Grid integration of electric vehicles: A manual for policy makers

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4 key steps for policy makers to successfully integrate EVs

① Prepare institutions for the electric mobility transition

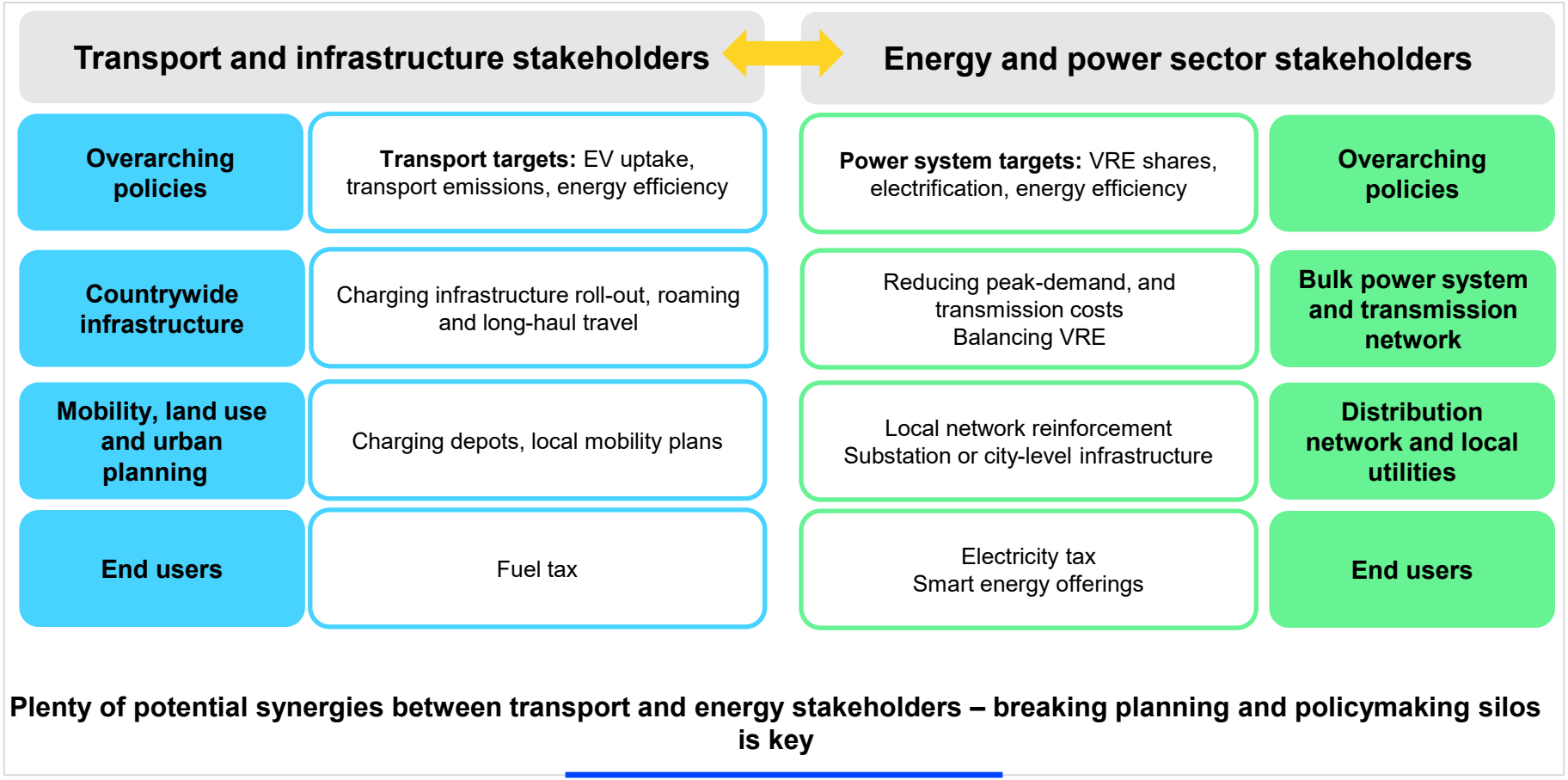
② Assess the power system impacts

③ Deploy measures for grid integration

④ Improve planning practices

1. Prepare institutions for the electric mobility transition

4.1, 4.2 Engage stakeholders and break silos of planning and policy



Plenty of potential synergies between transport and energy stakeholders – breaking planning and policymaking silos is key

Source: Adapted from Clean Energy Ministerial (2020), Electric Vehicle and Power System Integration: Key Insights and Policy Messages from CEM Initiatives.

Key recommendations

Designate contact persons in charge of cross-sectoral co-ordination

Create multidisciplinary working groups

- California VGI Working Group

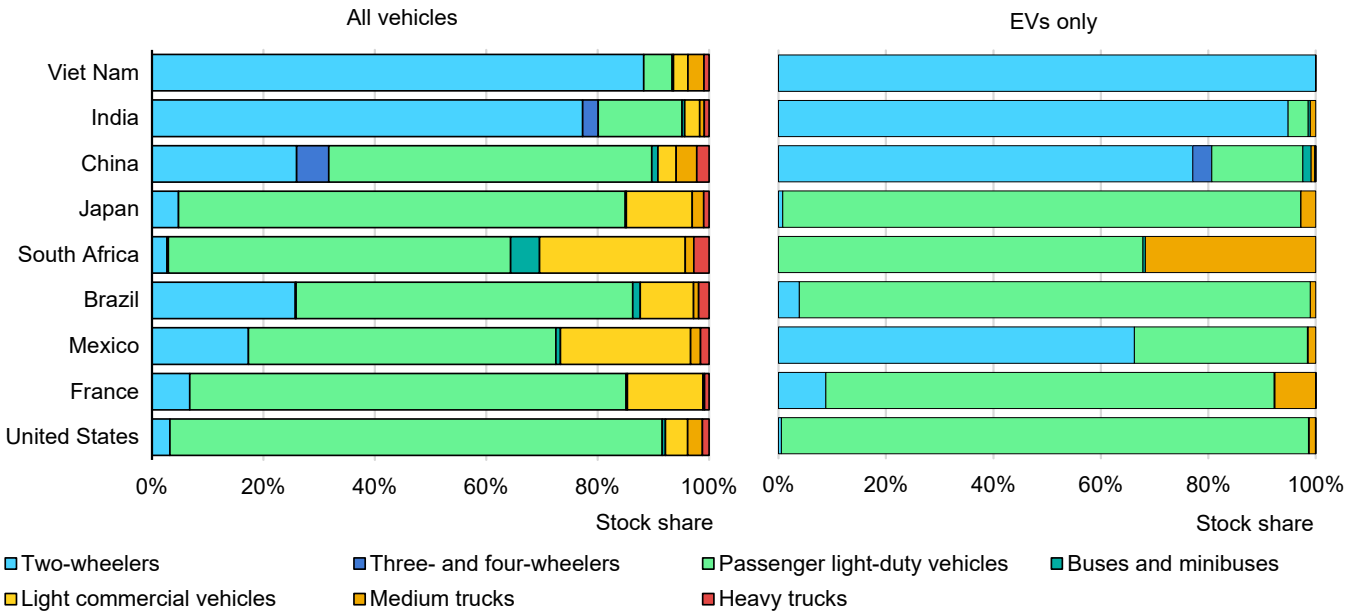
Establish co-operation at the policy-making level

- US Joint office of Energy and Transportation

2. Assess power system impacts

Determine vehicle electrification priorities

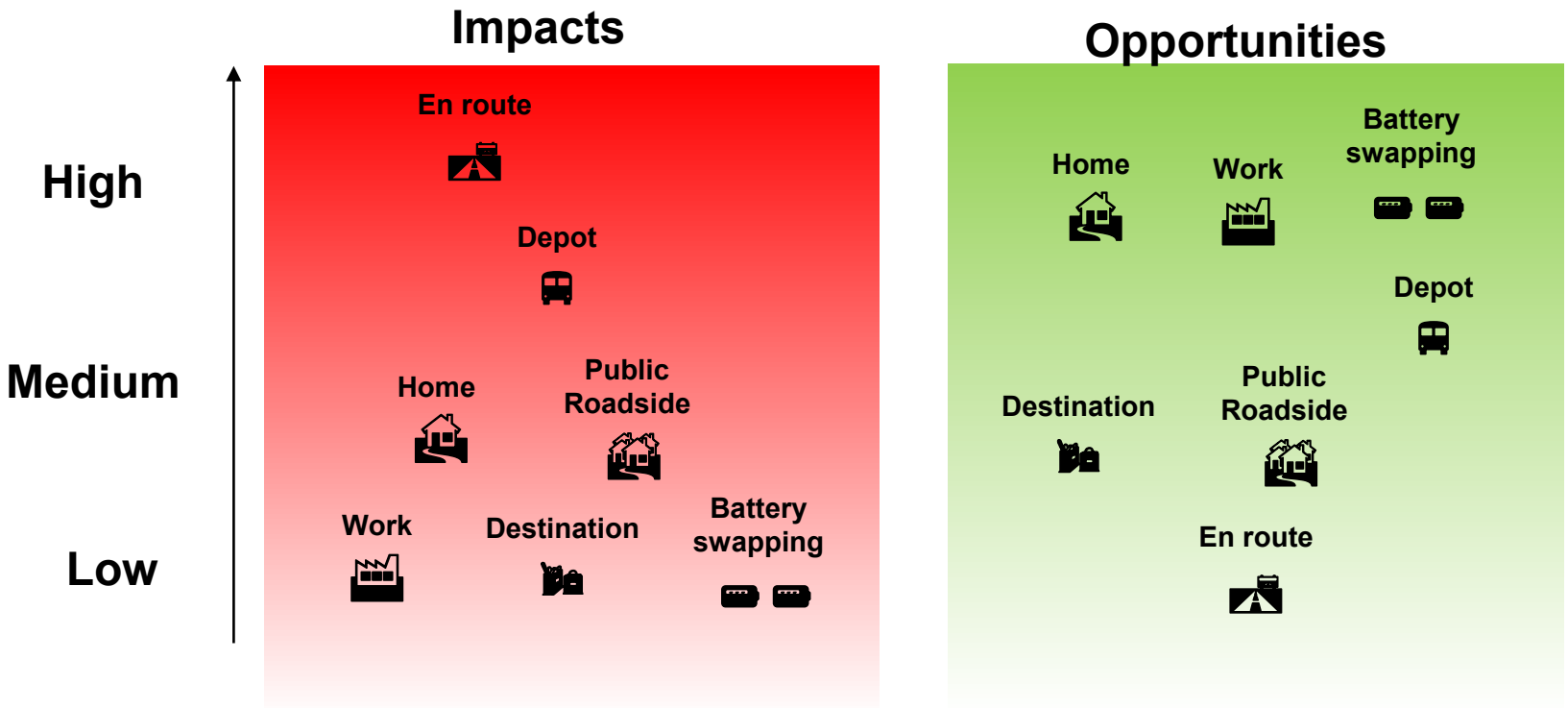
Stock share of all vehicles (left) and EVs (right) by vehicle type in selected countries



Different vehicle types and segments imply different charging solutions. Policy makers must identify electrification priorities to determine their grid impacts

 Source: Analysis of IEA Mobility Model

Different charging solutions based on vehicles electrified

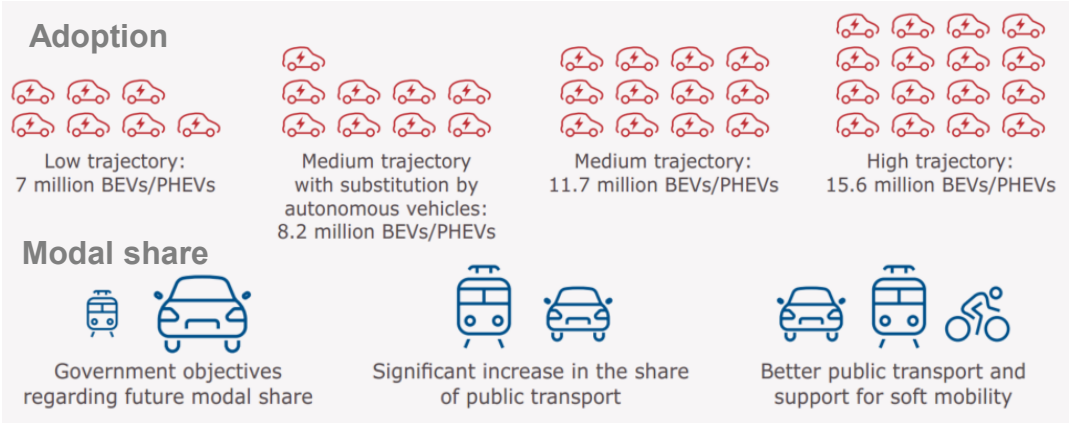


Grid impacts of charging solutions can vary based on local contexts. Modelling them should consider mobility scenarios to ensure a robust planning

Key recommendations

Mobility scenarios

- By transmission operator (France)
- By national lab (United States)



Source: RTE (2019) Integration of electric vehicles into the power system of France

Travel surveys

- Travel surveys (Chile, Thailand)
- EV charging patterns (France)

Digital Technologies

- GPS in LDVs and in Trucks (United States, Europe)

Record charging sessions + open access

- Obligation in public tender (Germany)

3. Deploy measures for grid integration

3.1 Accommodate all charging solutions but encourage managed charging

Mitigating the impacts of lowering barriers to e-mobility

Locational signals

- Hosting capacity maps (New Jersey New York and California)
- Variable fees by location, storage requirements

Non-firm connection

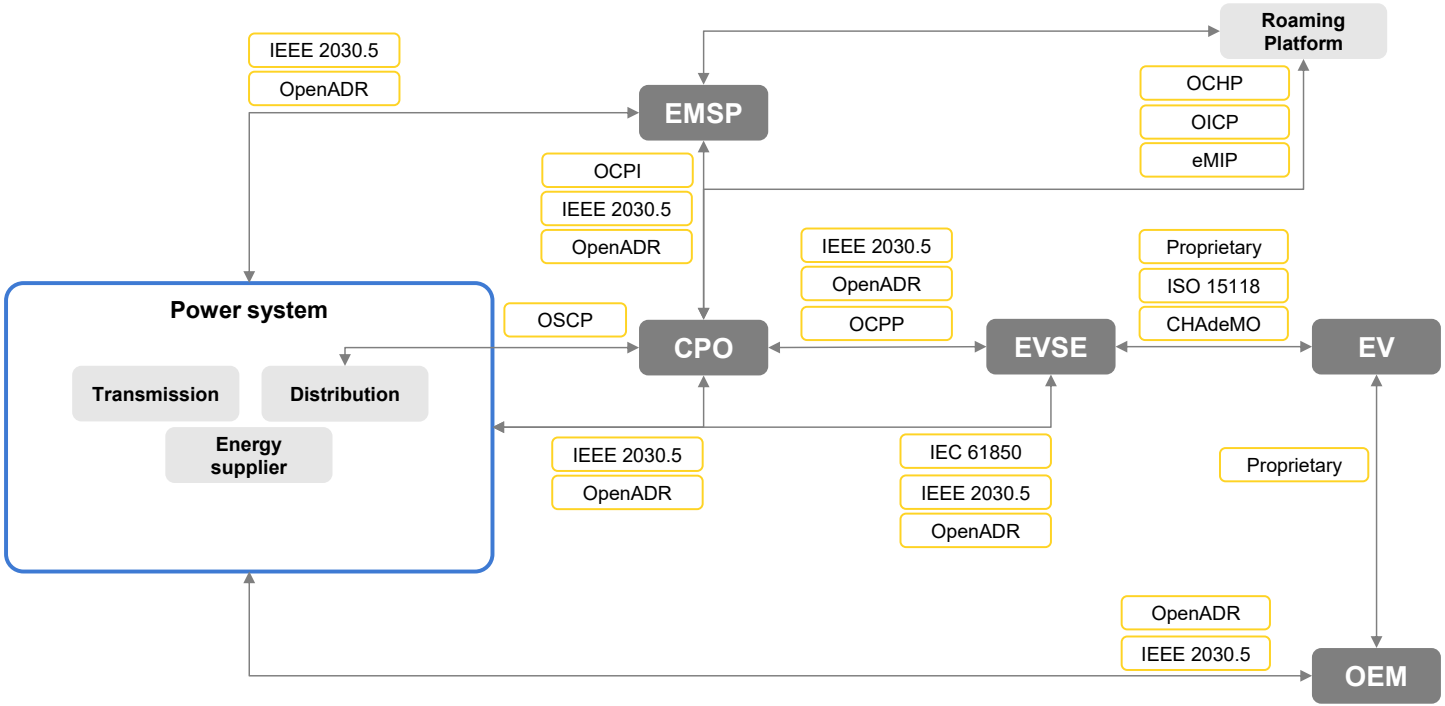
- Lower fees for “flexible connection” (DNO in United Kingdom)

Influencing connection

Variable fees

- Based on maximum power and controllability (proposed, Netherlands)

3.2 Facilitate aggregation by enforcing standards and interoperability



Several charging standards and communication protocols exist between different interfaces. Enforcing interoperability addresses the user's range anxiety, and increases the volume of aggregated vehicles

3.2 Facilitate aggregation by enforcing standards and interoperability

Incentives

- Tax deductions for residential and commercial EVSE (OCPP in Belgium)
- Grant for charging stations (OCPP in Luxembourg)

Regulations

- Public tender guidelines (OCPP and OCPI in the Netherlands)
- Charging regulations (OCPP in the UK and in India)

3.3 Value the flexibility of EVs

Tariff Design

- Time of Use (EV-specific in Korea)
- Real-time pricing
- Critical peak pricing (United States)

Flexibility Contracts and Markets

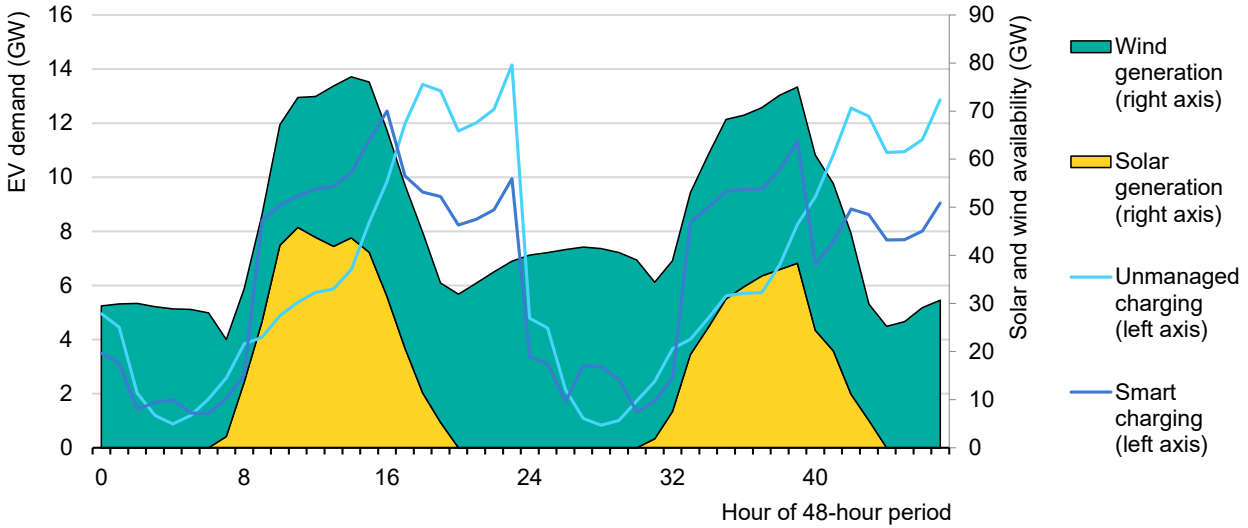
- Local flex markets (UK, Germany, Italy, Netherlands, Switzerland)

Wholesale + Balancing Markets

- Through aggregators (UK)
- Adjusting product specifications (100 kW minimum in Sweden for primary regulation)

3.4 Co-ordinate EV charging with renewables

Variable renewable energy patterns and the load-shifting potential of EVs in Korea, 2050



Encourage daytime charging

- Work place charger incentives (UK, US)

Incentives

- RE supplier or on-site generation (Belgium)

Options to directly contract RE supply

- Lowering size requirements (1 to 0.1 MW in India)

Source: IEA (2021), Reforming Korea's Electricity Market for Net Zero.

A framework for grid integration of electric vehicles

PHASE 1: No noticeable impact	**PHASE 2:** EV load noticeable with low flexibility demand	**PHASE 3:** Flexible EV load is significant with high flexibility demand	**PHASE 4:** Flexible EV load is highly available with high flexibility demand
No significant impact yet. Encourage higher EV uptake through incentives and public EVSE deployment.	Distinct variability observed caused by EV charging but demand for flexibility is low enough that simple flexibility measures would suffice.	Demand for flexibility is high, matching the availability of flexible EV load and paving the way for aggregated smart charging.	High flexibility demand along with highly available flexible EV load can provide energy back to the system in periods of deficit.
Co-ordinate charging station deployment in areas beneficial to the grid	**Passive measures:** time-of-use tariffs, vehicle-based charging time delays	Deploy active measures: unidirectional V1G	Deploy active measures, bidirectional charging: V2G
	Norway	**France, Netherlands, United States**	**Island power systems, certain vehicle segments**

A framework for grid integration of electric vehicles

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Co-ordinate charging station deployment in areas beneficial to the grid	Passive measures: time-of-use tariffs, vehicle-based charging time delays	Deploy active measures: unidirectional V1G	Deploy active measures, bidirectional charging: V2G
EV-EVSE interface standardisation and interoperability measures	Hourly metering or sub-hourly metering	Real-time advanced metering and communications infrastructure	Battery state-of-health measurements
Database for EV registrations and charging points	Separate metering for EVs or onboard charging measurement devices	Forecasting of EV availability, electricity prices, VRE generation and grid constraints	Enable platforms for decentralised power trading
Data collection of travel and charging patterns	Enable data exchange platforms for grid operators, EMSPs, OEMs, CPOs and EV users	Grid code definition for V1G	Battery state-of-health considerations for V2G cycling
Frameworks to incentivise demand response	EV-EVSE-grid standardisation of communication protocols	Real-time tariffs	Bidirectional protocols: ISO-15118-20:2022, CHAdeMO
	Time-of-use or critical peak tariffs	Contracts and markets for flexibility	Reducing or eliminating two-way taxation for storage
	Self-consumption policies	Market access for aggregators	Grid code definition for V2G

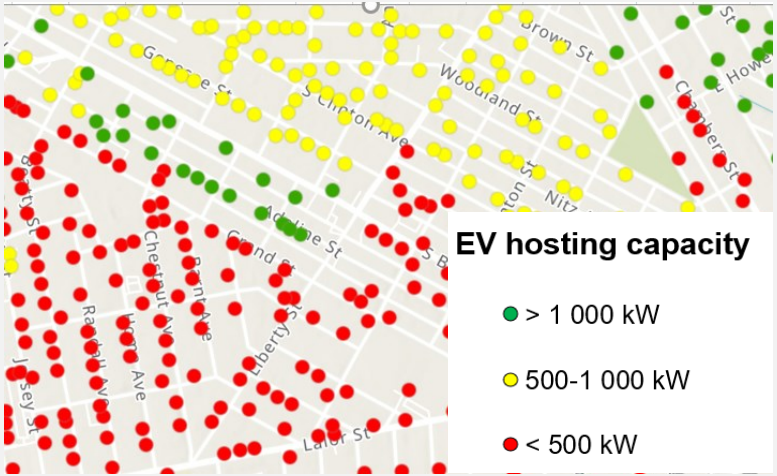
Charging strategy | *Technology requirements* | *System operations* | *Regulation and market design*

4. Improve planning practices

4.1 Pro active grid planning

Streamline interconnection

- Mandating publication of hosting capacity maps
- Minimum connection time windows (Netherlands)



Source: PSE&G. EV Hosting Capacity Map (accessed 3 August 2022).

Targets and regulatory incentives

- Clear deployment targets (Mobility Orientation Law in France)

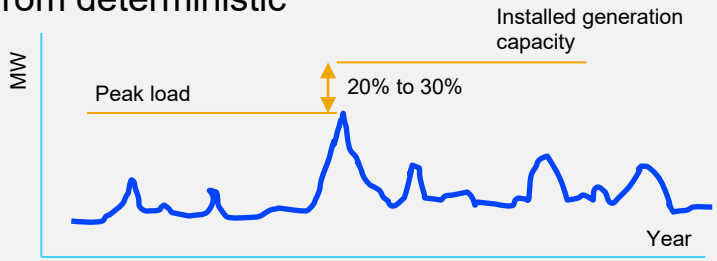
4.2 Reflect full value of EV charging

Grid expansion criteria

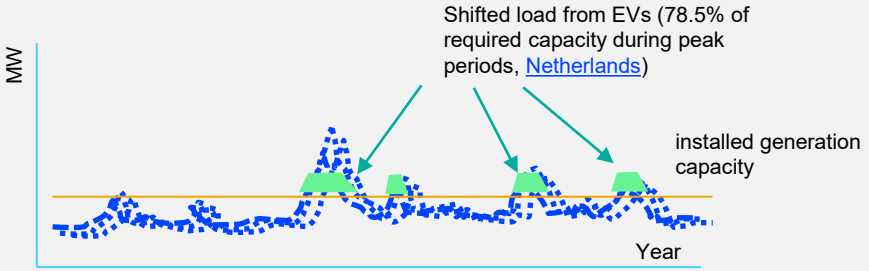
- Non-wire alternatives such as energy efficiency, and demand response programmes (New York)
- Distribution Deferral Opportunity Report (California)

System planning criteria

- From deterministic



- To holistic and probabilistic



4 key steps for policy makers to successfully integrate EVs

① Prepare institutions for the electric mobility transition

1. Engage electric mobility stakeholders
2. Break silos in planning and policy making

② Assess the power system impacts

1. Define an electric mobility strategy
2. Gather data and develop insights
3. Assess the grid impacts under mobility scenarios

③ Deploy measures for grid integration

1. Accommodate all charging solutions but encourage managed charging
2. Facilitate aggregation by enforcing standards and interoperability
3. Value the flexibility of EVs
4. Co-ordinate EV charging with renewables
5. Incentivise smart-readiness

④ Improve planning practices

1. Conduct proactive grid planning
2. Reflect the full value of EV charging

Full Report

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https://www.iea.org/reports/grid-integration-of-electric-vehicles