Enel X Electric Mobility

Vehicle Grid Integration Summit

11/19/2018

Company overview

Enel Group today

Evolution and achievements since 2014[1]

#1 private **network** operator globally
65 mn end users and 44 mn digital meters

+4.5 mn end users
+8.4 mn smart meters[3]

~20 mn free **retail** customers
#1 in Italy, Iberia and top 3 in Latam

+5 mn free customers
+20% electricity sold in free market

#1 **renewable** operator
~40GW managed capacity[2]

+6 GW
+80%
additional capacity

~47 GW **thermal** capacity
Highly flexible and efficient assets

10 GW
capacity closure

Enel X
+5.7 GW demand response

Countries of presence[4]

Enel X

4 Global Product Lines to capitalise upon the power industry transformation

e-Industries	e-City	e-Home	e-Mobility
Consulting and auditing service	Smart lighting	Installation, maintenance and repair services	Charging infrastructure (public & private)
Distributed generation on/off site	Fiber optic wholesale network	Automated home management	Maintenance and other services
Energy efficiency	Distributed generation & energy services	Financial services	OEM back-end integration
Demand response and demand side management	Demand response and demand side management	Home 2 Grid	Vehicle Grid Integration

Flexibility

Addressing new customer needs with innovative technologies

Our recent acquisitions

Targeted M&A operations to excel in the new energy ecosystem

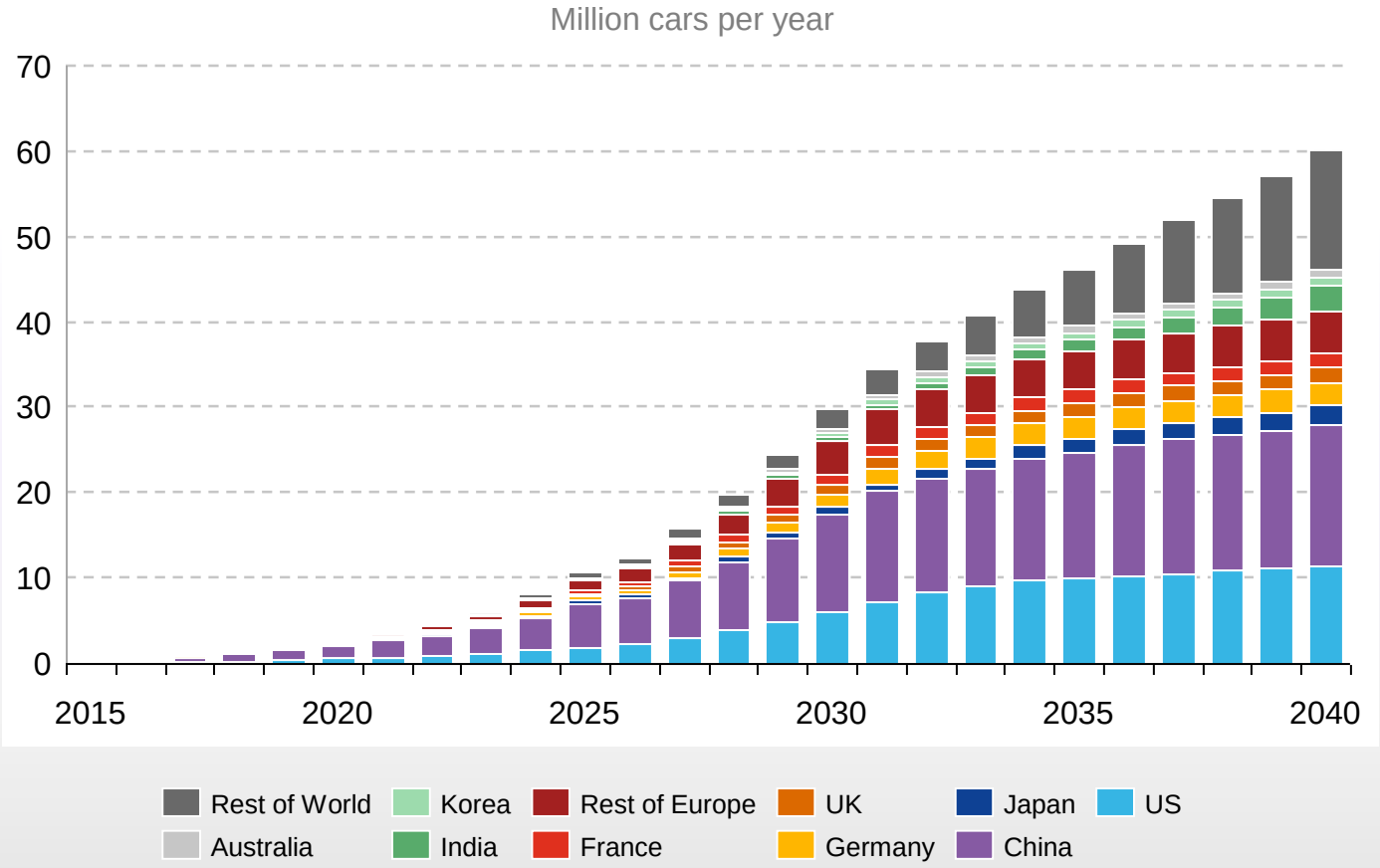
Acquisition of Demand Energy and its best in class platform for the behind-the-meter distributed resources and storage management

New industry understanding with the **acquisition of EnernNOC**, world's largest provider of demand response and energy intelligence software

Acquisition of eMotorWerks, developer of the market leading smart EV charging platform – Juice Net – that interfaces with local utilities & grid operators to optimise EV charging costs, reduce peak load and balance renewables

Electric Vehicles Market

Growth scenario



Source: Bloomberg, Long - Term Electric Vehicle Outlook, 2018

- Electric vehicles would account for **55% of new sales by 2040**
- US will be a major market in the next decade
- In EU, UK, Germany and France will lead the market

Infrastructure gap

Customers TCOs

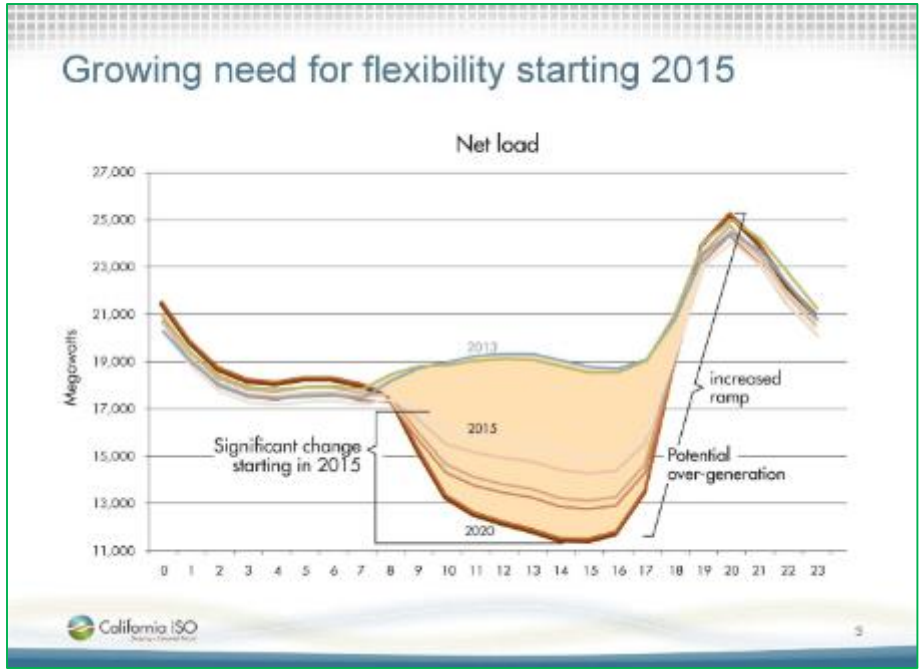
Car Offerings

must be addressed in order to boost the market

Electrical System Evolution

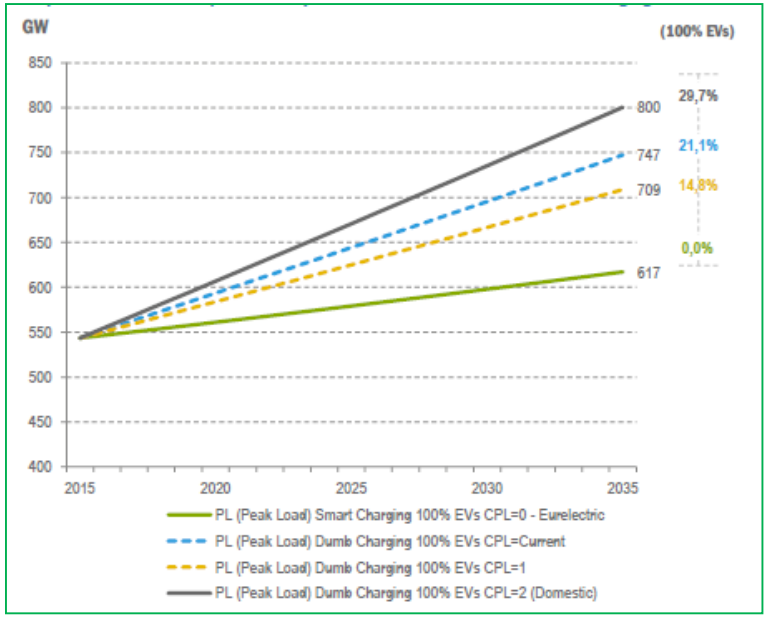
EVs & DER impacts on the Electrical System

EU grid operators might be forced **to invest over 50B€ by 2030** in order to cope with increased power demand and flexibility burden[1] required to meet:



Simulation performed by California ISO for 5% PV penetration and 10% EVs

- EV's massive increase
- Non-predictable Distributed Generation's increase
- Conventional Power plants phase out



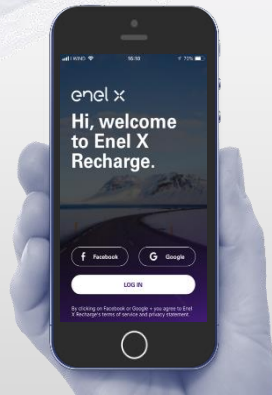
Evolution of EU peak demand for 100% Evs by 2035[2]

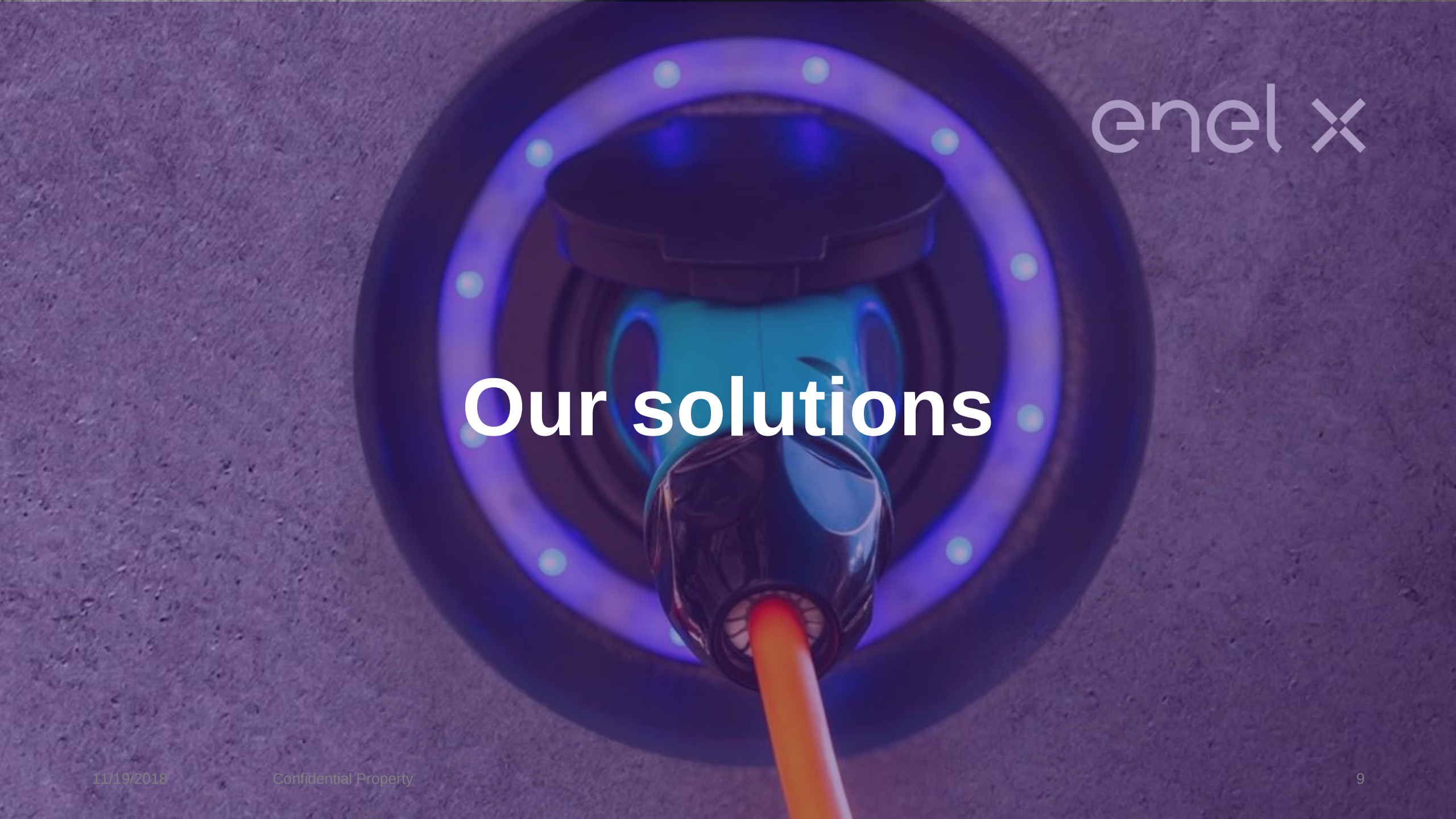
1 PlanGridEV Project, D7.1, EV-Grid Integration Best Scenario, 2016
2 Eurelectric, Smart charging: steering the charge, driving the change

Our offering

A flexible end-to-end charging ecosystem

What we offer are **flexible, best-in-class, end-to-end smart charging solutions** delivering benefits to the entire EV value chain

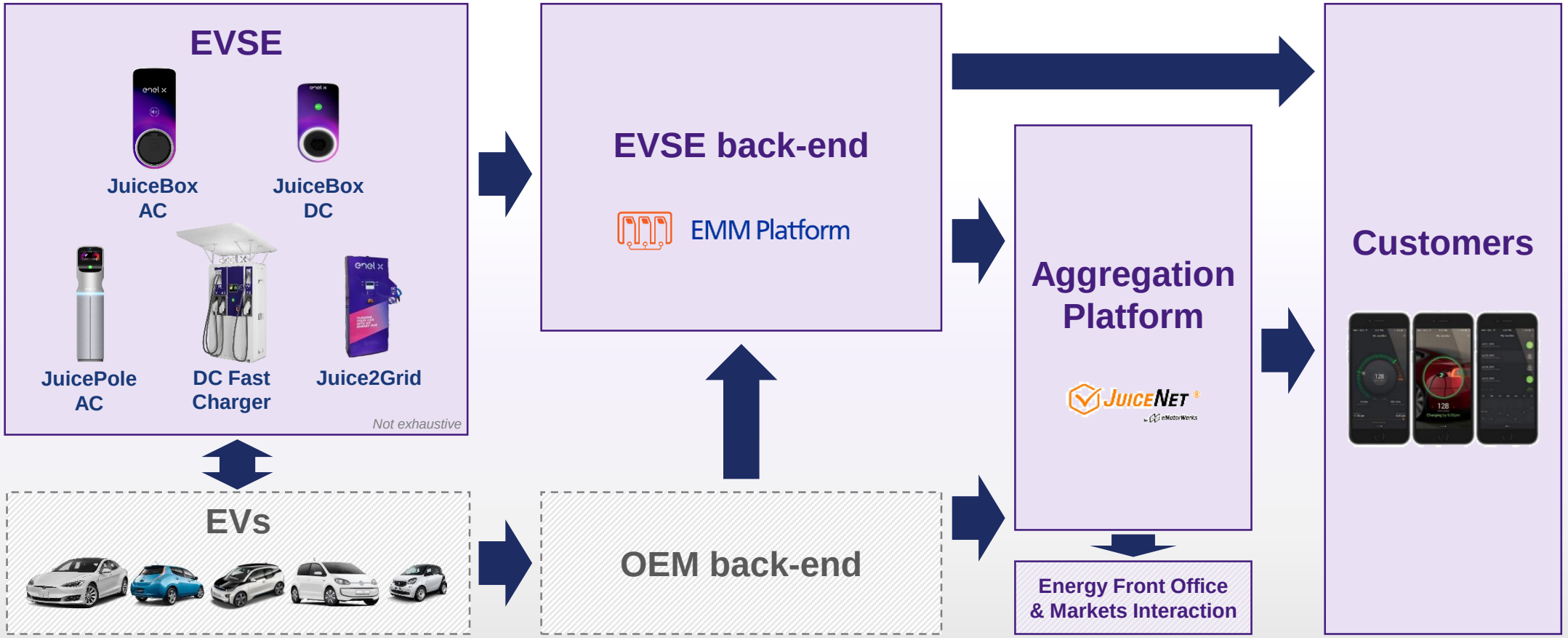




Our solutions

Enel X e-Mobility ecosystem

An open system ensuring interoperability



Enel can be a full stack technology provider (incl. EVSE) or an aggregation technology provider

Smart charging infrastructures

Field-proven charging technologies

A portfolio of highly affordable charging stations, ensuring reliability and industry-leading communications and control intelligence to meets all your needs

JuiceBox (3.7 – 22 kW)

- Single charging session handling
- **AC** charging
- **Indoor and Outdoor** Rated
- Socket and cable version
- Smart charging – Power Modulation

JuicePole (22 kW)

- Simultaneous charging of **two vehicles**
- **AC** charging
- **Indoor and Outdoor** Rated
- Socket and cable version
- Smart charging – Power Modulation

Juice2Grid (15 kW)

- Single charging session handling
- **Bidirectional DC** charging
- Enabled for **storage integration**
- Smart charging – Power Modulation

Fast Recharge (50 kW)

- Simultaneous charging of **two vehicles**
- **Indoor and Outdoor** rated
- **AC and DC** charging
- Smart charging – Power Modulation

Vehicle Grid Integration

The positive feedback loop for customers adoption

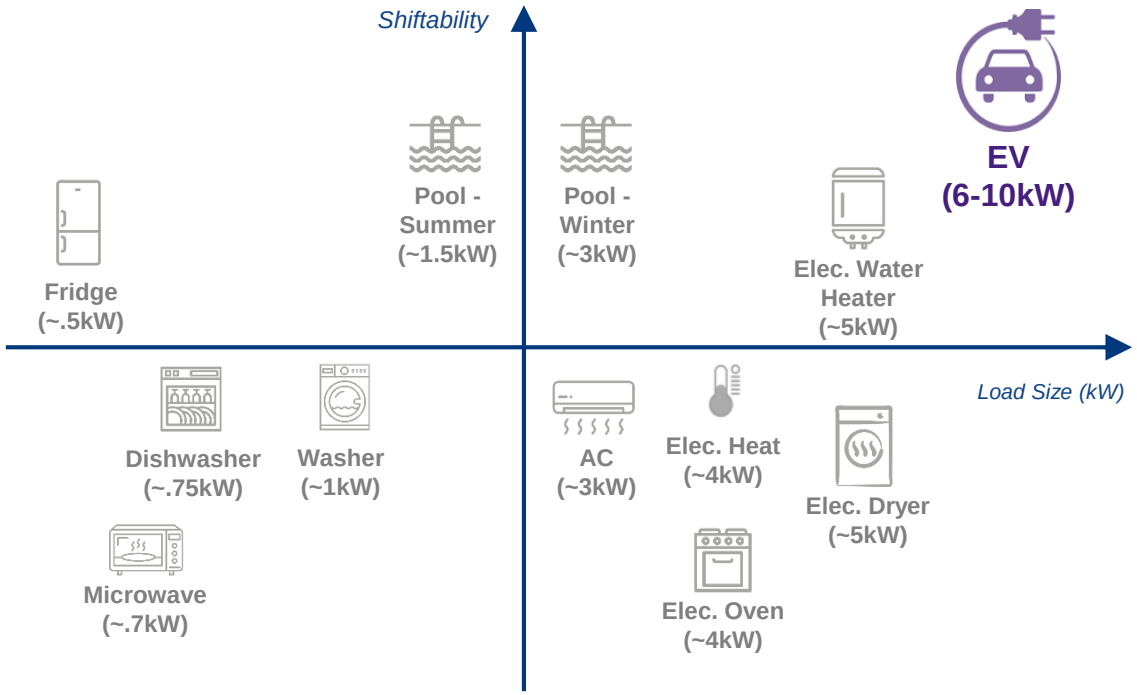
EV batteries are an example of existing distributed storage that might be **aggregated in a platform-based business model,** providing value for the electrical system and creating a virtuous cycle

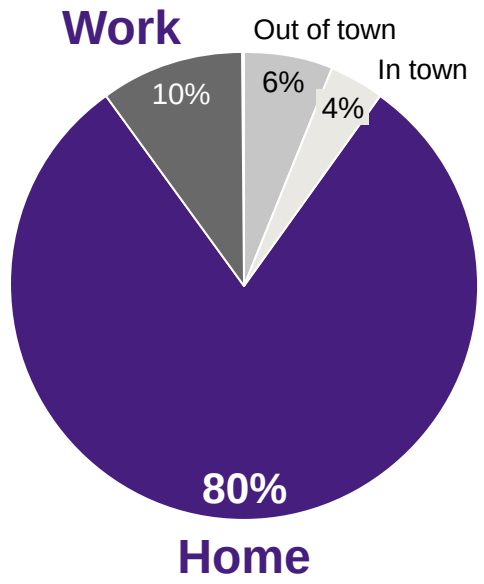
Vehicle Grid Integration helps **reducing the EV customer's TCO** combining **revenues from new grid services with fixed & variable energy cost saving**[1]

1) Depending on the reference Market: benefit may include Time of Use tariff, demand charge tariff, grid connection optimization plus grid regulation services to national TSO

Vehicle Grid Integration

Home and Workplace EV charging: a highly flexible load





30-40 mi. average daily commute requires 10-15 kWh energy per day with **1-2 h charge time**

Most long duration charging (over 6 hours) happens at home, but drivers usually need less than 2 hours of charging, creating many **opportunities to provide flexibility to the grid**

Vehicle Grid Integration

Unlocking EVs flexibility

Flexibility can be provided aggregating both unidirectional (V1G) or bidirectional (V2G) EV chargers:

V1G allows to **activate** a charge process **or** to **switch-off** an **ongoing charge**. It does not allow to provide power back to the grid

V2G allows to **activate** a charge process, **switch-off** an ongoing charge and **discharge the EV battery** to the grid. This results in a wider power aggregation with V2G compared to V1G

Best technology (V1G and/or V2G) to be used for aggregation, shall be defined based on the market requirements, EVs customer behavior and availability and considering the different investment and operating costs

Vehicle Grid Integration

Enel X Core Energy Services

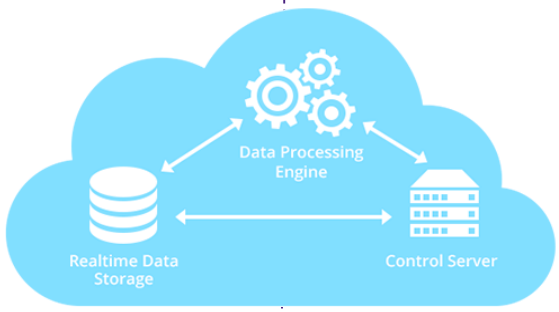
Local Energy Optimization
("behind the meter")

Time Of Use tariff optimization
Scheduling charging processes in order to optimize the share of energy consumed in the most profitable tariff (according to relevant Utility TOU Rates)

PV balancing/optimization
Manages EV charging to occur when generation source is operating (e.g., rooftop solar); second-by-second balancing of demand and supply

Demand Charge Management & Demand Limitation
Scheduling charging processes in order to reduce recurrent system costs linked to power absorption

Load Balancing (connection fee reduction)
Limit total coincident consumption of EVSEs during specific time intervals based on power constraints at site level



Grid Services Monetization
("in front of the meter")

Demand Response (Capacity Market participation)
Commitment to reduce/increase capacity available for periods of system stress in order to guarantee Power System Adequacy

DAM vs RTM optimization and hedging
Dispatch instruction to EVSEs from wholesale market for curtailment when market clearing prices are greater than bid prices

Frequency Regulation / Response
Provide fast reserve to maintain system frequency at operational levels

DSO managed congestion relief programs
Curtail a group of EVSEs as a result of a utility instruction

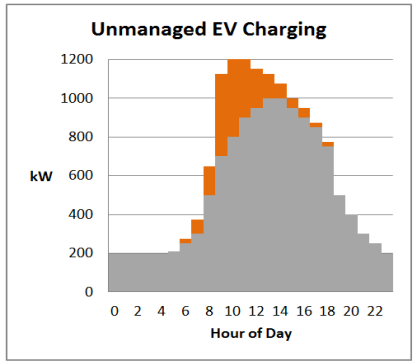
Energy2grid
Energy Arbitrage (with V2G)

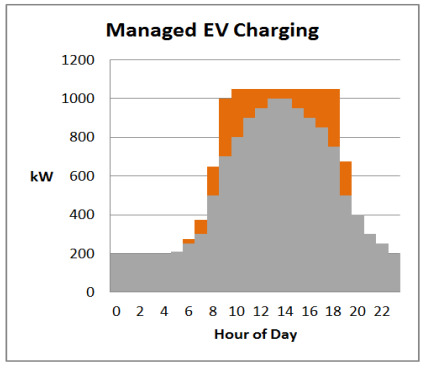
Vehicle Grid Integration Software

Optimize your investment through energy cost savings

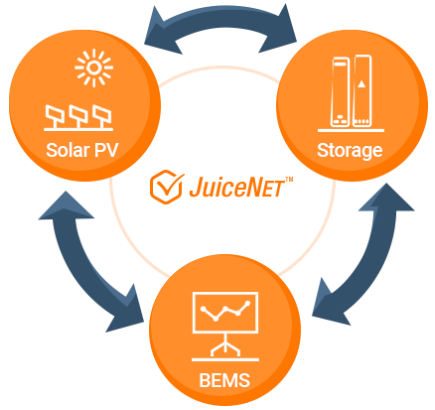
Cost Savings

Minimize unwanted demand peaks and reduce utility demand charges



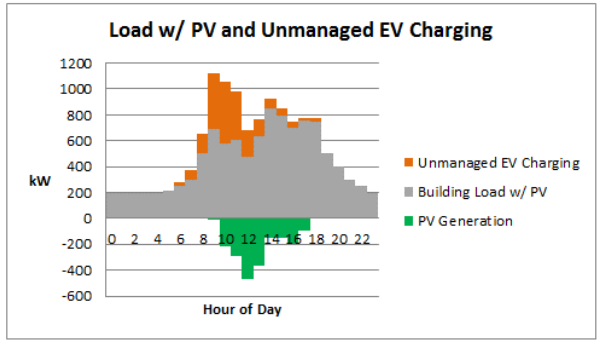


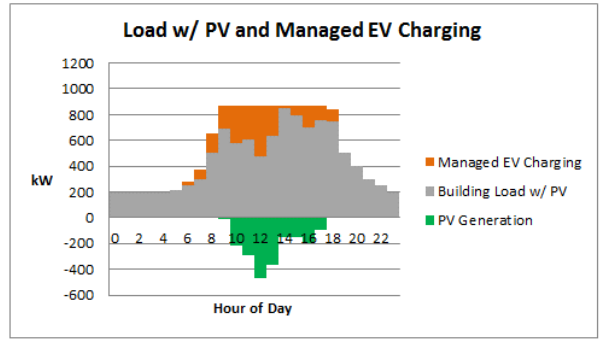
behind the meter



Energy Optimization

Coordinate your EV charging load with your on site generation and energy management systems





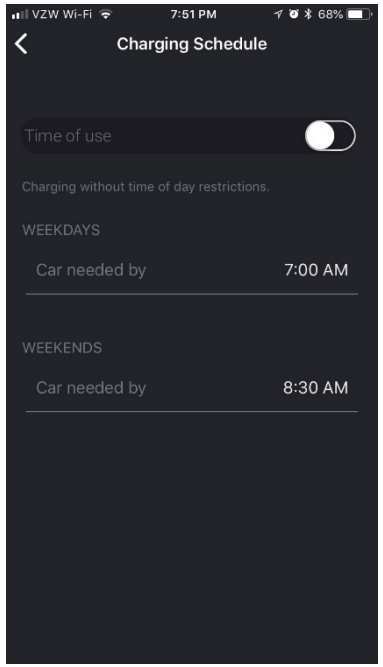
Our technology helps you **maximize your return on EVSE investment**, through **energy cost savings** arising from optimized charging load control

Vehicle Grid Integration Software

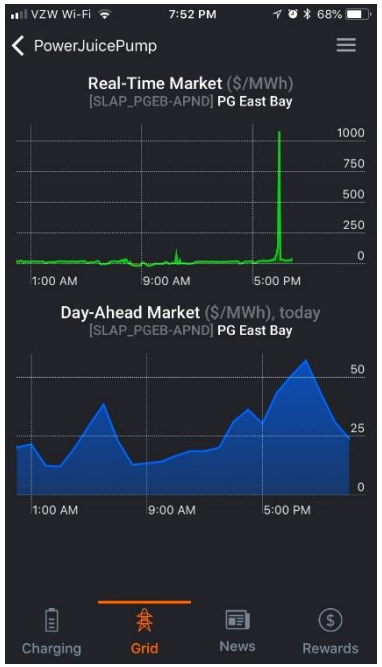
Optimize your investment through revenues from grid services

Front of the meter

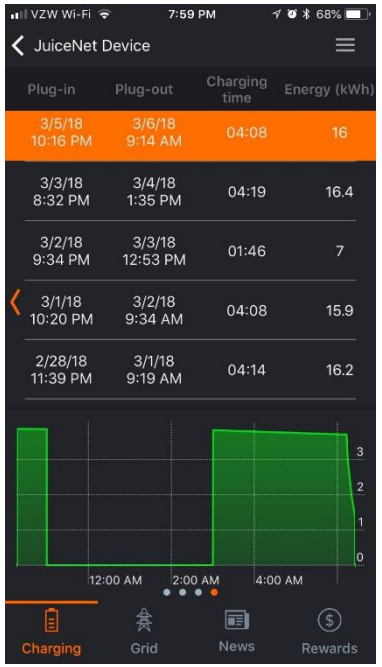
Customer Provides Mobility Preferences



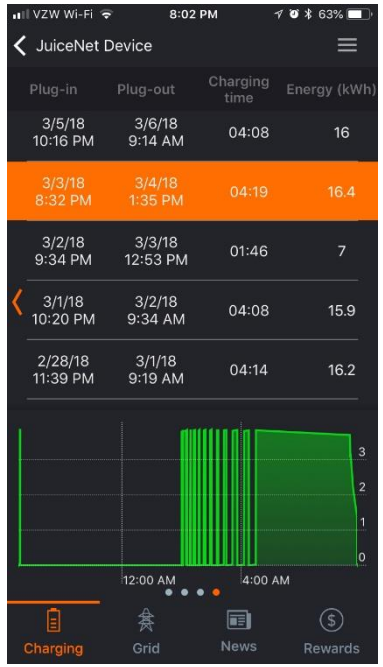
Bid & Awards based on Market Prices



Long Duration Curtailment



Fast Response Curtailment



Our technology helps you **maximize your return on EVSE investment**, through **revenues** from grid services provision

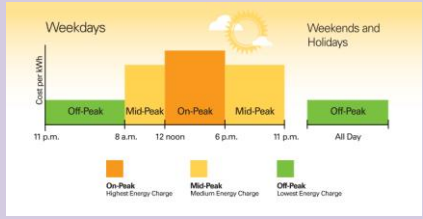
Enablers for EV demand participation in electricity markets

What is needed?

Behind the meter

Customers **shift charging of EV** during off-peak periods due to Time of Use retail prices, no direct/indirect participation to energy/balancing markets (smart charging / V1G)

- ✓ Availability of **retail dynamic pricing offers:** *Energy component*: e.g. day/night; hourly based or *Network component*: e.g. “on-peak” and “off-peak

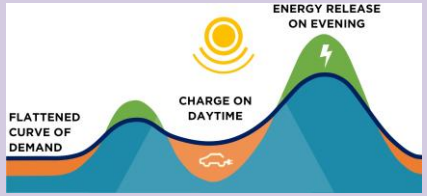


Front of the meter

Participation in energy/balancing/capacity markets through aggregators:

- Smart charging / V1G: charging of EV in response to signals from intraday and balancing markets (especially primary reserve)
- V2G: charging and discharging of EV in response to signals from intraday and balancing markets (especially primary reserve)

- ✓ **Market for primary reserve** (e.g. in Italy no market, obligation to reserve 5-10% of capacity, regulated payment for some production unit)
- ✓ **Asymmetric balancing products** (downward and upward) with **adequate size** (1 MW)
- ✓ **Long-term contracts for balancing services**
- ✓ **Aggregation allowed**
- ✓ **Possible participation to capacity market**



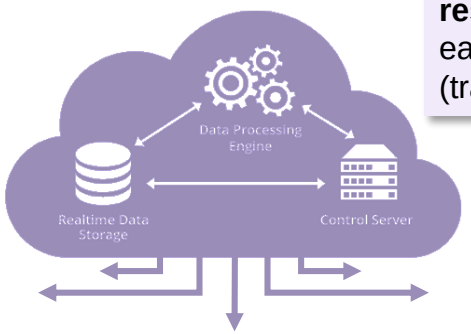
Multiple business opportunities for EVs but adequate regulatory framework needed

Case studies

Case study internal: Italian DR pilot

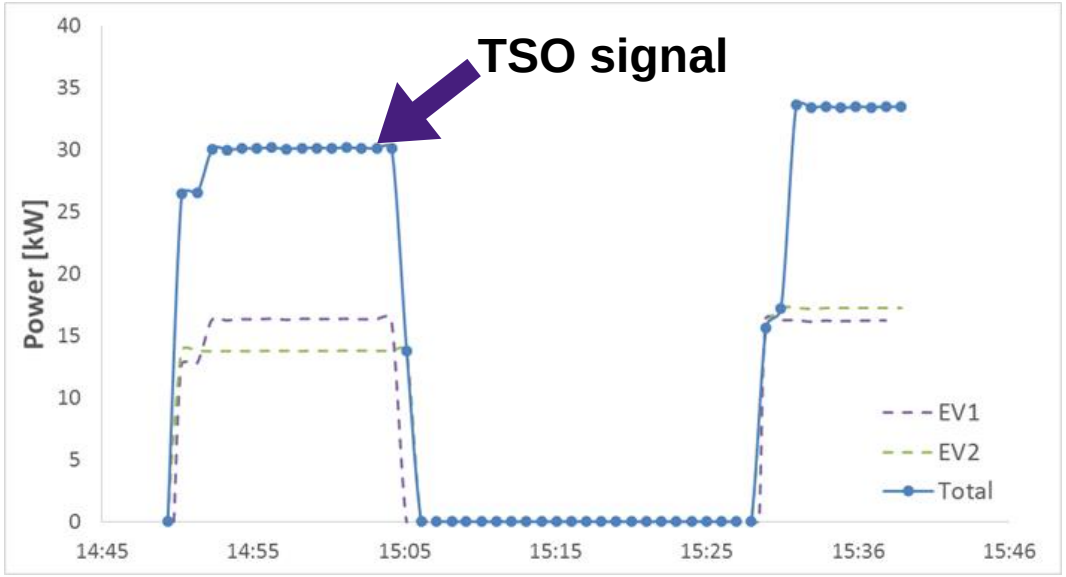
Experimental project in Enel X office - overview

The experimental project involves the participation of several models of electric vehicles, part of the internal **car sharing fleet of Enel X**, connected to the smart unidirectional charging infrastructures (V1G) of the Tor di Quinto car park.



Enel's intelligent infrastructures are connected to a management and monitoring **platform that allows the aggregation of resources** and the automatic variation of the power absorbed by each electric car in order to satisfy a **request by the TSO** (transmission system operator, Terna in Italy) **to reduce the load**.

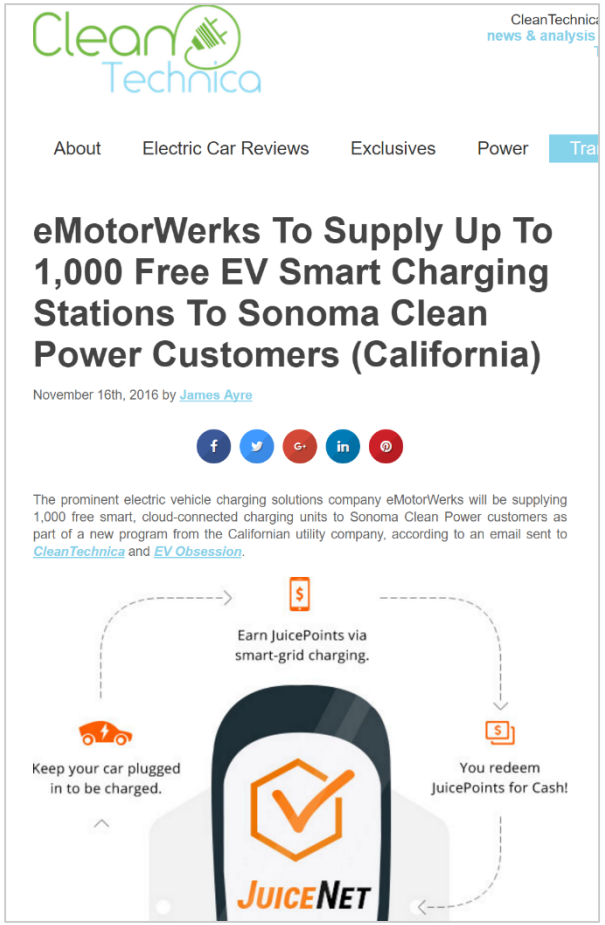
Recharging process modulation

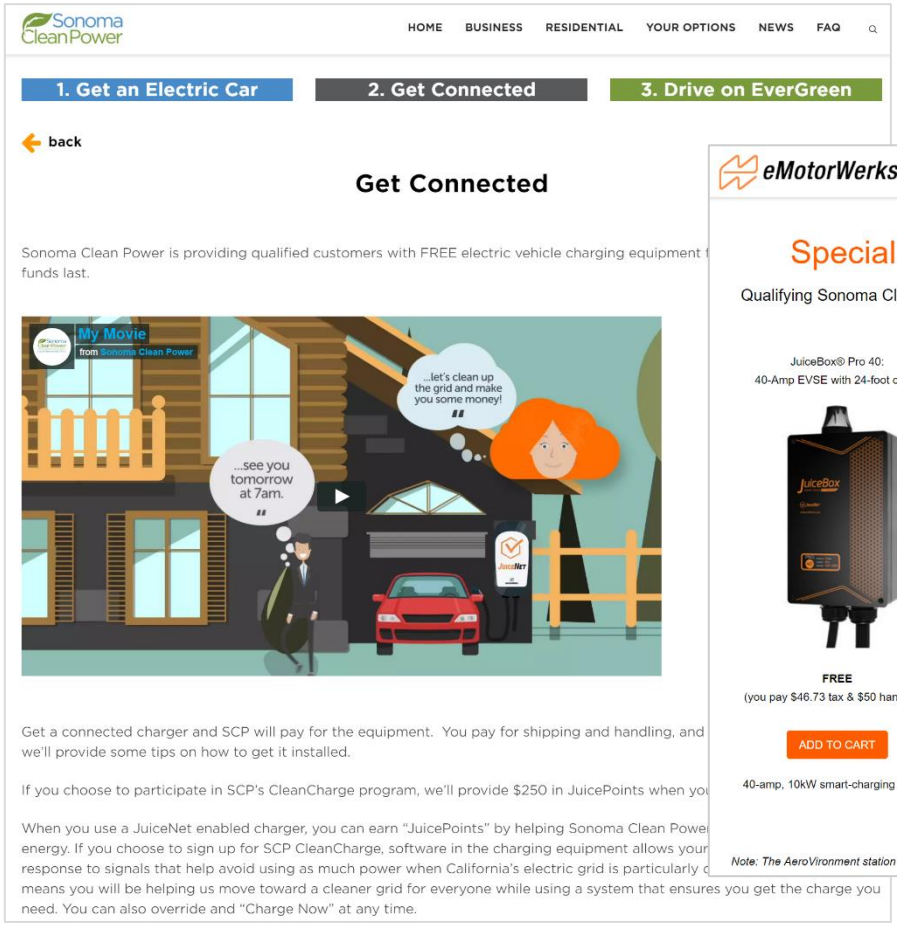


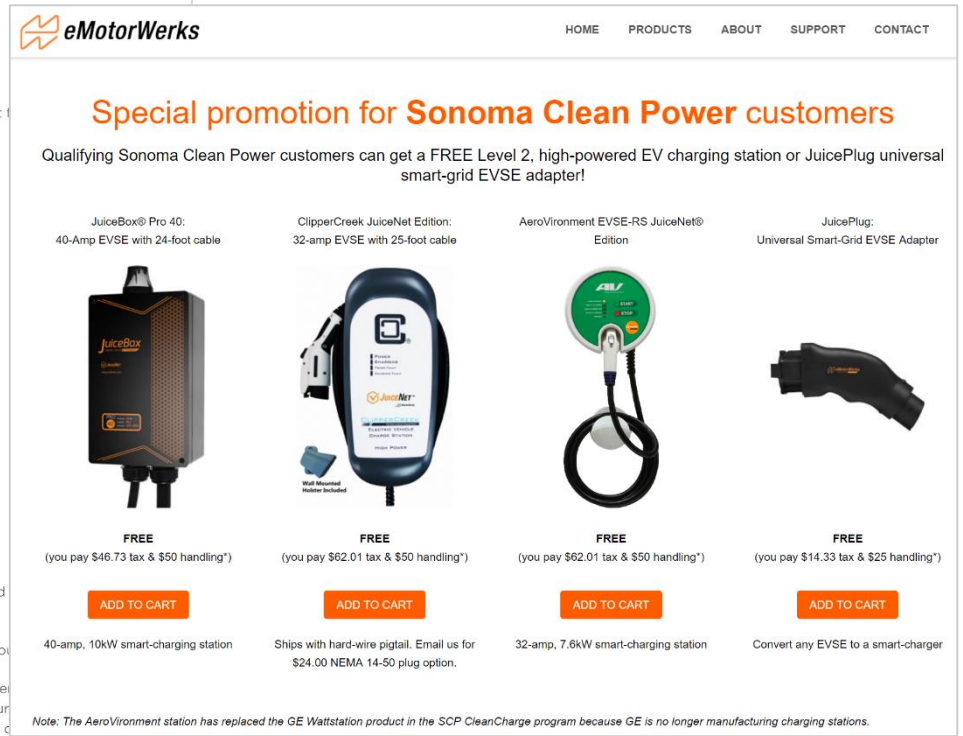
The platform therefore at the time required by the TSO **reduces the power absorbed during active charging processes** and at the end of the event restores the initial situation, responding to the needs of the TSO (in this case, to obtain the maximum possible power variation the recharges are totally suspended) – vehicle 1 grid service.

Case study Utilities: Helping Sonoma Clean Power integrate renewables

Turn-Key FlexCharge concierge program to help utilities develop and manage EV resources

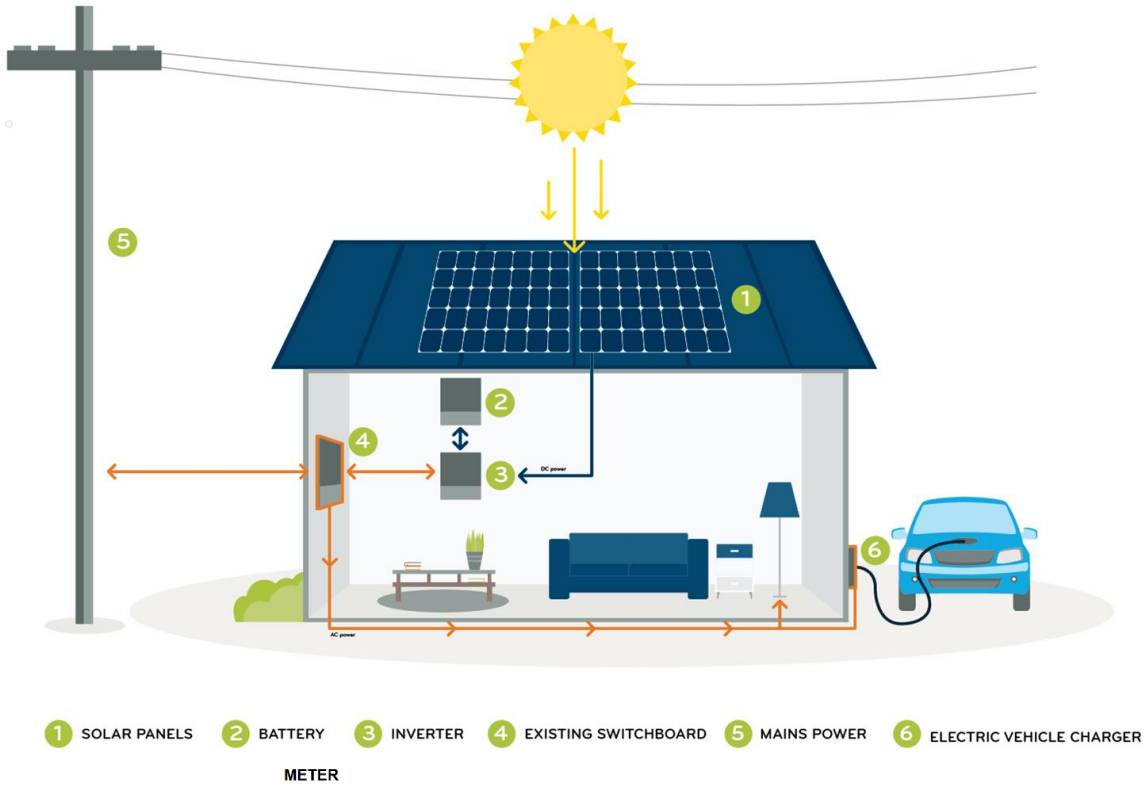




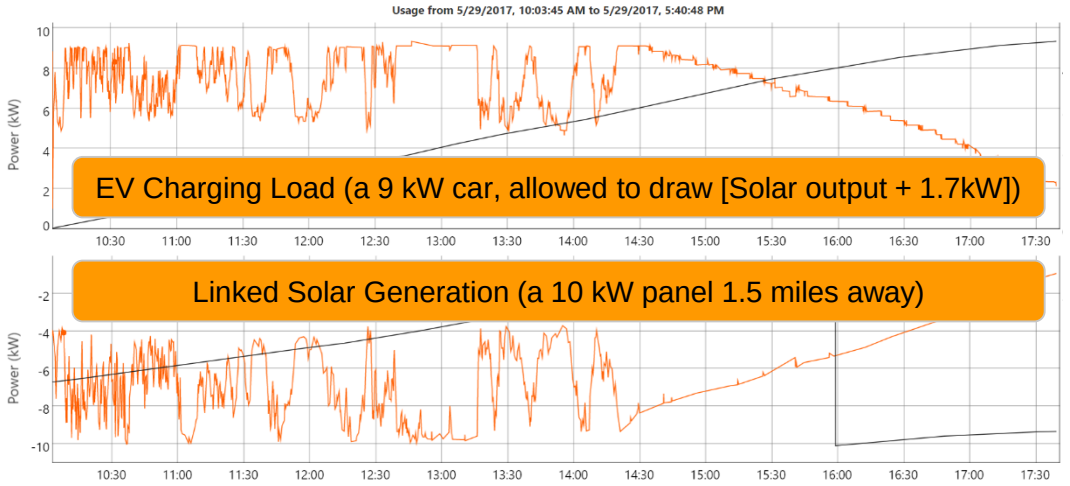


Case study Residential: **Solar balancing**

Generate up to $1,000 per year in energy cost savings in non-NEM markets (e.g., Germany)



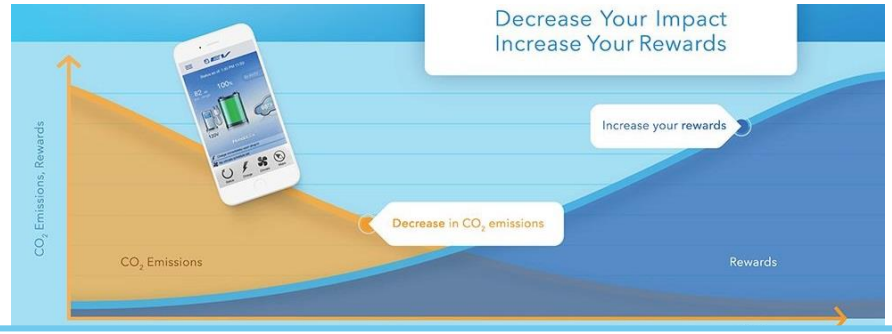
- **eMW JuiceMeter** (2) on the solar inverter output measures real-time solar production
- **eMW JuiceBox** (6) modulates charging rate to match solar production and maximize self-consumption
- Customer saves on their energy bill and ensures clean power



Case study Automotive: Helping Honda drivers to Save Money and Reduce Environmental Footprint

Find the best time to charge electric vehicles according to electric grid conditions:
reducing customer costs and CO2 emissions;
earing rewards through DR programs participation in California

Honda SMART CHARGE powered by JUICENET®



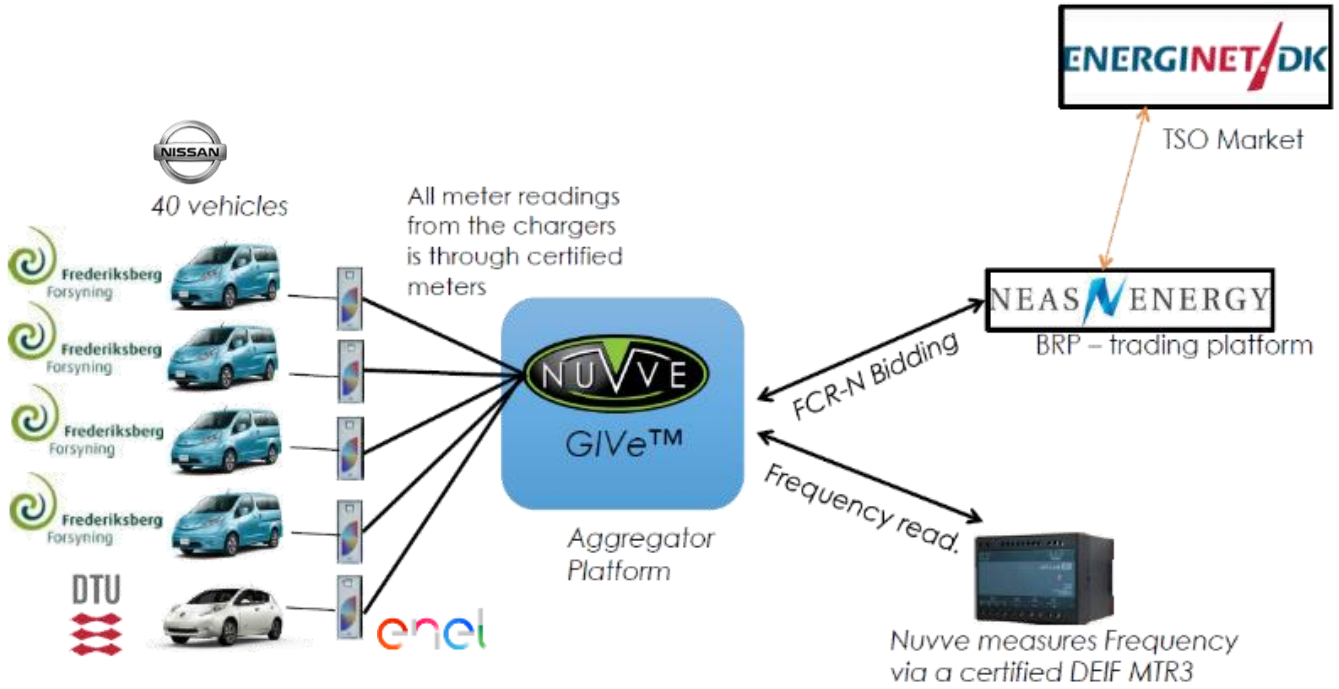
Honda SmartCharge monitors wholesale electricity markets for when energy demands spike and inefficient peaker power plants need to pick up the slack.

In such events, we defer charging temporarily until the grid electricity load has dropped sufficiently to avoid needing these inefficient fossil fuel power plants. This happens automatically, while ensuring your car is at maximum charge when you need it.

By adjusting the time of charging of your Fit EV along with other Fit EVs in your area, Honda earns payments from its utility partners and is then able to share those profits with you.

Case study Fleets: Denmark V2G Hub

The Danish Vehicle-to-Grid hub is the European's first fully commercial V2G hub.
The utility Frederiksberg Forsyning installed Enel V2G units and purchased electric vans to connect them together and to turn them into small power plants and micro distribution grids



Generate potentially up to €1,000 per EV per year through FCR-N remuneration

Denmark was a good test environment considering the possibility of providing frequency containment reserve (DK2 FCR-N) service through Low Voltage aggregated resources

Thank you

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Residential User Interface

Smartphone application

Improve EV user experience and increase brand differentiation with a **digital solution for home charging real-time control and monitoring**

- Charge start/ stop
- Charge scheduling
- Charge monitoring
- Remote charge control
- Charge completion time forecast
- Self-learning target charge completion time
- Historical charging data access
- Multi charging stations management
- Smart charging option
- Smart-charging override option

Public charging network Interface

Charging everywhere your customer need

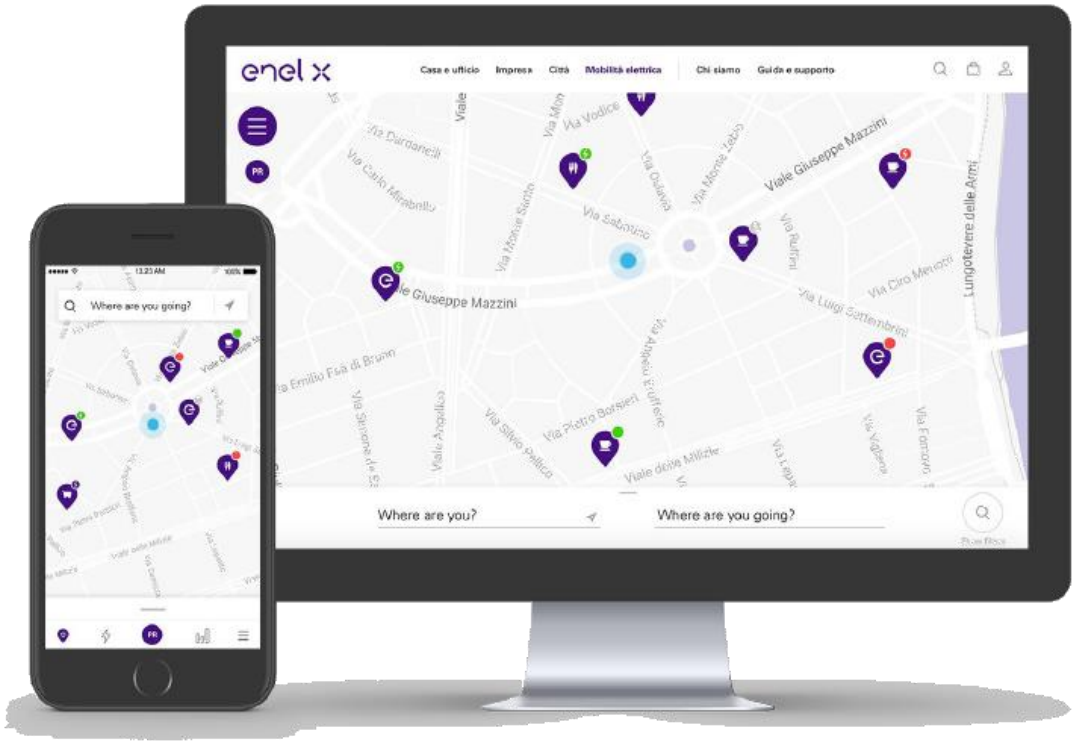
Offer your customers access to a widespread public charging network, setting aside “range anxiety” and improving customer experience

A *A simple and convenient way to enhance your EV offering with public charging:*

Offer your customers access to Enel X public charging network at **dedicated special rates** through Enel X Recharge APP/ Card/ Portal

B *A solution to become Mobility Service Provider and directly offer your customers public charging :*

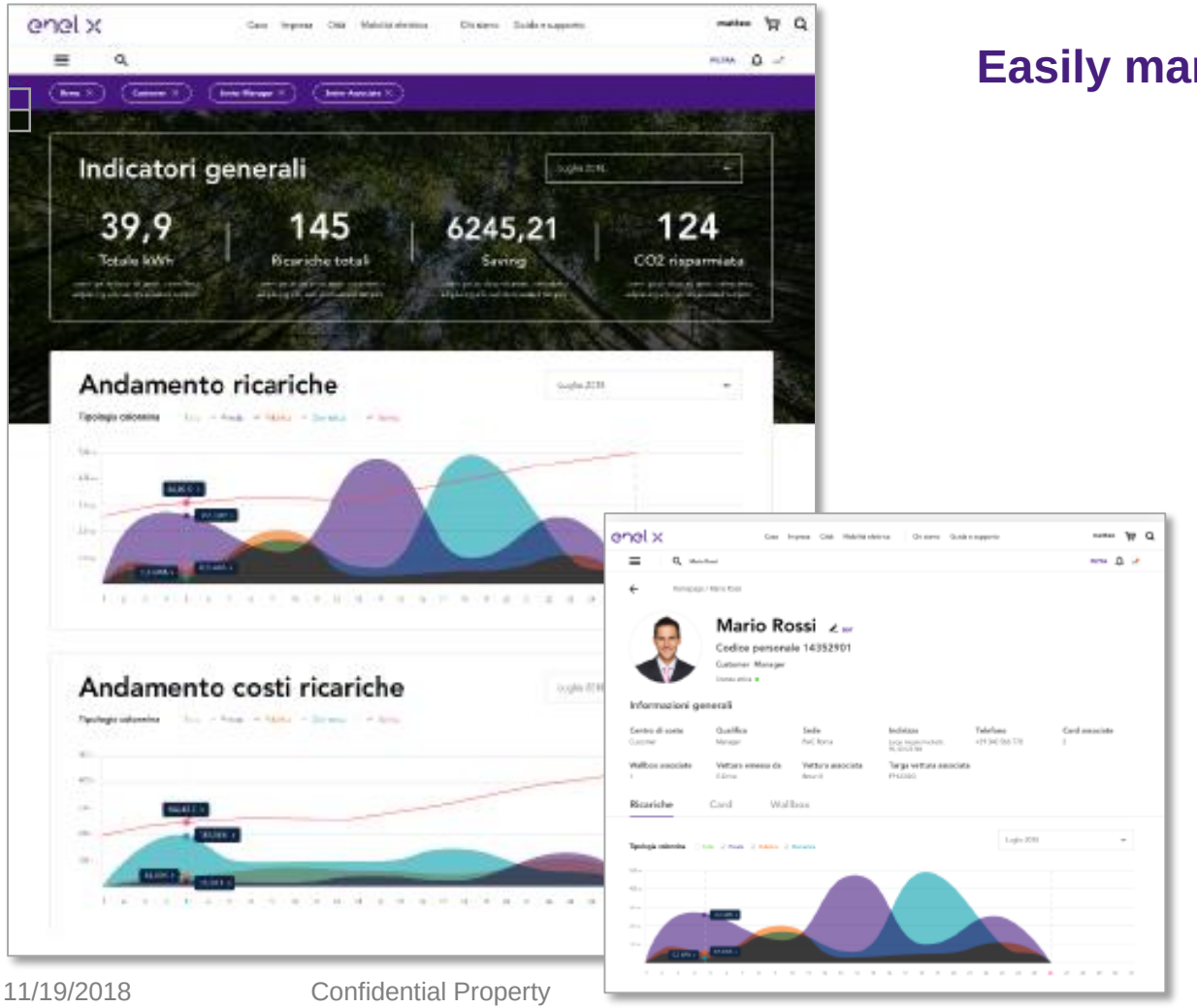
Offer your customers access to Enel X public charging network from your APP, through the provision of APIs enabling the **integration of your systems with Enel X charging network management system**



Note: Public charging network access is only available in certain countries

Fleet User Interface

Fleet Management Dashboard



Easily manage your EV Fleet from Enel X web portal

- Overview of **charge trends** divided by public, private and domestic
- Detailed data on **costs, savings and CO2 emission reduction**
- Possibility to **view and analyze data** in terms of whole fleet, single employee/ vehicle, single charging event
- **Configuration and management** of the employee roles and visibility
- Management of **reports** to Enel X and to employees