IA-HEV Task 20

"Quick charging technology"

EVS 28- Korea

May, 2015

IEA INTERNATIONAL ENERGY AGENCY
HYBRID & ELECTRIC VEHICLE IMPLEMENTING AGREEMENT

Introduction to IA-HEV Task 20

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- Task 20 addresses **QC technologies for PEV**. Approved in November 2011, for a running period of 3 years (2012-2015)
- CIRCE operating agent of the task. **Participants**: Spain, USA, Germany and Ireland.
- **Funding**: national funds of participating countries + attendees covering their expenses.
- Task aims at bringing together all stakeholders: OEM, utilities, battery companies, government representatives, academia and equipment manufacturers. To avoid gaps along the QC management systems

Task 20: Goals

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- Discuss **QC's role** in deployment of electric vehicles.
- Knowledge share on market deployment **roadmaps** for QC. Special focus on:
  - Diminish the grid and EV-battery impact
  - Breakdown non-technical barriers
- Get consensus and give **recommendations** on the standardization process for vehicles electrification. Involvement of participants in standard committees (JARI, BWM, VW, JRC-EC…)
- The requirements and issues of quick charging technology for future smart grid promotion
- Designing and ensuring convenient, safe, and secure handling for consumers

Why QC?

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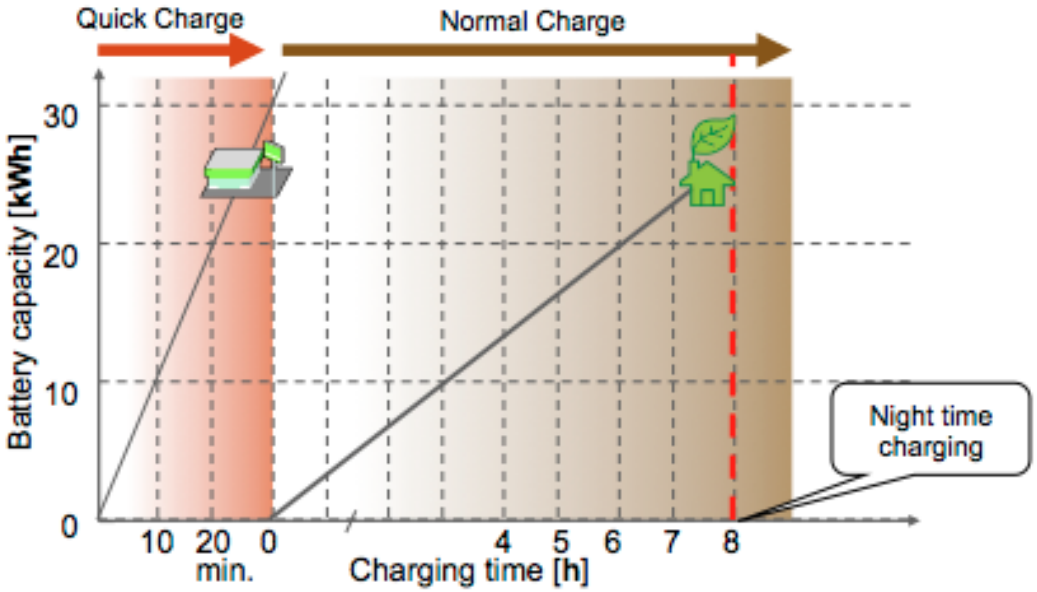
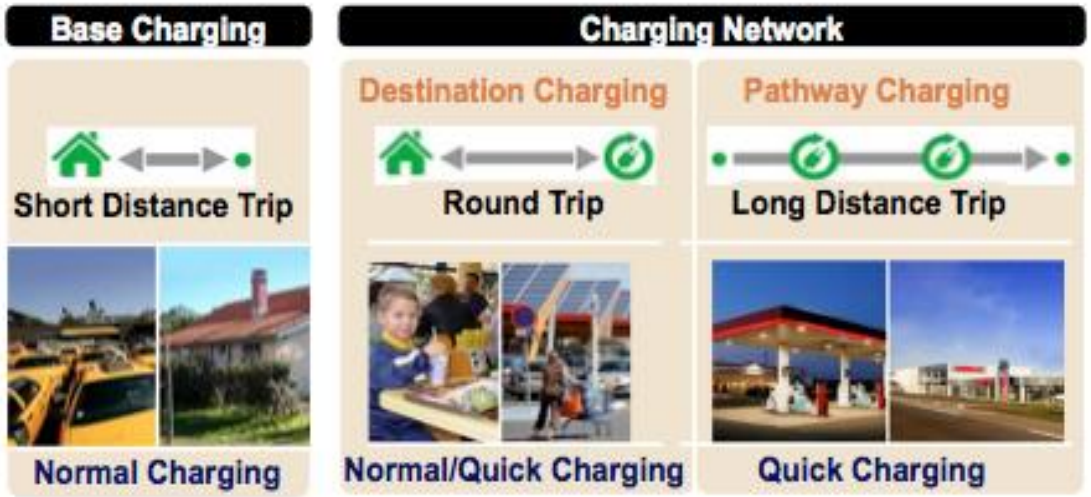
- QC: 80% of EV battery charged in less than 20 minutes
- Main role: reduction of **range anxiety** (big barrier to deployment of EVs)
- **Complement** (not substitute) "normal" charging
- Main use as public infrastructure in urban and **inter-city trips**





Task 20: Working method

- Four **workshops**:
  - Kick-off meeting (L.A., May'12): main challenges and barriers for QC
  - 2nd Meeting with METI (Japan, June'13): QC technology development trends

  - 3rd Meeting with EVS 27 (Barcelona, Nov'13): interoperability
  - 4th Meeting with Task 10 and Batteries 2014 (Nice, Sep'14): impact of QC in EV's battery

- **Survey**: barriers and solutions for large deployment of QC (2014)

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Final report

Final report; Content

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1. Introduction

2. Quick Charging Technology: State of the Art

2.1. CHAdeMO

2.2. Combined Charging System (CCS)

2.3. CHAdeMO versus COMBO

2.4. Other quick charging technologies: inductive charging

3. Impact of the quick charging on the electrical grid

4. Impact of the quick charging on the battery

5. Business models for quick charging

6. Vehicle-to-grid (V2G)

7. Situation of Quick Charging Technology

Actions at EU level

Specific national programmes

ANNEX 1: IEA SURVEY RESULTS; BUSINESS MODELS, CHARGER INFRASTRUCTURE, OEM, GRID IMPACT, ROADMAP, LIST OF PARTICIPANTS
ANNEX 2: RELEVANT STANDARDS FOR QUICK CHARGING

Charger standards; Trends

- Two main industrial standards for DC QC: **CHAdeMO and Combo**
- CHAdeMO first (2010) by 4+1 Japanese organizations: +430 organizations in CHAdeMO association (today)
- Combo system later (2013) supported by ACEA and SAE
- EC: DC QC points deployed in EU to comply **AT LEAST** with Combo from 2017

CHAdeMO

Nissan Leaf charging sockets: CHAdeMO (left) and ISO61196-2 Type 1 (right) to use 1 to 3 (AC)

COMBO

Widespread standards; CHAdeMO vs. Combo

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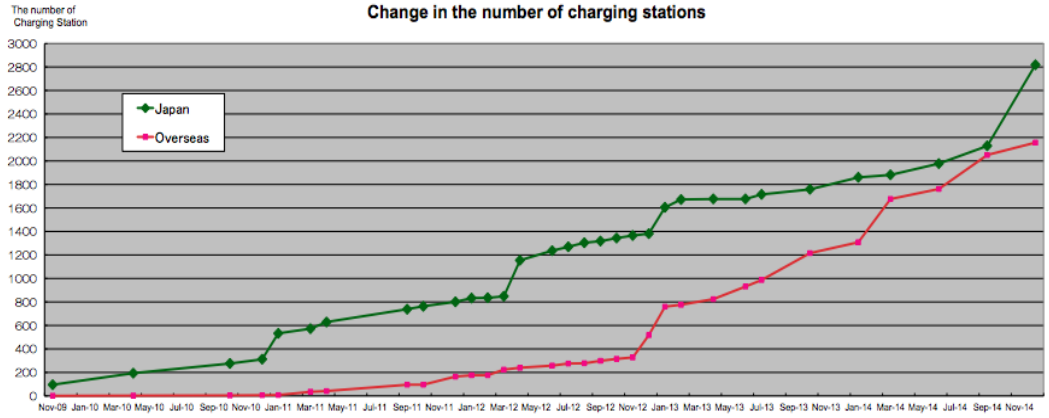
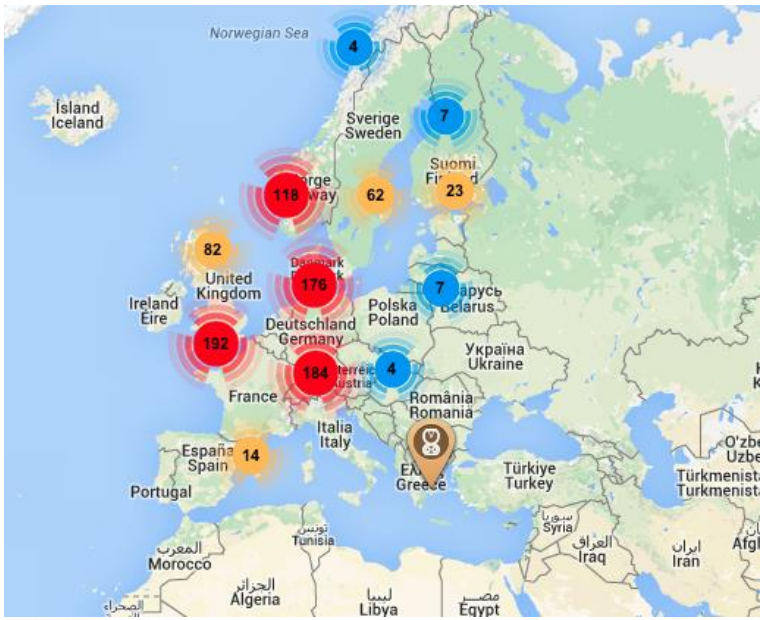
CHAdeMO



CHAdeMO website



CCS-Map

COMBO

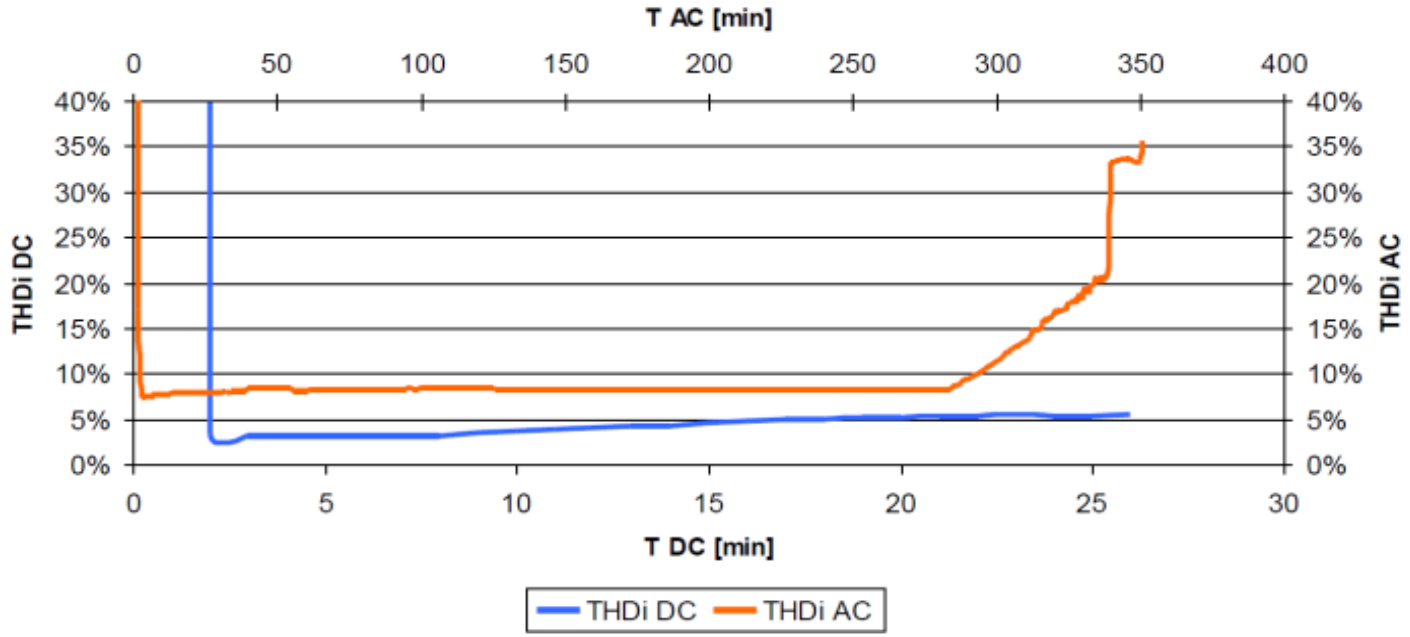
Combo chargers installed in Europe

- Main difference: Combo system allows **2 types** of charging (AC and DC) in same charging inlet in EV
- CHAdeMO and Combo non interoperable → problem for car manufacturers!!
- **Coexistence** possible → multiple-arm chargers now in market
- Proved in EU: installation of both CHAdeMO (1600) and Combo (830) increasing

QC impact on grid; I

Deterioration quality of grid (reactive power, harmonics, etc.) → advanced power electronics available have limited the problem

Distortion; DC quick charging produces proportionally less quality distortion to the electrical grid than slow and medium AC charaina



QC impact on grid; II

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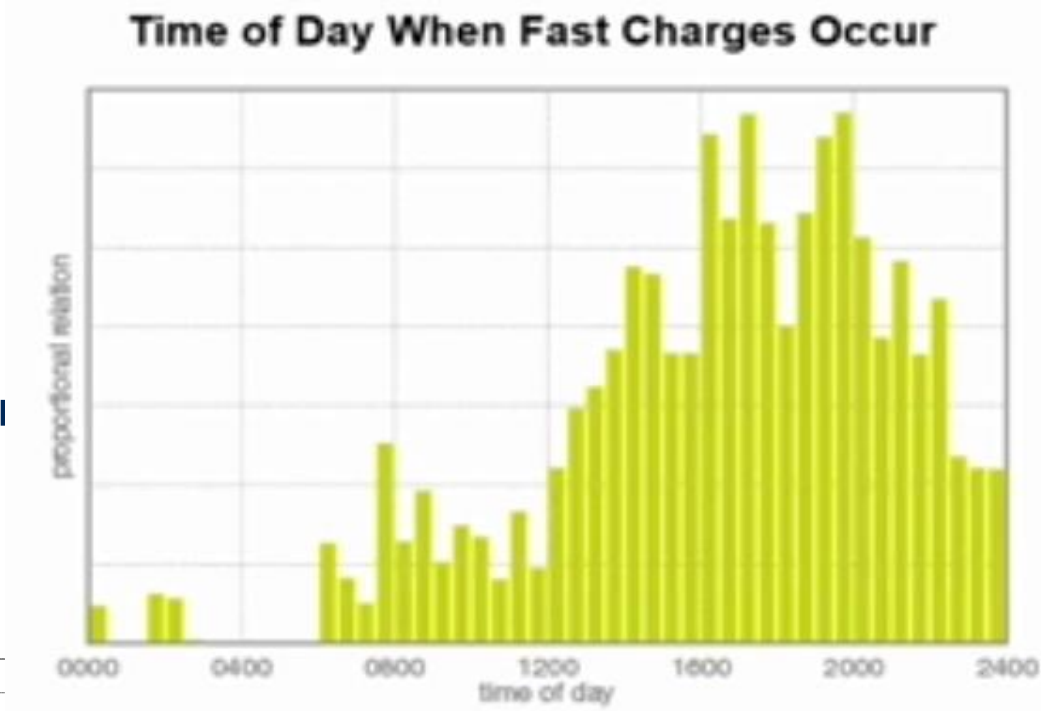
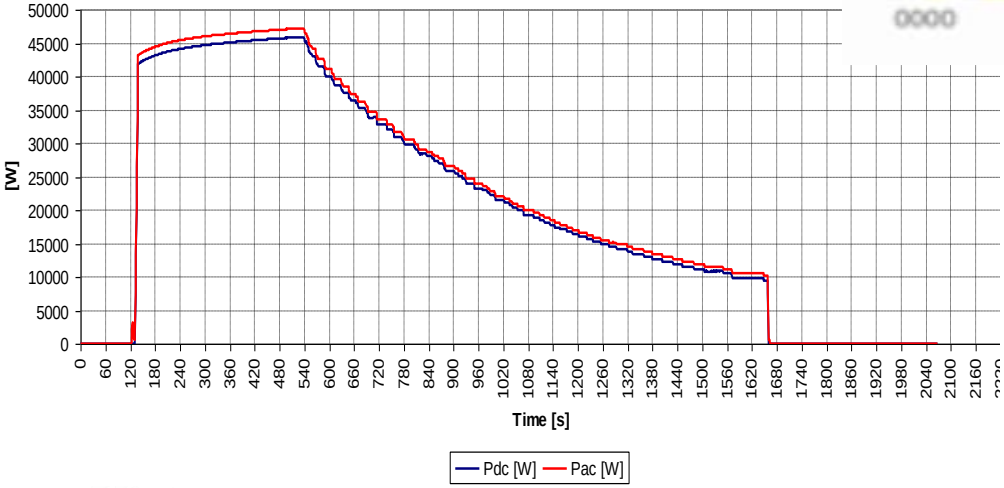
Overload of the grid:

- Issue for weak networks
- QC occurring in peak-times
- Installed capacity not an issue i
US, Spain….



Green Lots

Power consumed by quick charger

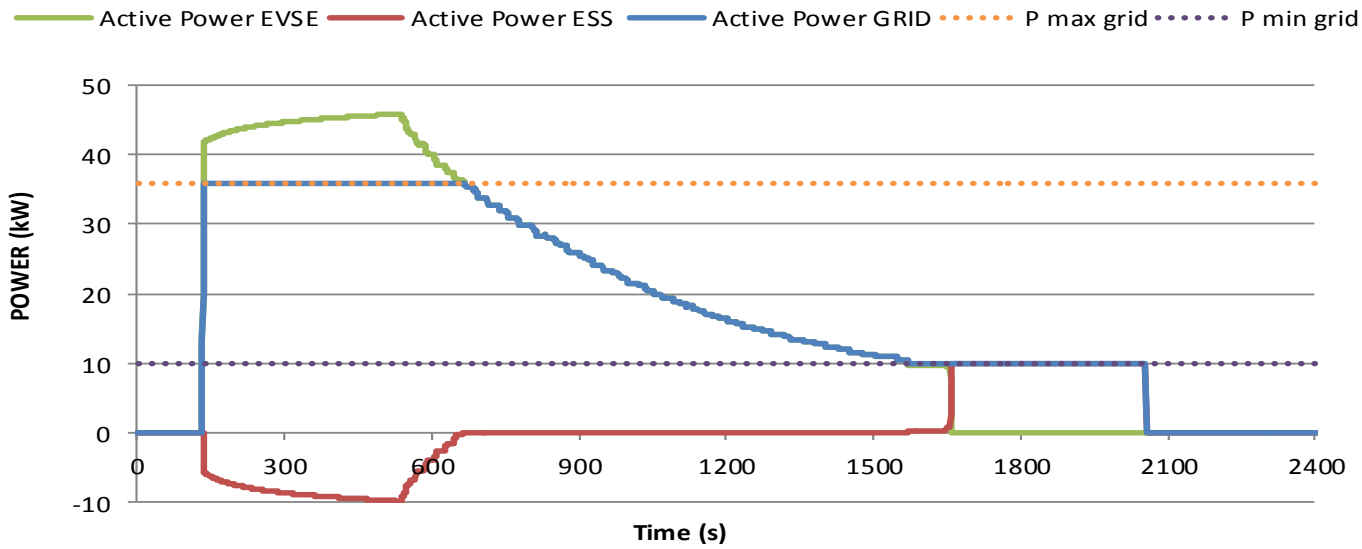


CIRCE; CRAVE Project

QC impact on grid (II)

Solutions explored:

1. Integration of **ESS** and **renewables** in the chargers for peak shaving → effective but important cost



Peak shaving using ESS

CIRCE; CRAVE Project

2. **Smart charging** strategies → **drivers' behavioural change :**

demand control of the EV charging → modify drivers behaviour → complicated, require data mining, innovative communication, ICT, incentive programmes

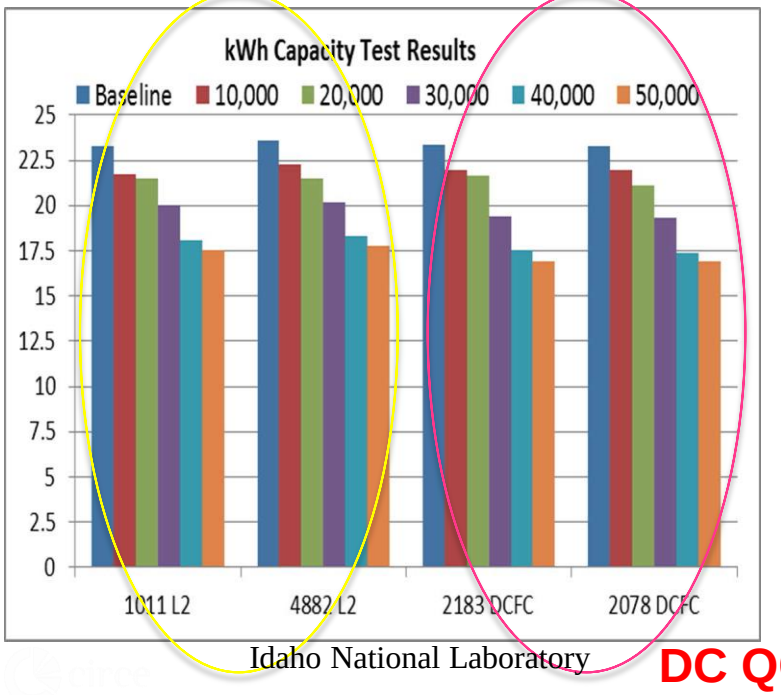
Smart Charging App

BMW

QC impact on EV battery

- Batteries are the most expensive component of EV, contributing to high prices of EVs→ **concern** from OEMs about QC damaging batteries
- Tests performed by participants of the task proved this wrong:

Normal Evolution of battery's capacity



Idaho National Laboratory

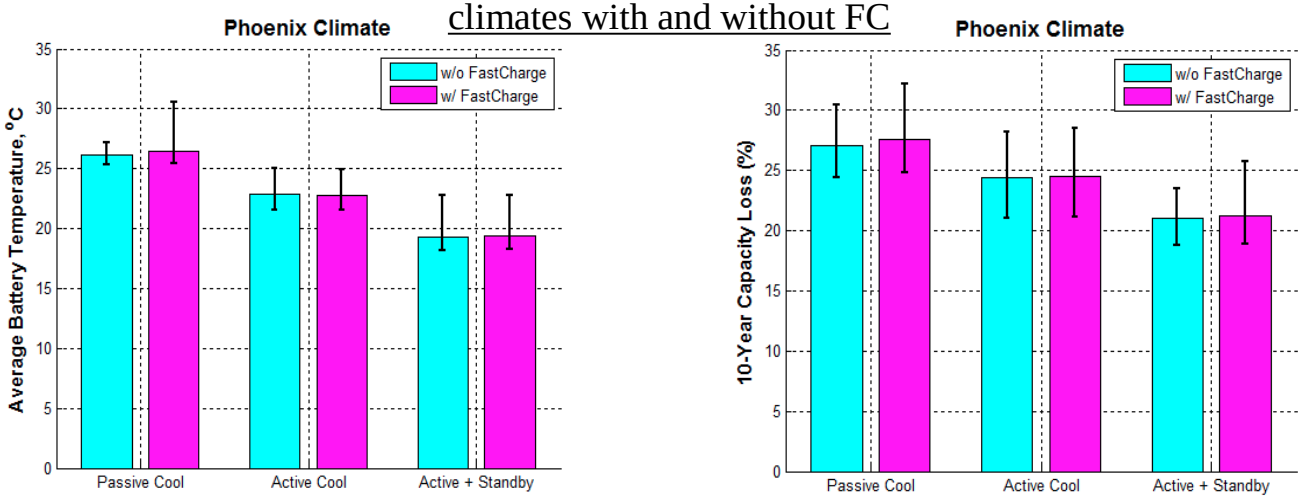
DC QC

- Average capacity **difference** between EVs charged using slow and quick charged of 0.6 KWh (2.6% SOC) after 50,000 miles

QC impact on EV battery (II)

- Other studies proved relation of battery pack temperature and degradation
- Low temperatures → **lithium plating** → degradation and safety issues
- Potential degradation in hot climates → importance of **BMS**

Battery pack average temp and % capacity loss after 10 years in extreme climates with and without FC

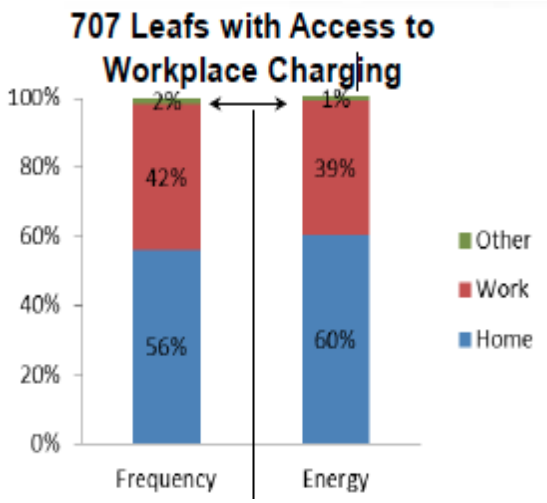


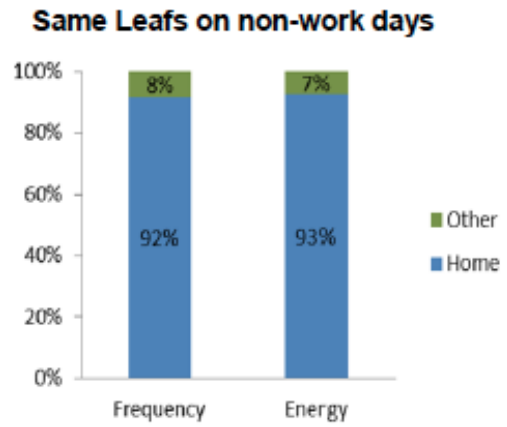
National Renewable Energy Laboratory

Business models

- Not clear and unique business model for QC
- Very related to **EV driver's behaviour** and patterns → short trips → charging home/work
- High installation & operation costs + relatively low average charge events/day → **public support** needed
- Pricing strategies an issue → impact of electricity price
- Paying methods: for a small EV market → **membership fees**

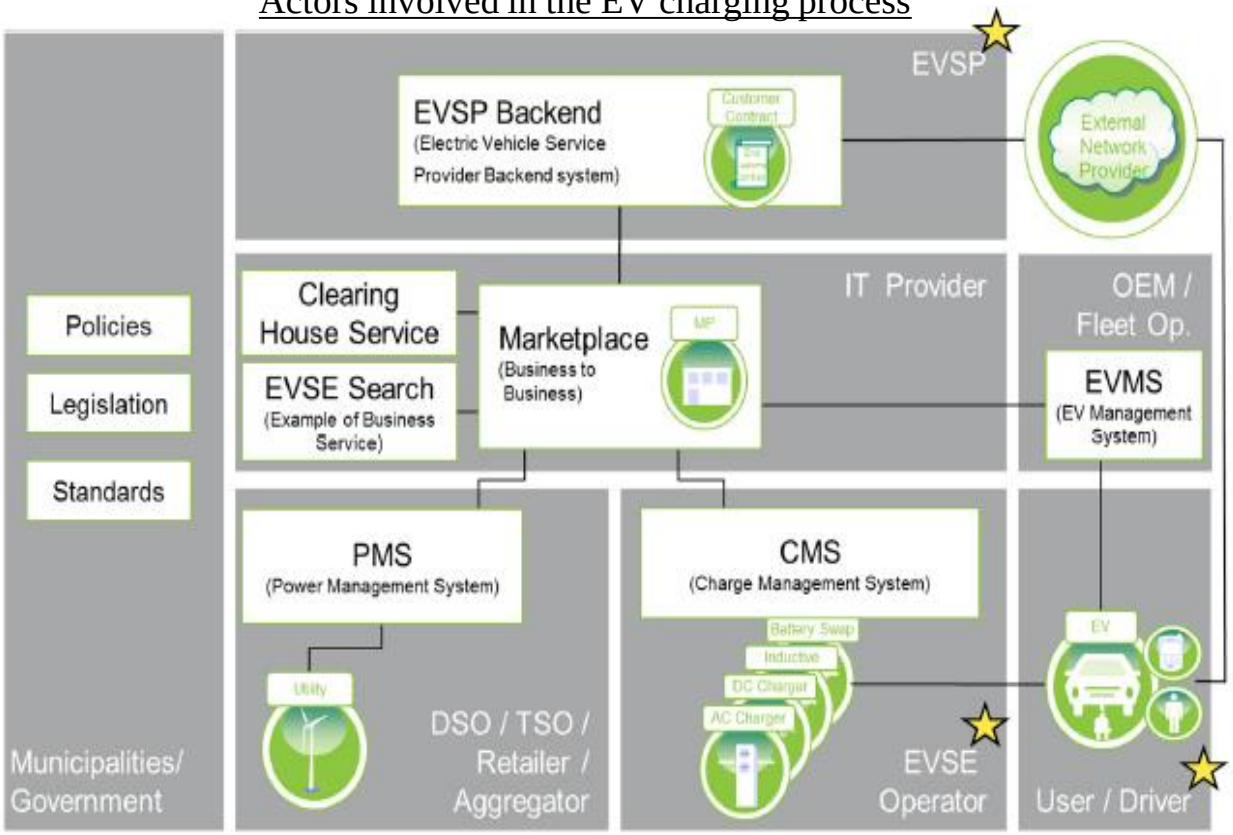
Charging profile EV drivers





Business models

Actors involved in the EV charging process



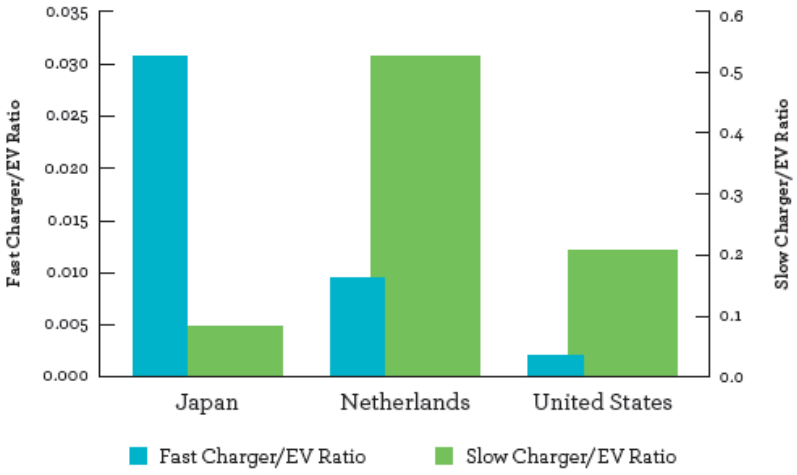
Green eMotion project

- Very **complex ecosystem** → many actors, different interests
- **Interoperability** a big issue → lack of standardization of identification and communication protocols → customers locked to same EV service provider … an issue even after standardization

QC in different countries

- EVI countries targets for 2020: **6,000 Quick Chargers** → only Japan 5,000 (3,000 already deployed). 600 CSS Chargers by 2017+Korea 1100-1400 QC by 2020
- EU no common targets now: some countries ambitious programs (Ireland, Estonia, Netherlands). But **Directive 2014/94/EU** → countries to establish targets and plans for charging infrastructures (incl. QC) for 2020
- Different charging strategies per country
- Public authorities most common support **measures**: tax exemption, financial incentives, direct funding, procurement regulation

EVSE Deployment profiles (2012)



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Quick Charging Survey

Survey: Participation

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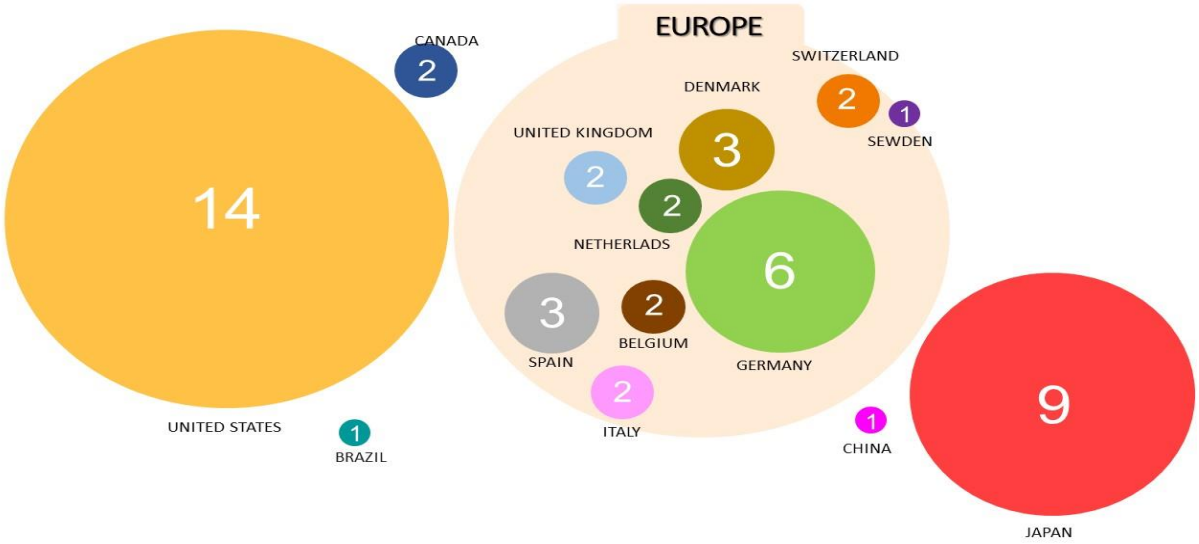
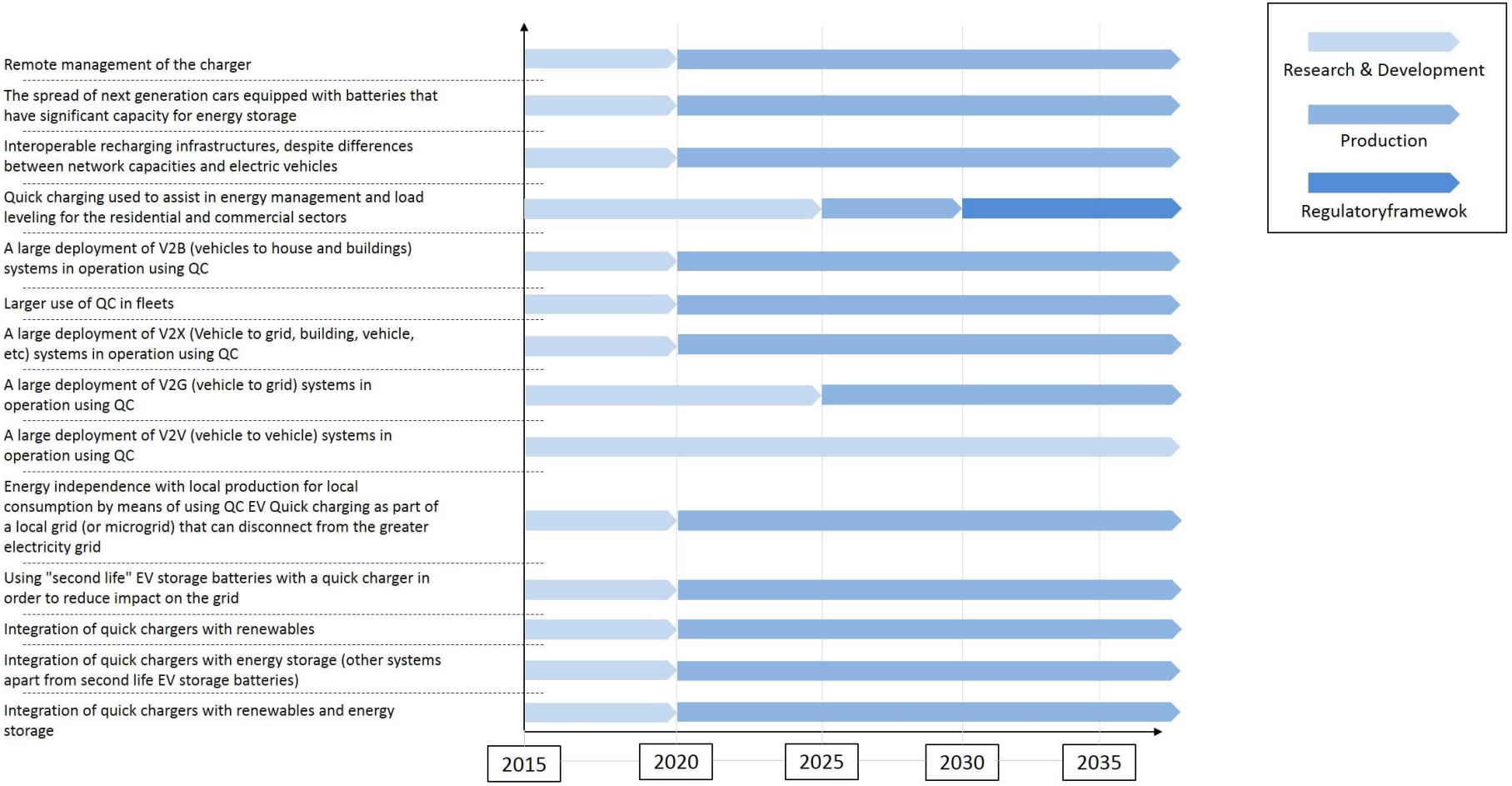
Per country →



← Per type of organization

Survey: Roadmap



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