A user-centric decision support tool for electric mobility charging infrastructure planning / INCIT-EV

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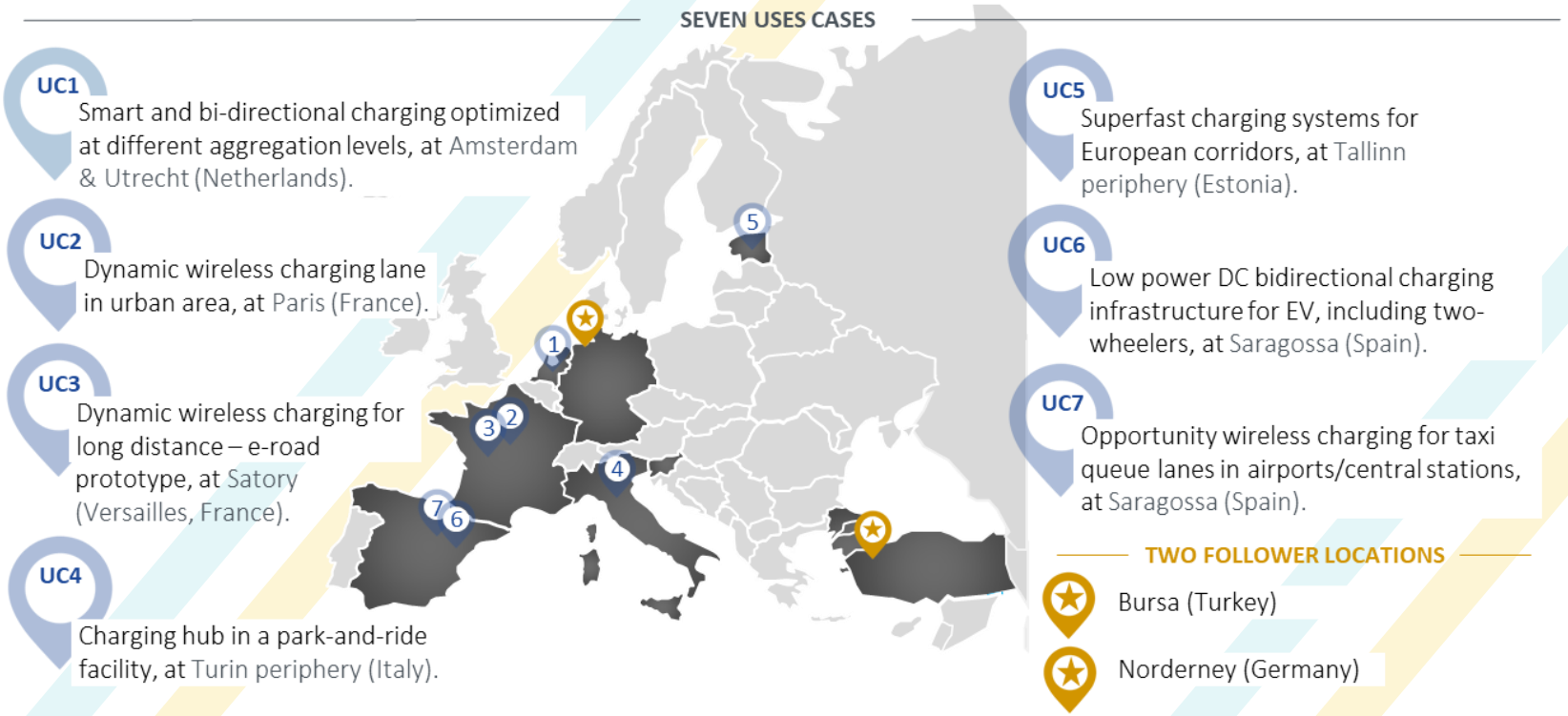
The project

INCIT-EV is a H2020 project led by CIRCE in which **electric vehicle charging technologies** will be developed and validated in **five European countries**, thus **improving the user's perception of electric mobility**.

INCIT-EV aims to demonstrate, at **five demonstration environments**, an innovative set of **charging infrastructures**, **technologies** and its associated **business models**, ready to improve the EV users experience with the ultimate goal of **fostering the EV market share in the EU**.

INCIT-EV in figures

18,6M€ budget
15M€ funded by the EC
32 partners
48 months 2020-2024



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 875683.

The consortium

CIIRCE coordinates the INCIT-EV project, to improve the experience of electric vehicle (EV) driving with a consortium of **33 partners from eight countries**

Atos

AVERE FRANCE

Zaragoza

Bitbrain

BURSA BÜYÜKŞEHİR BELEDİYESİ

COLAS
WE OPEN THE WAY

VILLE DE PARIS

CITTÀ DI TORINO

Eesti Energia

ELES

ENEDIS

EUROVIA VINCI

EVBOX

INSTITUT VEDECOM

FONDAZIONE links
PASSION FOR INNOVATION

FPT
POWERTRAIN TECHNOLOGIES

GROUPE RENAULT

GreenFlux

idneo
we design your dreams

tria

IFSTTAR

QiArrow
Green Deal Advisors

STELLANTIS

STADTWERKE NORDERNEY

University of Ljubljana
Faculty of Electrical Engineering

WE DRIVE SOLAR

POLITECNICO DI TORINO

iren
luce gas e servizi

Prima Electro
electronics and laser technologies

FPT
POWERTRAIN TECHNOLOGIES

MRA elektrisch

The outcomes

EV users preferences and expectations

3,475 EV drivers engaged

Grid Congestion
Smart Energy / Charging
Interoperable payment

V2G ready
30 kW modules

Up to 130 km/h

Wireless Charging 120 kW Static and Dynamic

Wireless Interoperability In all demos

Low cost scalable V2G DC chargers up to 200 kW

Decision **S**upport **S**ystem for **mobility planners**

Promote investment in charging infr **Attractive Business Models**

8.87 M€ investment on the Use Cases
Regulation and standards
Based on Project devep

DSS objectives

OVERALL OBJECTIVE

- Fostering the harmonious development of electric mobility throughout Europe, especially supporting cities without powerful tools, data or competencies

MAIN TARGET USERS

- Municipalities, Transport/Energy Authorities/Agencies, DSOs, CPOs, EMPs, FSCs, PGOs

2 MAIN FUNCTIONS

- Supporting the optimal CPs planning in the city (Cities/Agencies/CPOs/FSOs)
- Estimating the impact of already planned scenarios (Cities/DSOs)

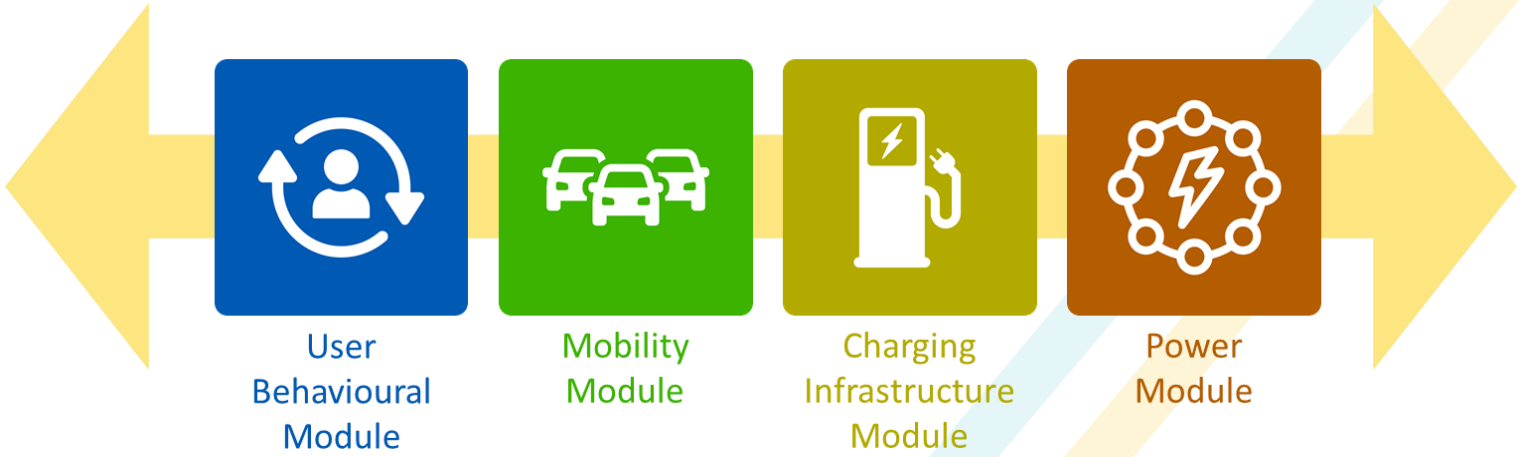
FOCUS

- Public & semi-public charging (but considering also private charging)
- Private cars (87% of the total vehicles in EU, source: ACEA)
  - no public transport, commercial vehicles, private fleets
  - no fleets for mobility services (e.g. taxis, car sharing)

DSS requirements

- **ROBUST AND RELIABLE**
  - Simple, easy to calibrate and validate (validated in the INCIT-EV cities)
  - NO complex and data-demanding approaches
- **APPLICABLE IN ALL EU CITIES**
  - Based on official, always up-to-date and publicly available data (e.g. JRC database)
  - Complemented by INCIT-EV collected data (WP2, WP5)
- **SUPPORTING THE STRATEGICAL CPS LOCATION**
  - Operative decisions will be taken by the decision makers using detailed local data
- **USER-FRIENDLY AND CUSTOMIZABLE** by the users (e.g. to upload available data)
- **FAST COMPUTING** (results provided in a short time)

Decision Support System for planning



4 modules:

- **User Behaviour**: outline and describe users' mobility habits and behaviour.
- **Mobility**: support the decision making of DSS users providing insights related to the impact of user behaviour and habits to the city mobility.
- **Charging Infrastructure**: provide the information related to the expected usage of the charging stations, their type and quantity in different city zones.
- **Power**: estimate how the additional charging infrastructure would affect the existing power system.

An innovative approach

2 charging macro-behaviours

- **MOBILE PHONE** (*whenever I can*)
  - They charge in the origin or destination zone of their trips → usually **low** power CPs
- **GAS STATION** (*if necessary*)
  - They charge along the way (minimizing the detours from their route) → usually **high** power CPs

2 modelling approaches

- mobile phone → **parking-based approach** (we need to know **parking behaviours**)
- gas station → **traffic-based approach** (we need to know **traffic flows**)

<u>Questions to be answered by the models</u>

Parking-based approach (mainly for urban mobility → low power CPs)

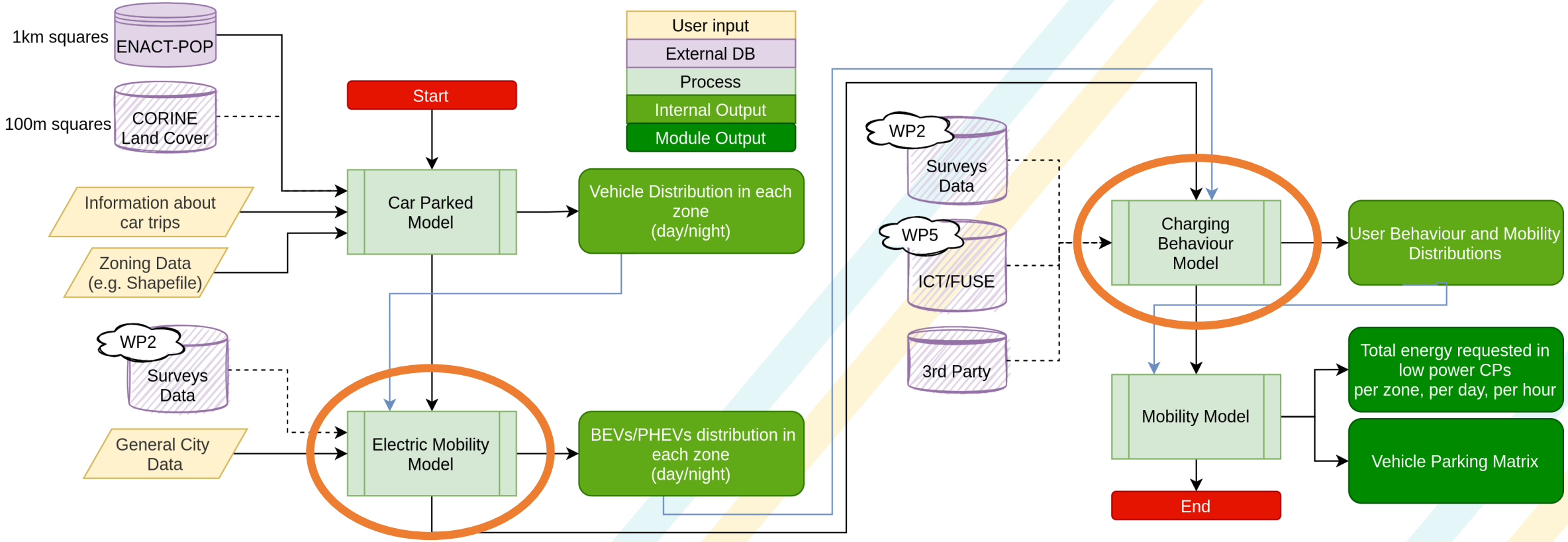
- Where are parked the cars at a specific time slot? Do they charge?

Traffic-based approach (mainly for interurban mobility → high power CPs)

- Where are travelling the cars at a specific time slot? Do they charge?

Conceptual workflow

User Behaviour and Mobility Module



Modeling users' choices (I/II)

How many electric cars there will be?

- **Logit model** based on stated choice experiments (DCM)
- **Likelihood** of buying a **BEV or PHEV** estimated using the **perceived utility =** linear combination of **several factors**:
  - *Utility = β1·attr 1 + β2·attr 2 + … + βn·attr n*
- The model considers **different prices/purchasing power** in each Country
- The model is **estimated for 3 different city clusters (NL, IT, SP)**, in order to consider other factors that cannot be quantify (such as current high uptake of EV, people mindset and wealth, available sustainable urban mobility options)

CAR FEATURES (attributes)	Levels description
Car segment	1. **B** (subcompact cars) 2. **C** (compact/medium cars) 3. **D-E** (large/executive cars)
Engine	1. **ICEV** (gasoline/diesel) 2. **Bio-fuel ICEV** 3. **LPG/NGV ICEV** 4. **HEV** (Hybrid Electric Vehicle) 5. **PHEV** (Plug-in HEV) 6. **BEV** (Battery Electric Vehicle)
Price [k€]	1. 15 2. 20 3. 25 4. 30 5. 40 6. 45 7. 50 8. 60 9. 70
Operating cost per 100 km (only fuel/energy)	1. **+25%** 2. **Baseline** 3. **-25%**
Incentive on purchase	1. **Disincentive** (taxes based on CO_2 emissions and engine power) 2. **None** 3. **Limited** in Italy 3k€ with scrapping 4. **Medium** in Italy 6k€ with scrapping 5. **High** in Italy 10k€ with scrapping
Incentive on utilization	1. **None** 2. **Limited** (in Italy access and free parking in LTZ) 3. **High** (in Italy access to bus lane, LTZ, free parking)
Range (with a single full refuel/recharge)	1. **200 km** 2. **300 km** 3. **400 km** 4. **500 km** 5. **600 km** 6. **700 km** 7. **800 km** 8. **1000 km**
Charging time (to recharge 50% of the battery)	1. **2 hours** (Slow charging) 2. **1 hours** (Accelerated charging) 3. **30 minutes** (Fast charging) 4. **15 minutes** (Ultra-fast charging)
Diffusion/maturity of charging infrastructures Public spaces (petrol stations, parkings, malls, …) equipped with charging points	1. **Only home/work private charging** 2. **1 out of 5** (20%) 3. **1 out of 2** (50%) 4. **3 out of 4** (75%) 5. **All** (100%)

Modeling users' choices (II/II)

Where will electric cars charge?

- **Logit model** based on stated choice experiments (DCM)
- Likelihood of charging at the **location option A**
  - *Utility = β1·attr 1 + β2·attr 2 + … + βn·attr n*

5 options

- **HOME** = Overnight **low power** at home (PRIV) or near home (PUB)
- **WORK** = Daytime **low power** at work (PRIV) or near work (PUB)
- **OTHER** = Daytime **low power** at other locations (PUB) or publicly accessible (semi- PUB)
- **FAST** = Daytime **high power** on the way
- **NO** charging

Factors considered

- characteristics of **charging opportunities (<u>different for each ZONE</u>)** (e.g. density, price, charging time, availability e.g. EVs/CPs, accessibility)
- **user** characteristics (e.g. private parking spot at home, private parking spot at work, free charging at the office, income)

Main choice attributes included in the model

CHARGING POINT FEATURES (attributes)		Levels descrip
Charging point typology	1.	Charging station on the road
	2.	Parking area equipped with charging p
	3.	Home (private)
	4.	Near home (public)
	5.	Work (private)
	6.	Near work (public)
Charging price per 100 km	1.	<2 € (with periodic subscription)
	2.	2 € (-50% than average EU price at hon
	3.	4 € (average EU price at home)
	4.	12 € (x3 than average EU price at home
Charging time (to recharge 50% of the battery)	1.	**4 hours** (home charging)
	2.	**2 hours** (Slow charging)
	3.	**1 hours** (Accelerated charging)
	4.	**30 minutes** (Fast charging)
	5.	**15 minutes** (Ultra-fast charging)
Possibility of booking	1.	No
	2.	Yes, optional
Waiting time	1.	< 5 minutes
	2.	From 5 to 15 minutes
	3.	> 15 minutes
Comfort and ancillary services	1.	None, only cp
	2.	Covered charging point
	3.	Food and shops (in place or nearby)
Energy from renewable sources	1.	No
	2.	Yes
Connection technology	1.	Wired
	2.	Wireless

Final comments

- Tool to **support EU cities** in electric mobility charging infrastructure planning
  - Especially cities without powerful tools, data or competencies
- Innovative and sound **methodology**
  - **User-centric** approach → starting from the demand (EV users preferences, needs and expectations
  - **NO data-demanding**
  - Applicable in **all EU cities**
  - Based on official, up-to-date and publicly available data, complemented by **INCIT-EV collected data**
- Such tools can support decision makers but **not take decisions**
  - Operative decisions will be taken by the decision makers using detailed local data
- First release by the **end of 2022**
- Further developments
  - **Wireless** charging (1. static ; 2. stationary or dynamic)

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Thank you!