Institut de Recerca en Energia de Catalunya
Catalonia Institute for Energy Research

International Energy Agency HEV-IA Task 28
"Home Grids and V2X Technologies"

IEA INTERNATIONAL ENERGY AGENCY
HYBRID & ELECTRIC VEHICLE IMPLEMENTING AGREEMENT

Gwangju, May 1st 2015

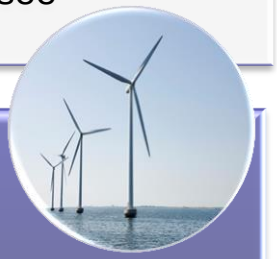
Miguel Cruz
Operating Agent

RESEARCH AND TECHNOLOGICAL AREAS

- **Advanced Materials**
  - Functional Nanomaterials
  - Catalysis
  - Materials for Solar Systems
  - Nanoionics and Fuel Cells
  - Energy Storage and Harvesting
- **Bioenergy and Biofuels**
  - Thermochemical Conversion
  - Biorefinery and Microalgae

Research Units

- **Energy Efficiency: Systems, Buildings and Communities**
  - NZEB (Net Zero Energy Buildings and Communities)
  - Integration of Renewables.
  - Smart Grids and Microgrids
  - Green IT
  - Electric Mobility
  - Lighting
  - Economic analysis and regulation
- **Offshore Wind Energy**
  - Aerodynamics and Aeroelasticity
  - Electric Machines and Control Systems
  - Grid Integration
  - Wind resource assessment at see
  - Project “ZÈFIR Test Station”



Technological Development Units

IREC
Institut de Recerca en Energia de Catalunya
Catalonia Institute for Energy Research

GOVERNING BODY

GOVERNMENT OF CATALONIA	Min. Enterprise and Labour (President) Min. Economy and Knowledge (VPresident)
GOVERNMENT OF SPAIN	CIEMAT (Min. Economy and Competitiveness) IDAE (Min. Industry, Energy and Tourism)
UNIVERSITIES	Barcelona TECH (UPC) Barcelona (UB) Rovira i Virgili (URV) in Tarragona
COMPANIES	ENDESA GAS NATURAL FENOSA Fundación REPSOL CLH ENAGÁS ALSTOM Wind

OPERATING AGENT

The **IREC** has two headquarters: Barcelona and Tarragona.

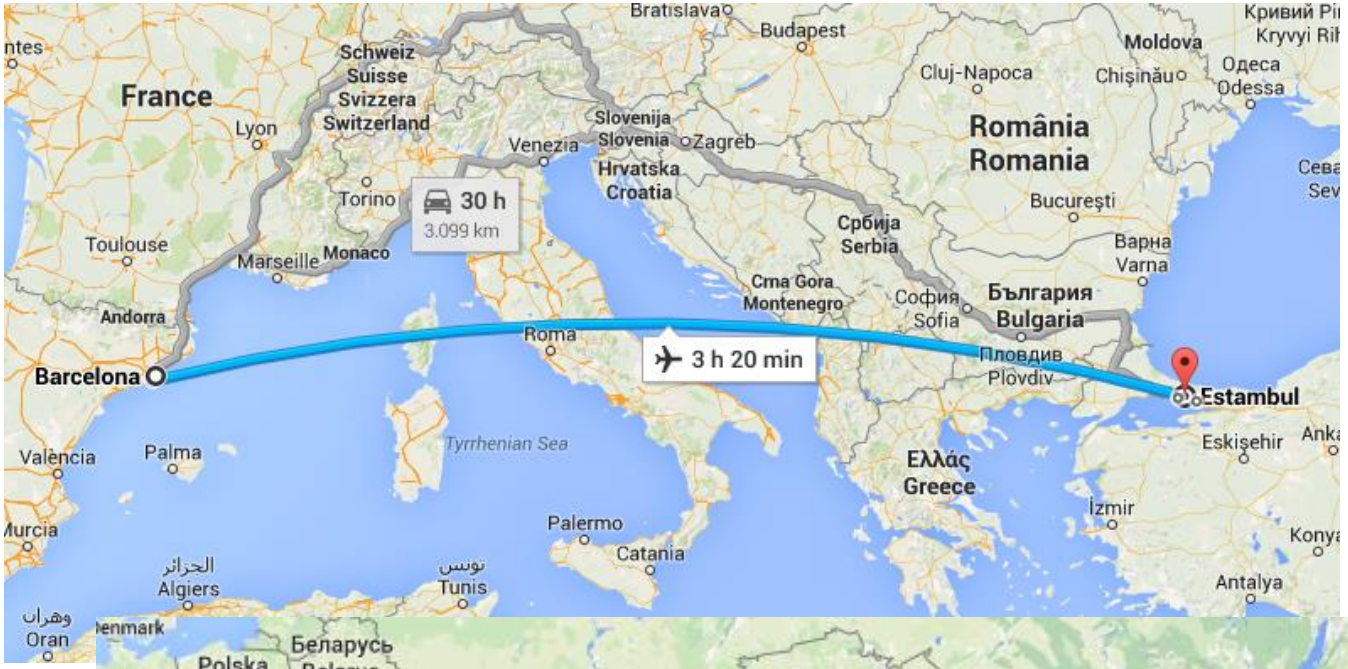
The **center in Barcelona** deals with:

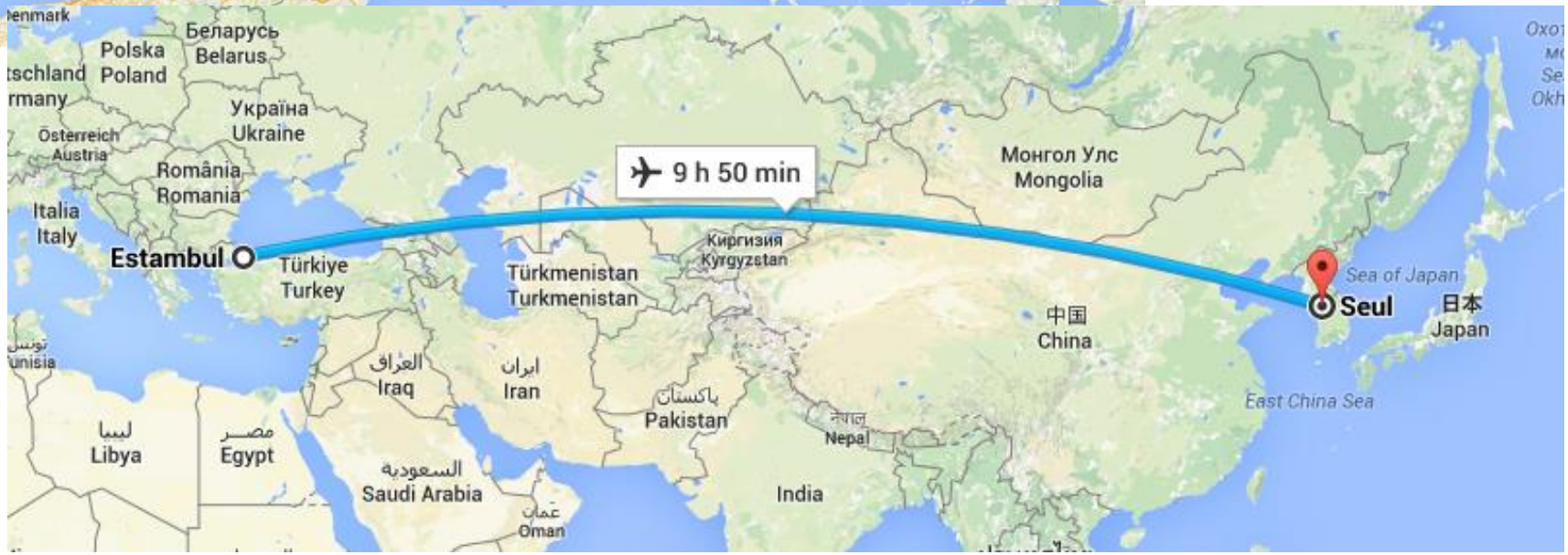
- Thermal Energy. Lighting
- Electrical Engineering. Offshore Wind Energy
- Advanced Materials for Energy

The **center in Tarragona** deals with:

- Bioenergy
- Laboratory for Thermal Energy and Energy Integration

IEA INTERNATIONAL ENERGY AGENCY
HYBRID & ELECTRIC VEHICLE IMPLEMENTING AGREEMENT





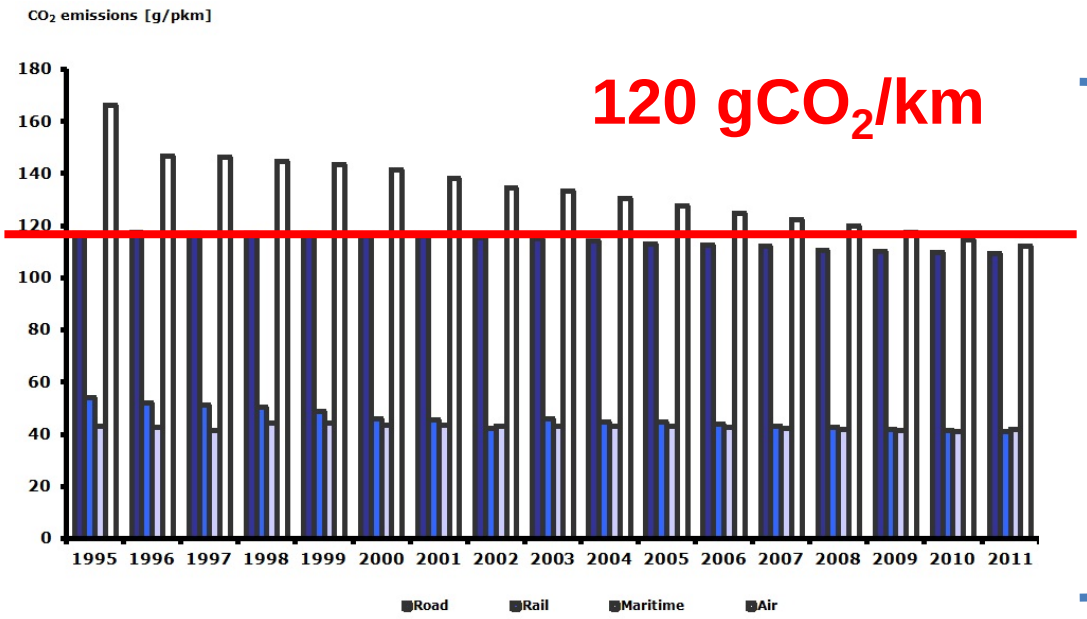
Air transport:
9,600 km

Spanish soccer time:
9h00 pm
Korean soccer time:
4h00 am

😔 😔 😔

😍 😍 😍 😍

Air transport:
9,600 km x 2 = 19,200 km



120 gCO_2/km

Total CO_2:
2.3 tons CO_2

Total CO_2 (30 persons):
80 tons CO_2

??

IEA INTERNATIONAL ENERGY AGENCY
HYBRID & ELECTRIC VEHICLE IMPLEMENTING AGREEMENT

A

B

Around 20 CO_2 tones

cts

Operation

A

B

Electricity consumption EV: 15 – 30 kWh/100 km

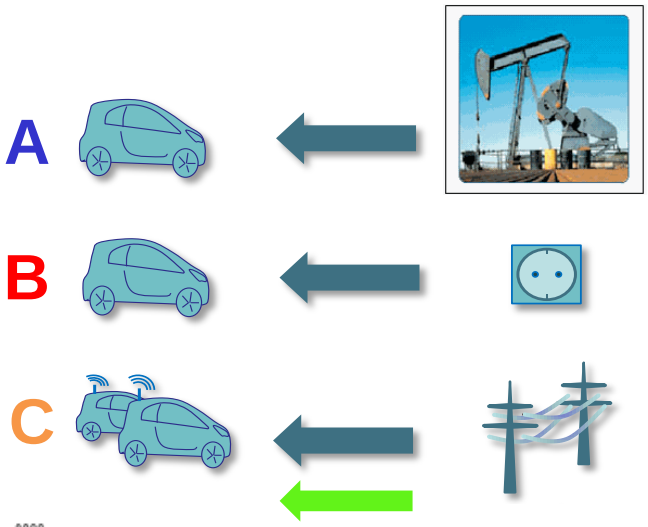
Source: Joanneum Research using Econinvent Data (Task 19 presentation)

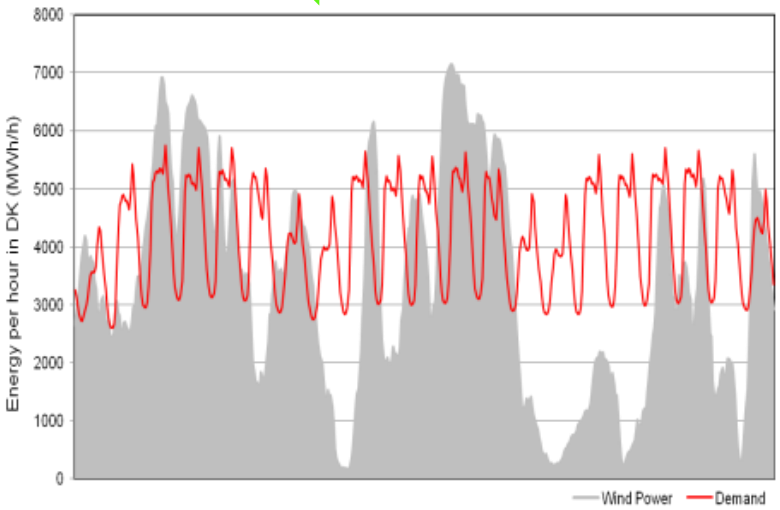
Greenhouse gas emissions [g CO_2-eq/km]

400
350
300
250
200
150
100
50
0

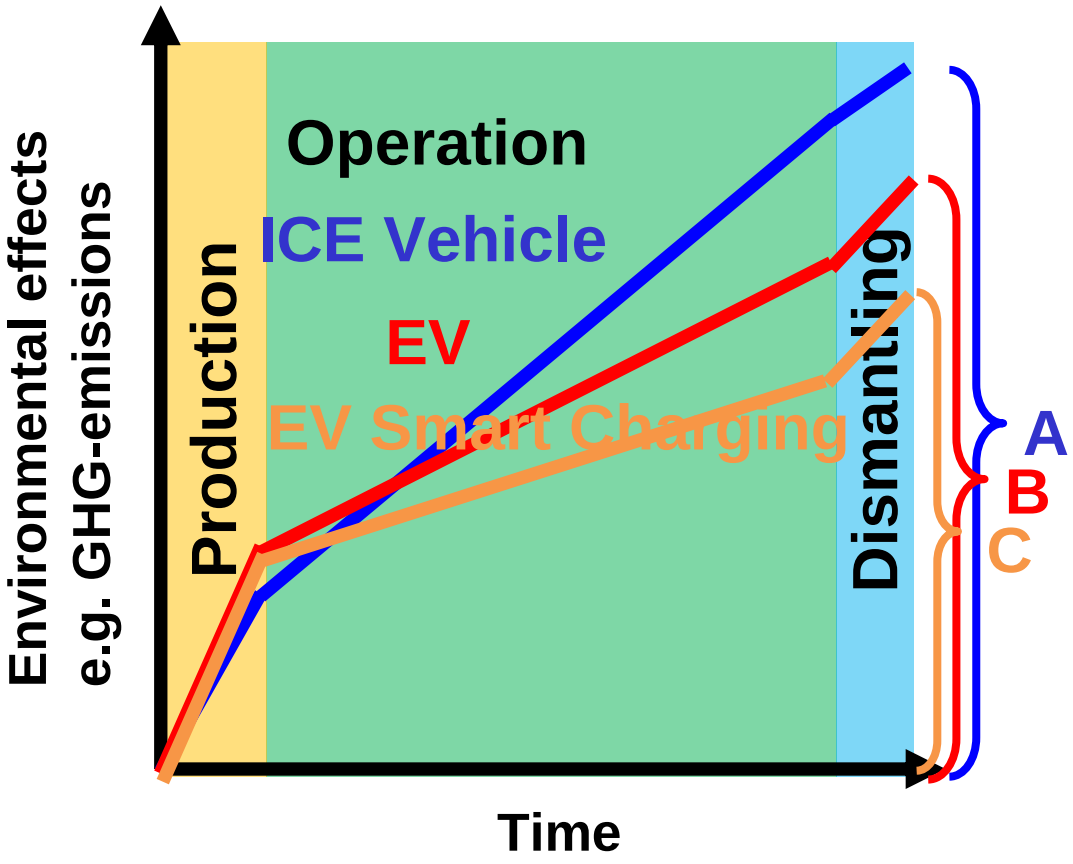
NO CA-QC SE FR CH BE AT FI US, NPCC SI ES SK DK PT IT KR JP RO LU US, WECC NL DE HU GB CA-AB TR BG IE US, SERC CZ GR US, MRO AU CN PL diegas

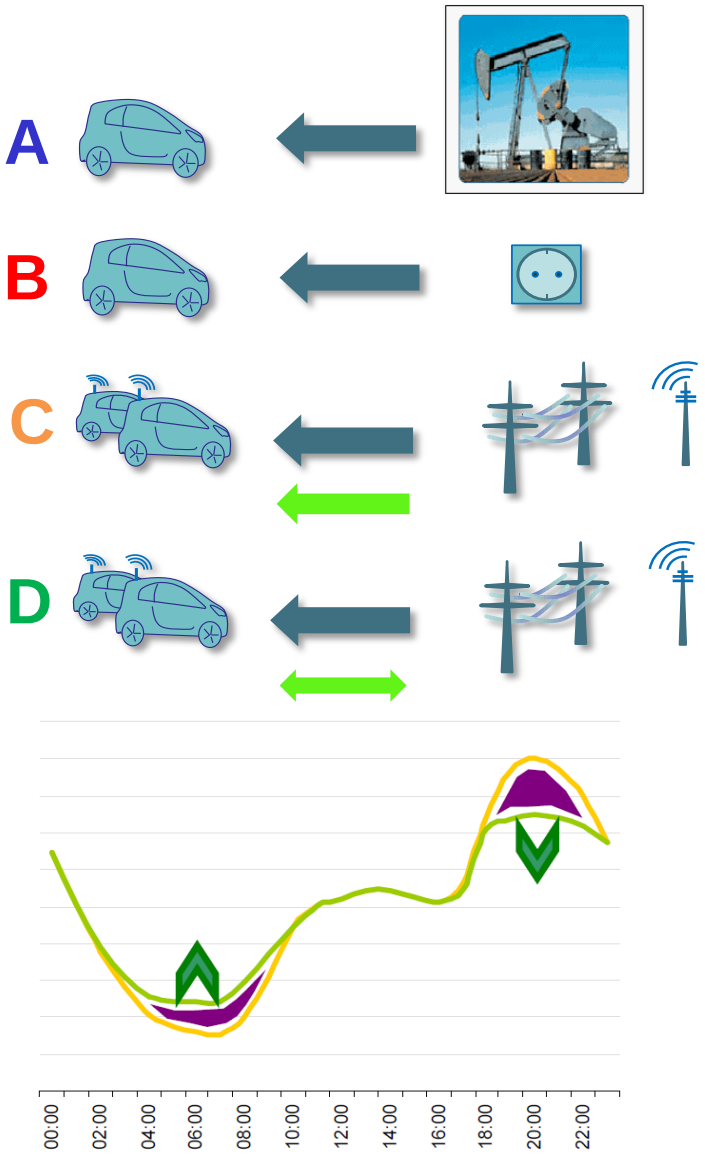
Average GHG change (CO2, CH4, N2O): from a 80% reduction to a 30% increase

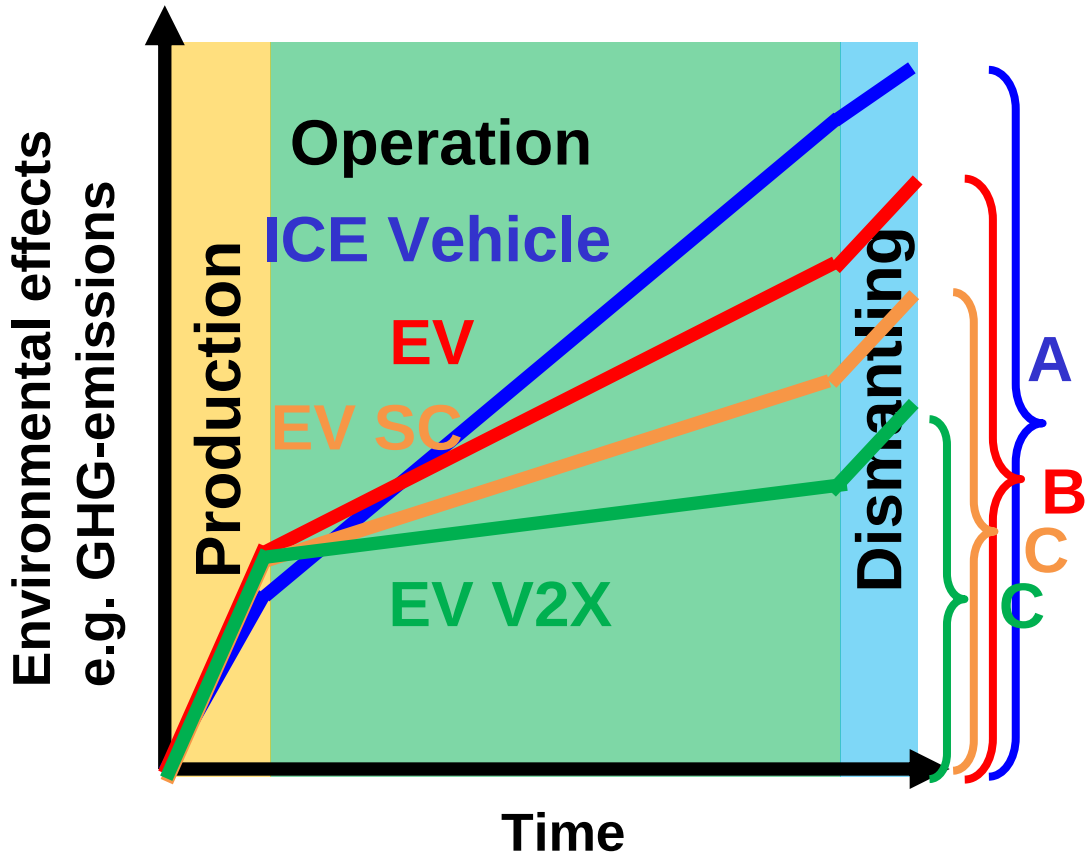




Lower renewable energy curtailment!







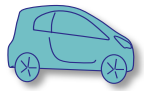
Less grid reinforcement!

Less peaking power plants!

Higher security of supply!

… So… how many drivers should we convince for switching??

B

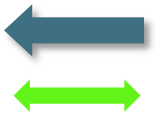


CURRENT SITUATION:
DUMB CHARGING

C

MEDIUM TERM:
MART CHARGING

D



LONG TERM:
VEHICLE-TO-EVERITHING (V2X)

Outline

1. **Introduction to Task 28: Home grids and V2X technologies**
2. **Objectives achieved so far…**
3. **Next steps**

Outline

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Current Participants on Task 28

IEA INTERNATIONAL ENERGY AGENCY
HYBRID & ELECTRIC VEHICLE IMPLEMENTING AGREEMENT

COUNTRIES


Denmark


Switzerland


France


Spain


United States

COMPANIES

NISSAN
Innovation that excites

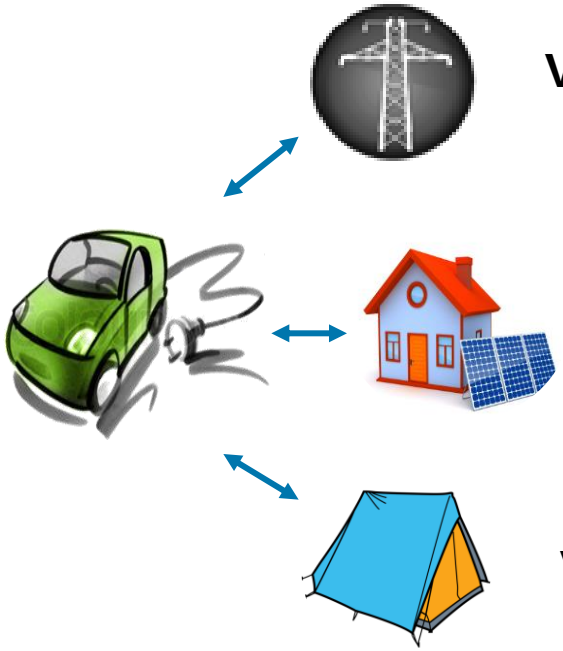
endesa

IREC
Institut de Recerca en Energia de Catalunya
Catalonia Institute for Energy Research

Task 28 “Home grids and V2X technology”

SCOPE

Customers may use the electric storage available from PEVs for uses other than powering the vehicle:



V2G: VEHICLE-TO-GRID

V2H: VEHICLE-TO-HOME

V2L: VEHICLE-TO-LOAD

V2X

VEHICLE TO EVERYTHING

(NIST, 2010)

Task 28 “Home grids and V2X technology”

VISION

Different countries can use V2X technologies for **different objectives** depending on their **specific energy context**.

Security of supply:
- Use of V2X as a back-up resource
- V2X applications for service restoration

Sustainability:
- RES integration
- Emission reduction
- Power smoothing

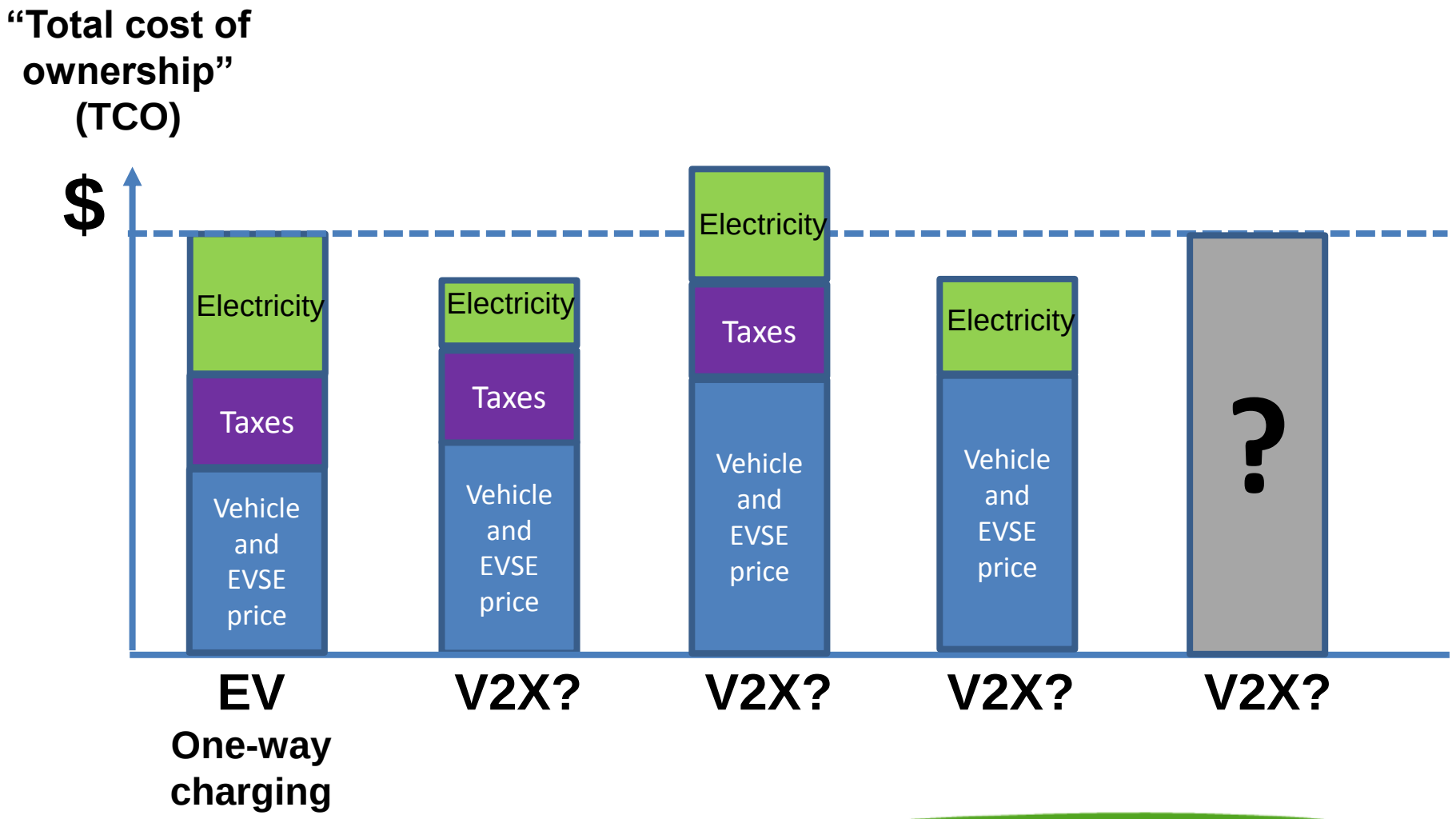
Efficiency:
- Energy Arbitrage
- Ancillary services
- Investment deferral

ADDED VALUE SERVICES TO BE PROVIDED BY EVs

Reduced EV’s “Total cost of ownership” (TCO)

Task 28 “Home grids and V2X technology”

VISION



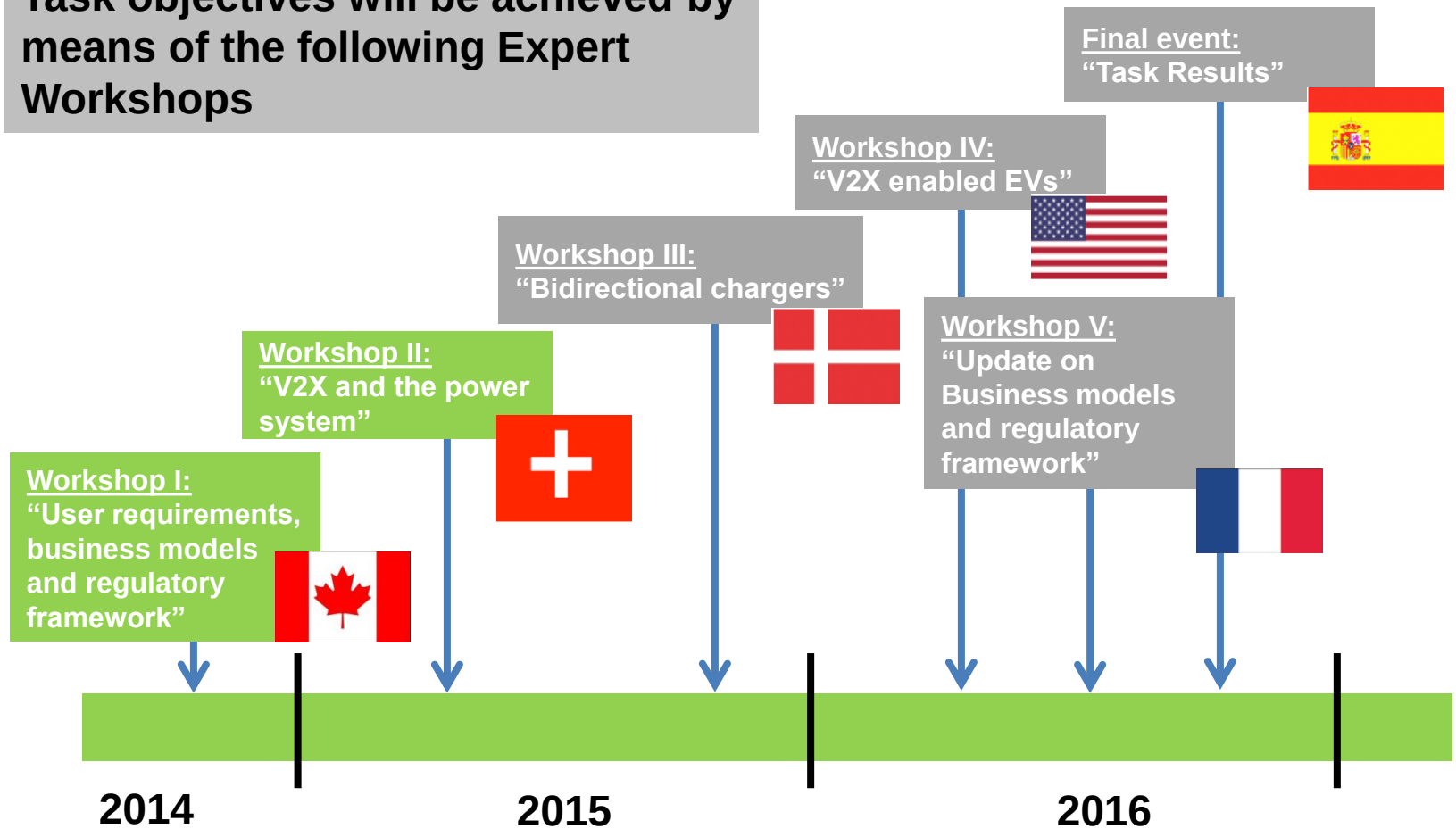
Task Objectives

1. Analyzing the **technical and economic viability**	→	**Potential V2X modes and functionalities** **Existing codes, regulations and BMs**
2. Connecting and synchronizing the different **V2X research and demonstration projects**	→	**Continuous contact V2X technology key actors** **Coordination with other HEV IA Tasks**
3. Coming up with a **policy making toolbox** and a **technology roadmap**	→	**Definition of a typical set of country specific systems and regulatory frameworks for the choice of a given portfolio of energy policy options**
4. International technical information exchange	→	**Expert Workshops**
5. Promotion of new **V2X technology demonstration** projects.	→	**Collaboration with international organizations and call for proposals (e.g. EC - H2020)**

Task 28 “Home grids and V2X technology”

WORKING METHOD

Task objectives will be achieved by means of the following Expert Workshops

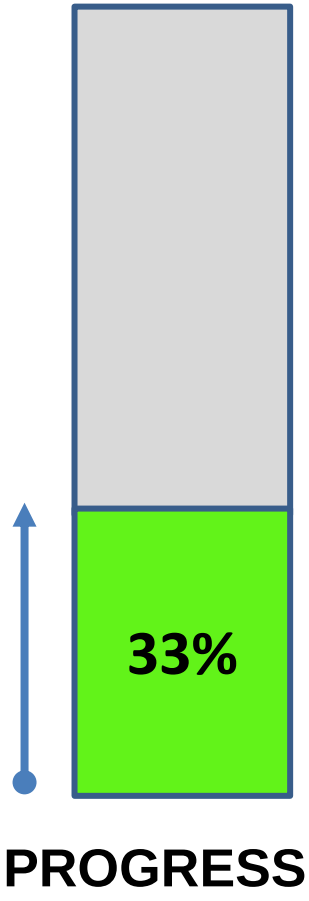


Outline

1. Introduction to Task 28: Home grids and V2X technologies
2. **Objectives achieved so far…**
3. Next steps

Achievements so far…

- 1) Who are the **main players** in V2X activities? Which is the **market forecast** for the coming years?
- 2) Which is the **business case viability** of V2G across the world? Which are the **national regulations** favoring the taking off for V2G activities? Is V2G **already profitable** in any region?
- 3) Which are the **existing interoperability standards** nowadays and which are their main gaps?

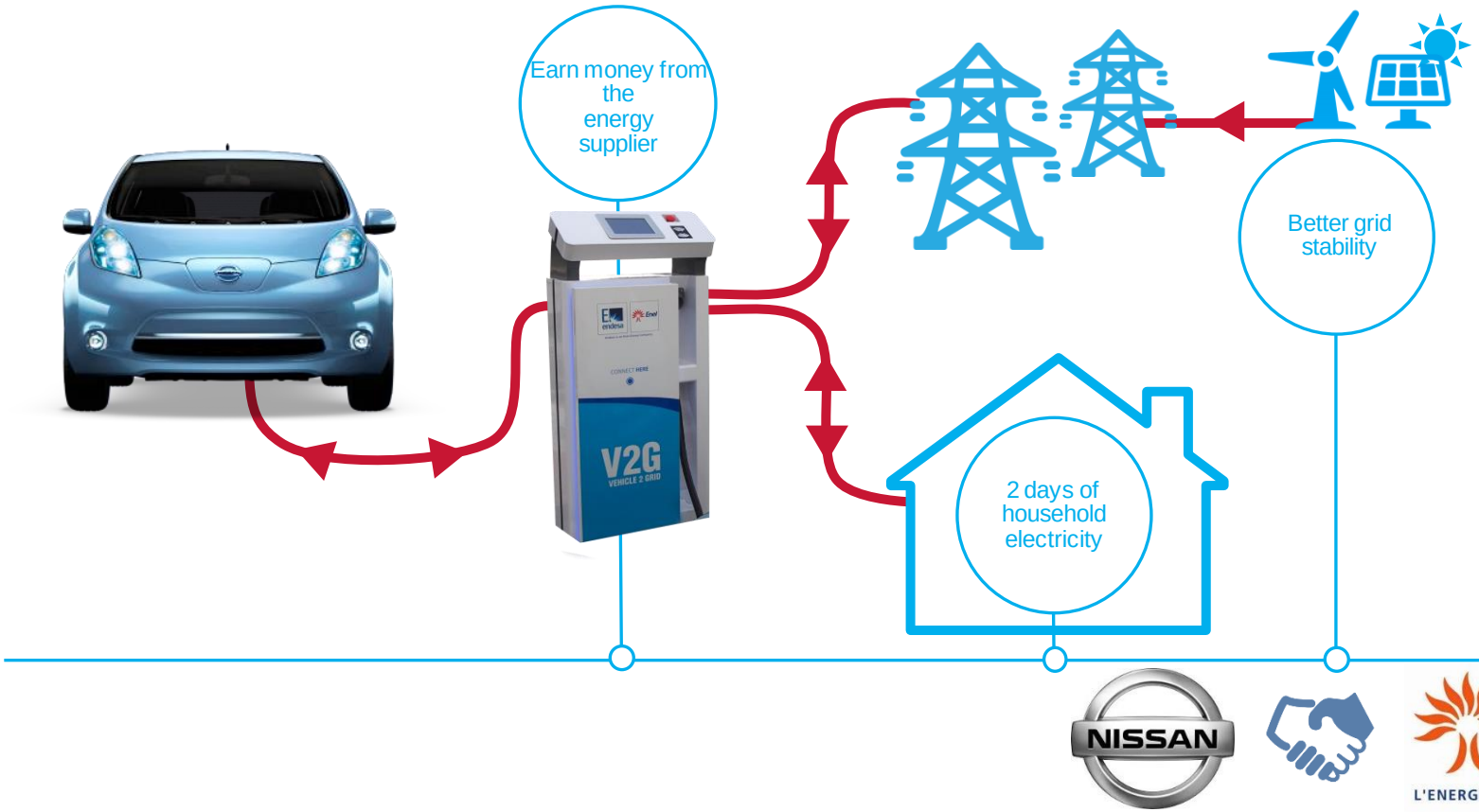


1) Main players: commercial deployment

1. Since 2012 V2H available as back-up storage and bill saving tool in Japan

1) Main players: commercial deployment

2 Partnership announced at 85th International Motor Show (March'15)



1) Main players: demonstration projects

3 Some V2G demonstration projects in the US: States of interest

The Federal Energy Regulatory Commission has passed rules allowing alternative energy-storage systems, but state and local regulatory bodies have been slow to follow its lead.

1) Future markets

- **Japan** is quite mature: around 10% of Nissan Leaf owners have a V2X enabled two-way charger.
- Tests in **US** mainly focused on V2G for **frequency regulation**.
- Tests in **Europe** also focused on V2G, but less profitable.
- Other conclusions so far…
  - **Battery size** to be increased during the coming years… more room for V2X *(See Mr. Brennan's presentation, April 30th)*
  - First **fleet operators & energy managers** as an **entrance door** for the mass market
  - The **higher share of RES**, the more open the country to V2X
    - New TSO balancing markets, and **emerging DSO flexibility remuneration means**

2) Business Cases and Regulation

- A) Results from some **demonstration projects**…
- B) Some **regulatory proposals** so far…

2) A) Demonstration projects

- An average revenue of $5 per vehicle per day from ancillary services
- Frequency regulation is a viable market

V2G School Bus

BMW i ChargeForward Program

Goals

- Demonstrate DR at home
- Aggregation of stationary second use batteries with in use vehicles

Costs and Revenue

- Earn $1,000 at launch and $540 at project completion in gift cards

Costs and Revenue

- $100,000 diesel bus (“C” or “D” sized bus)
- $230,000 EV bus (plus $30,000 bi-directional retrofit)
- Revenue: $5,000 to $20,00 per bus per year

2) B) Regulatory proposals

Expected remuneration for frequency control:

Current French rules: revenues = 0€

Ideal market rules: revenues from 193€ to 593 € / EV/ year

Ideal market rules

1. **Minimum rated power** to be included in the market – 100kW
2. Possibility to aggregate units across **various DSO** technical zones
3. Possibility to **aggregate power flows** and not only financial products
4. **Nature** of the payment scheme
5. Avoid **incompleteness** of the payment
6. **Extra bonus** for intense flexibility

2) Business Cases and Regulation

Summarizing…

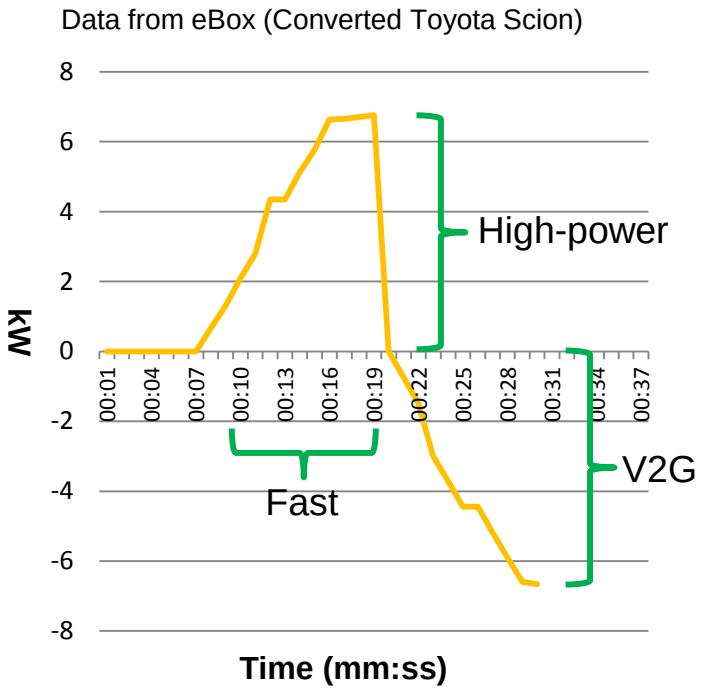
1. United States:
   - Impact of market design on V2G demo projects deployment
     - Delaware – PJM
     - California – energy storage and EV infrastructure initiative
   - Preliminary results: around **4-5$/day for cars** (cost included), and around **15-60$/day for buses**
2. Europe
   - ENTSO-E network codes are paving the way for enabling these technologies
   - National/local TSOs and regulators should made endeavors to improve their rules
   - Preliminary results: around **0.8-2$/day for cars** (lower charging power and less parking time)
   - What if **additional added value services** are considered in addition to “balancing services” (frequency regulation)???
     i. Peak shaving
     ii. Energy arbitrage
     iii. Congestion management services for TSOs and DSOs
     iv. Others??

3) Standardization

The Electric Vehicle

Special properties:

1. Fast response time.
2. High-power load
3. Possibility of V2G support



3) Standardization

V2X Enabling standards:

- EV – EVSE **ISO/IEC: 15118**
  - Ongoing work on V2G use cases (early stage…)

- EVSE – Upstream: **OCPP 2.0**
  - Delta from version 1.5: pricing, smart charging, monitoring

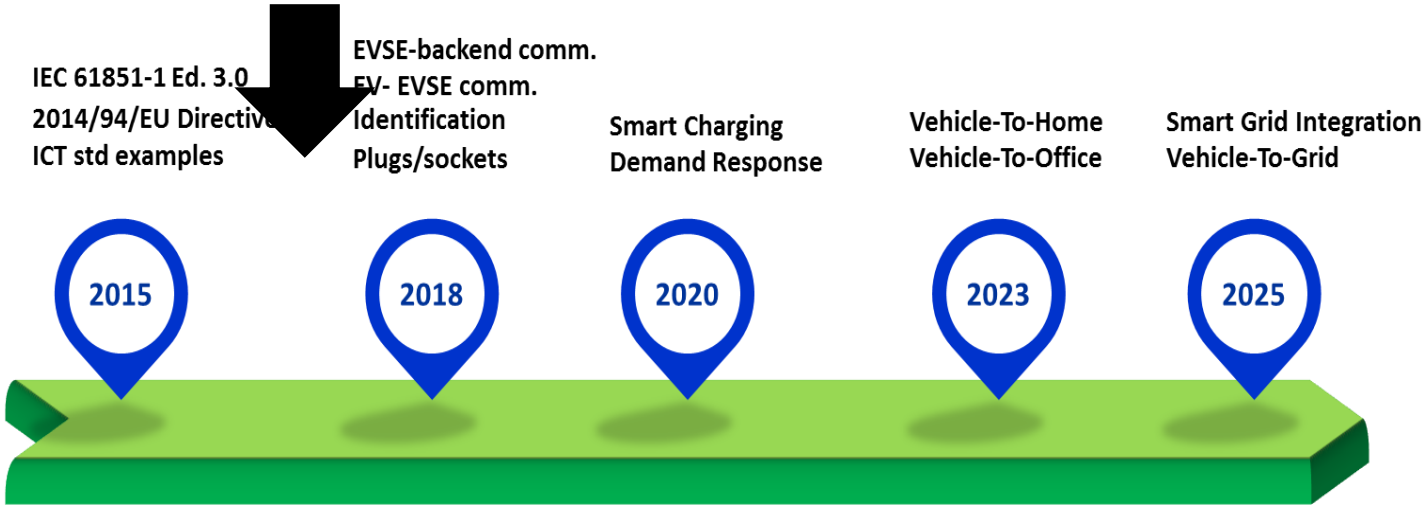
3) Standardization

Honorable mentions:

- CHAdeMO: perfect example of “de-facto standard”
- IEC 61851
- IEC 61850-90-8
- OSCP

OCPP 2.0

ISO/IEC 15118



Green eMotion Standardization Roadmap

3) Standardization

Global Harmonization Efforts (US driven):

European Commission

- EV-Smart Grid Interoperability Centers
  PEV-EVSE interoperability, PEV-grid integration and PEV test procedures

Germany

- Global InterOP Team
  AC and DC interoperability requirements, test procedures and tools

China

- MIIT-DOE Letter of Intent
  Cooperation on industrial efficiency and EVs

Outline

1. Introduction to Task 28: Home grids and V2X technologies
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Next steps…

- **Open questions:**

  - What is the **Cost** (e.g. marginal replacement battery cost, software/hardware for AS participation) - **Benefit** (e.g. participation on reserve capacity market) of V2X functionalities (V2G, V2H, V2L)?
  - How **building codes, self-consumption regulation, and DSO market** rules should be modified?
  - **LCA** of V2X enabled EVs vs. normal EVs?
  - Energy storage is very competitive... how **electricity markets prices will evolve in the future**?
  - Further understanding battery impact for various use cases and **warranty implication**…

Next steps…

Workshop I:
"User requirements, business models and regulatory framework"

Workshop II:
"V2X and the power system"

Workshop III:
"Bidirectional chargers"

Workshop IV:
"V2X enabled EVs"

Workshop V:
"Update on Business models and regulatory framework"

Final event:
"Task Results"

2014 2015 2016

Thank you very much for your attention

Enjoy the rest of the ExCo!

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http://www.ieahev.org/tasks/home-grids-and-v2x-technologies-task-28/

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