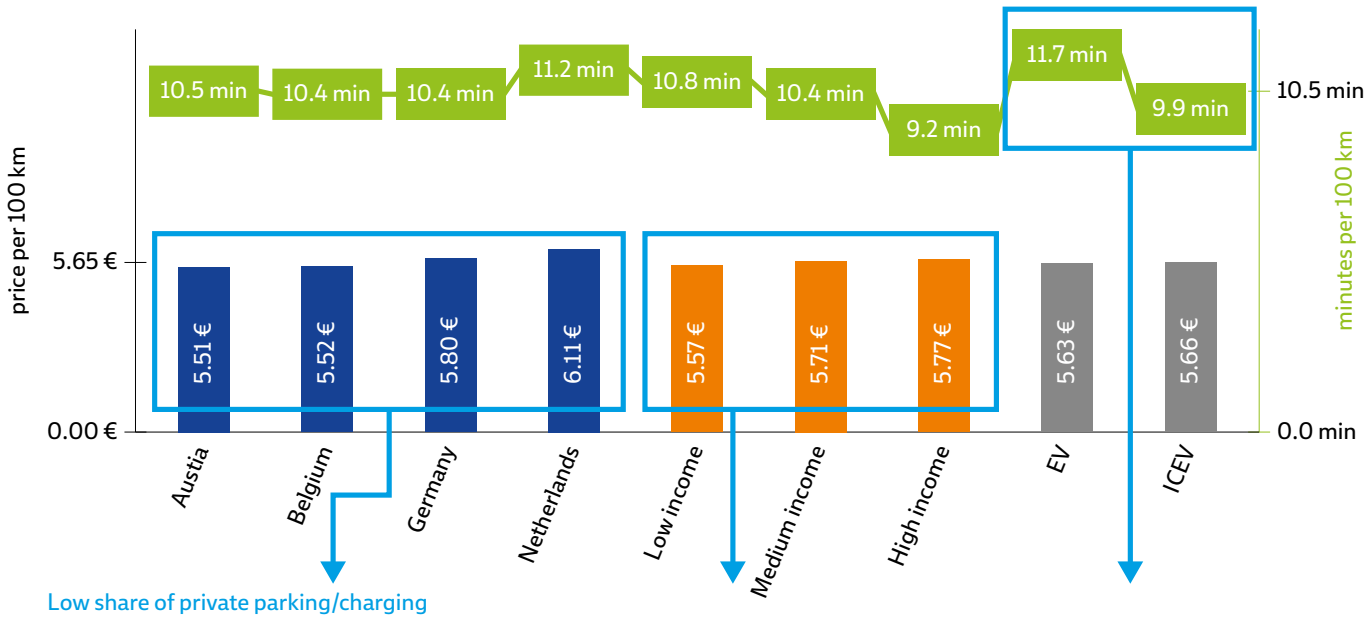
UC stations at highways: clean, safe, easy to use and with additional amenities

Charging at a UC station at highways on long-distance trips pretty much corresponds to refuelling at a highway petrol station as known today: users expect a clean, bright environment, a roof, and further amenities such as a restaurant, toilets and a small shop. According to the user survey, billing and payment should be as transparent and simple as possible (e.g. Plug & Charge), and there should be a UC station approximately every 50 kilometres within no more than 5 minutes detour from the highway.

The price of UC is going to be one of the major criteria for UC success

There is currently a significant difference between the users' willingness to pay for UC charging and the expected prices for the service offering. The lack of experience with UC on the user side combined with very high investment costs for CPOs make it difficult to match the UC offering to user expectations.

Price and expectations for primary UC charging



Low share of private parking/charging opportunity in the Netherlands increases the willingness to pay.

Willingness to pay increases slightly with income.

ICEV drivers expect a considerably faster charching time than EV drivers.

Additional services to increase UC attractiveness

The majority (39%) of people willing to sign a contract with a mobility service provider would pay an increased monthly fee if they could use UC stations as well. Only for 32% is a higher fee out of the question. An additional 29% could imagine paying a premium if additional services were included in the package.

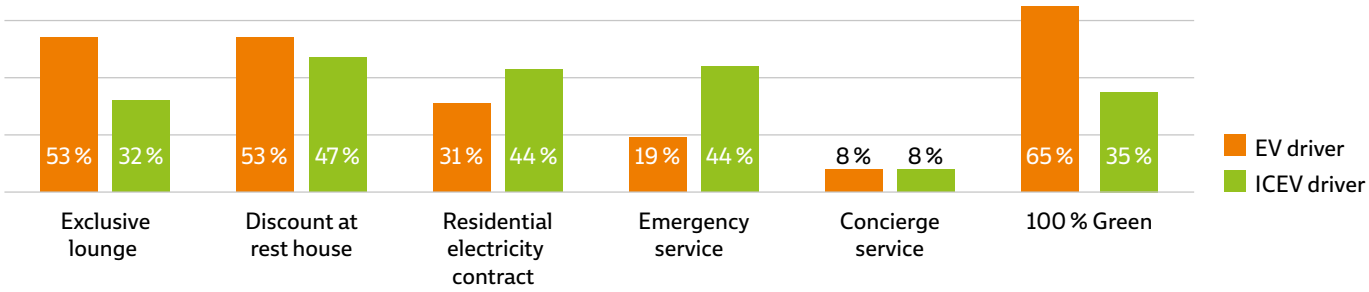
Higher monthly fee for ultra charging?

39 % Yes

32 % No

29 % Only with further services

Which additional services would make it more attractive?



POLICY SUPPORT

The **"Alternative Fuels Infrastructure Directive" (AFID)** defines the framework for European Member States for the deployment of publicly accessible charging infrastructure for electric vehicles. It defines minimum standards for charging technologies and gives recommendations to Member States in order to achieve a pan-European interoperable charging network.

Type of charging points according to their power output:

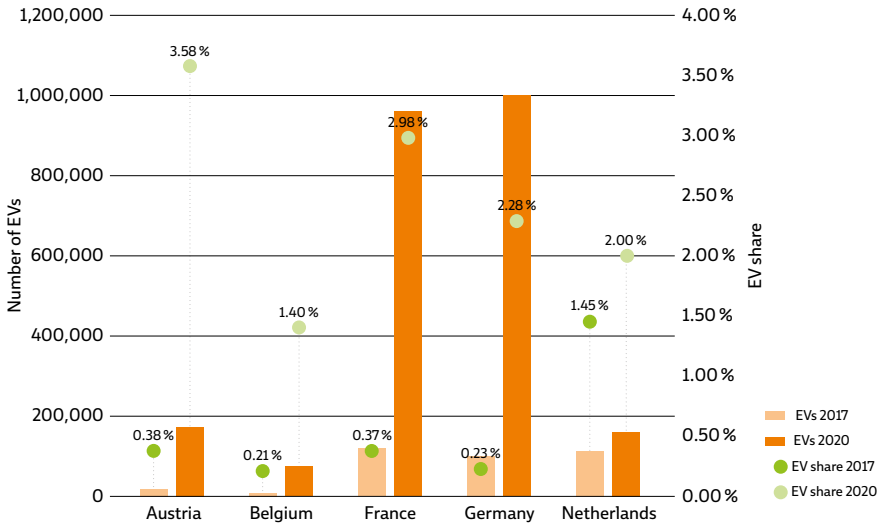
- **Normal power charging point: 3.7 kW to ≤ 22 kW**
- **High-Power Charging Point (HPC): > 22 kW**

Recommendation: at least **1 CP per 10 EVs**

Following the AFID, Member States had to deliver a National Policy Framework by November 2016, specifying the current status of the electric market, i.e. number of electric vehicles (EV) and charging points (CP), and the deployment targets for 2020 and beyond.

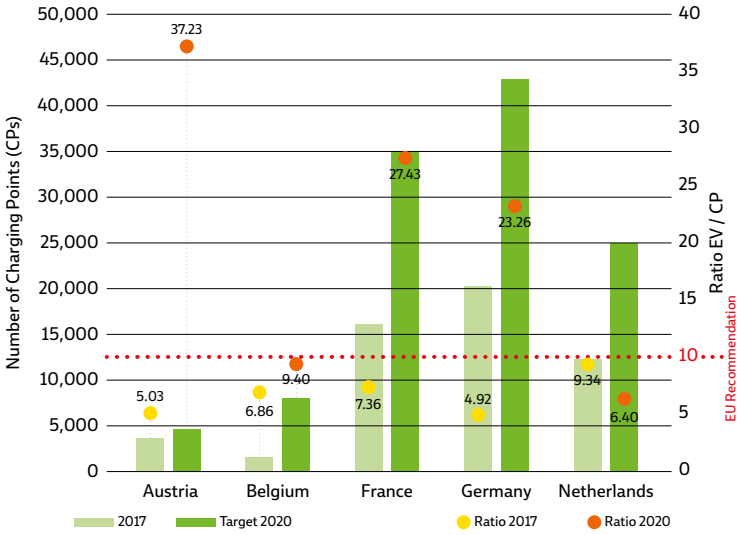
ultra-E countries have ambitious targets for the number of electric vehicles in 2020

EV share of the total passenger car fleet is set to grow dramatically by 2020, with percentages between 1.4% (Belgium) and 3.58% (Austria). In all countries except the Netherlands, this represents 10 times more electric vehicles than today.



The targeted density of public charging points varies widely, with some countries offering significantly fewer charging points as recommended

Even if the number of public charging points would double in almost all ultra-E countries by 2020, their availability according to the EV targets would be over the ratio recommended by the EU in most cases: a maximum of 10 EVs per charging point. Of course, the charging speed of the public chargers and the availability of private charging options will influence the actual need for public chargers.



Most policies in place do not consider UC or, if so, the degree of support is considered insufficient

The majority of the support measures for charging infrastructure deployment in the ultra-E countries focus on normal charging. Measures for HPC often only consider lower charging speeds (50 kW) and therefore UC remains excluded from the incentives or the funding conditions are very limited.

Incentives for charging infrastructure deployment

	normal charging (up to 22 kW)	fast charging (up to 50 kW)	ultra chraging (from 100 kW up)
Austria	very strong emphasis	medium emphasis	weak emphasis
Belgium	strong emphasis	weak emphasis	weak emphasis
France	medium emphasis	not existing	not existing
Germany	very strong emphasis	very strong emphasis	medium emphasis
Netherlands	very strong emphasis	very strong emphasis	medium emphasis

not existing · weak emphasis · medium emphasis · strong emphasis · very strong emphasis

UC support policy – Recommendations for policy makers

Non-financial support measures:

- **Establish** an EU-wide definition for ultra charging.
- **Define** clear national UC goals.
- **Monitor** the goals regularly in order to assess the achievement of the targets and adapt the policies accordingly.
- **Guarantee** a reliable national database of charging points, organised either by public or private actors.

Financial support measures:

- **Consider** the eligibility for funding of grid connection costs and local energy storage systems.
- **Adapt** or remove financial caps for ultra charging, and reconsider maximum financing per applicant.
- **Set** minimum requirements for funding such as:
  - interoperability of the charging stations
  - preparation for a future upgrade (higher charging performances and use of Plug & Charge)
  - use of electricity from renewable energies
- **Provide** CEF funding for innovative technologies such as UC, which is still at an early stage of market development

An efficient legal and regulatory framework can also accelerate the UC roll-out

BARRIER	SOLUTION APPROACHES
Lack of necessary demand volumes	Further incentives for EVs and OEM regulations.
High initial investment costs	Debt financing by the EIB or private financial institutes is mandatory for large rollout. Adapt national programs for UC.
Regionally regulated energy laws	Regulated and unified grid fees at UC locations will decrease OPEX that endanger future mass rollout.
Time-consuming application processes	Simplify building permit process for UC. Simplify and harmonize grid connection contract process. Governments & public institutions can play a key role in educating often ill-informed public bodies that deal with regulation, permits and infrastructure (highway & energy).
Difficulty acquiring preferred sites and securing locations	Location agreements with major site owners like gas & oil companies to secure best matching locations.

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ACRONYMS	
AFID	Alternative Fuels Infrastructure Directive
CP	Charging Point
CPO	Charging Point Operator
EIB	European Investment Bank
EV	Electric Vehicle
HPC	High Power Charging
ICEV	Internal Combustion Engine Vehicle
ICT	Information and Communication Technologies
OEM	Original Equipment Manufacturer (car manufacturer)
OPEX	Operational Expenses
RES	Renewable Energy Source
UC	Ultra Charging

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