FABRIC

Feasibility analysis and development of on-road charging solutions for future electric vehicles

Unplugged

Dynamic charging for more efficient FEVs: The FABRIC project

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UNPLUGGED Final Event, Zaragoza
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ΕΠΙΣΕΥ ICCS

FABRIC FP7 Integrated Project

Budget: 9 M€ | Funding: 6.5 M€
Duration: 48 months | Start: 1 January 2014

Coordinator: ICCS

Jan 2014

User requirements
Technical feasibility
Standardization/ Interoperability

Liaison with other projects
Innovation
Collaboration

Dynamic wireless charging of FEV

Jan 2018

Motivation: Why dynamic charging?

- Allows EV charging while travelling (dynamic) or during short stops ideal for urban environment (stationary)

Increased range → Reduced range anxiety

Smaller batteries → Cheaper EVs

Increased mobility

No visual pollution

Driver benefits: Reduced range anxiety | Cheaper EVs | More comfort | Safer

- Drivers do not have to deal with dirty and potentially dangerous cables (rain, cable vandalism, cable wear, etc) + Easier charging process

Roosegaarde and Heijmans

FABRIC objectives

DEVELOPMENT

- Three wireless EV charging prototypes able to support dynamic charging
- Supporting ICT
- Integration with road and grid infrastructure

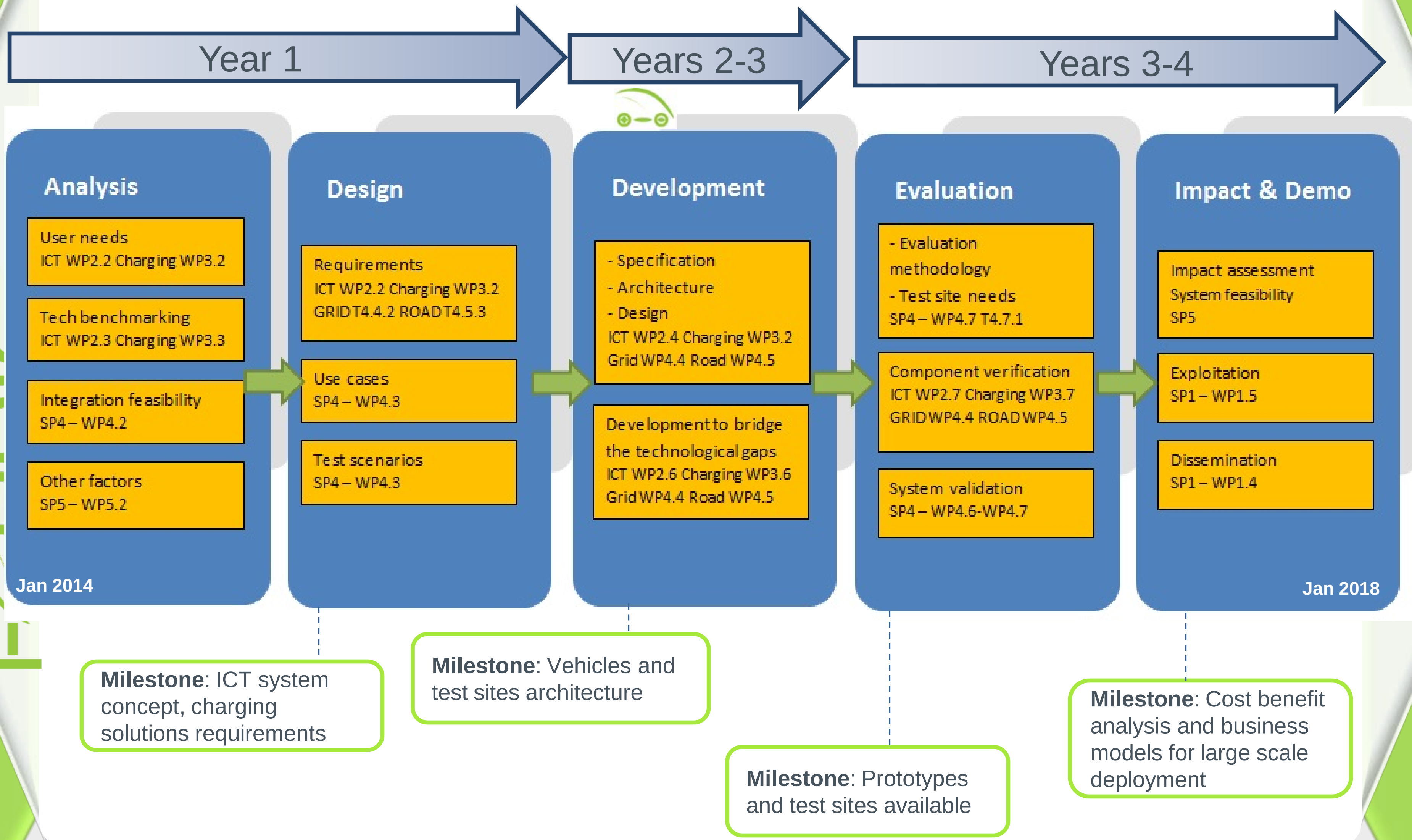
TESTING

- ITALY
- FRANCE
- SWEDEN

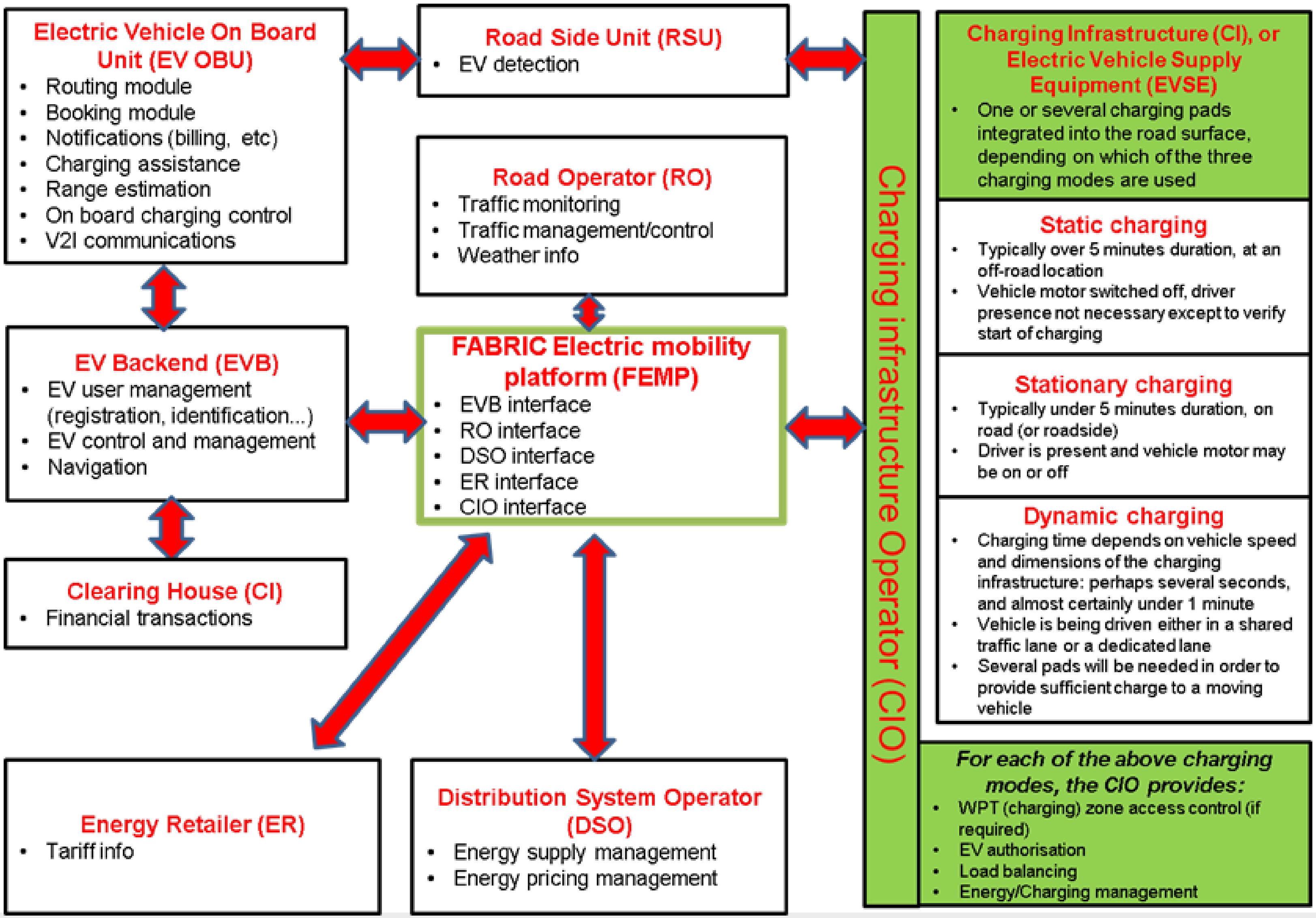
FEASIBILITY

- GRID
- ROADS
- BUSSINESS
- ENVIRONMENT

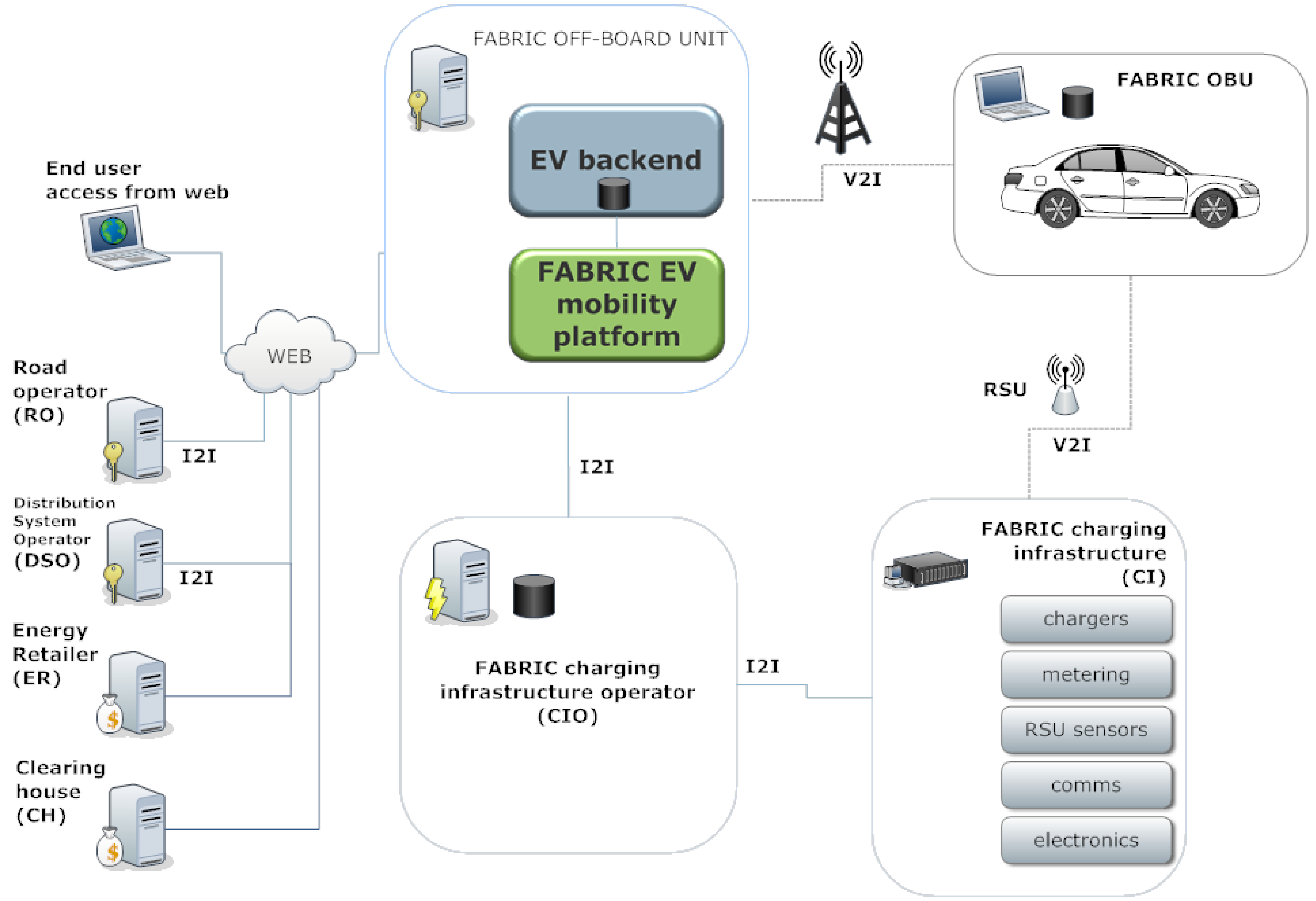
Project workflow and schedule



ICT architecture



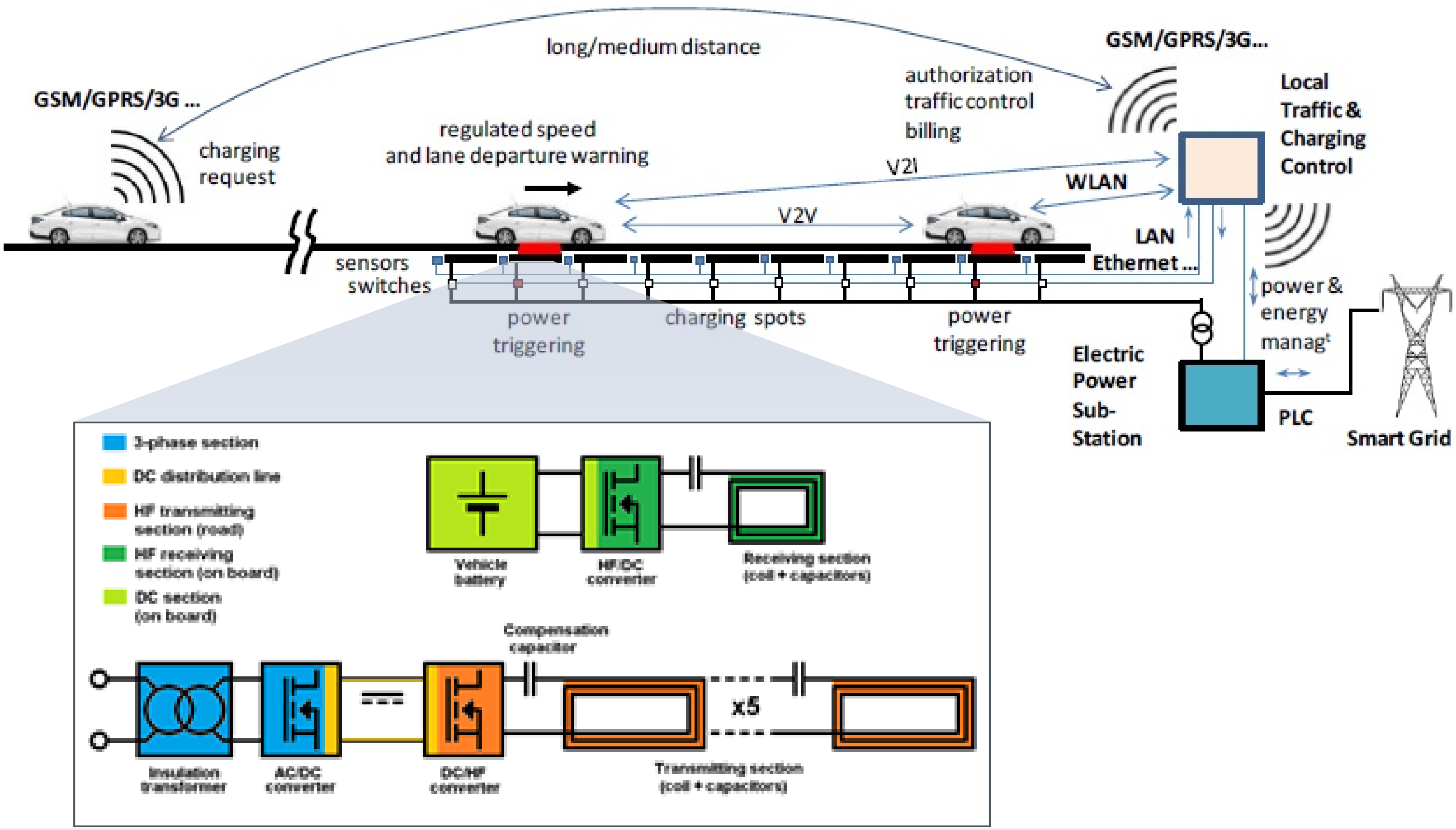
ICT architecture



FABRIC prototypes – POLITO, IT (I)

Dynamic charging prototype no.1 – Italy (POLITO, CRF)

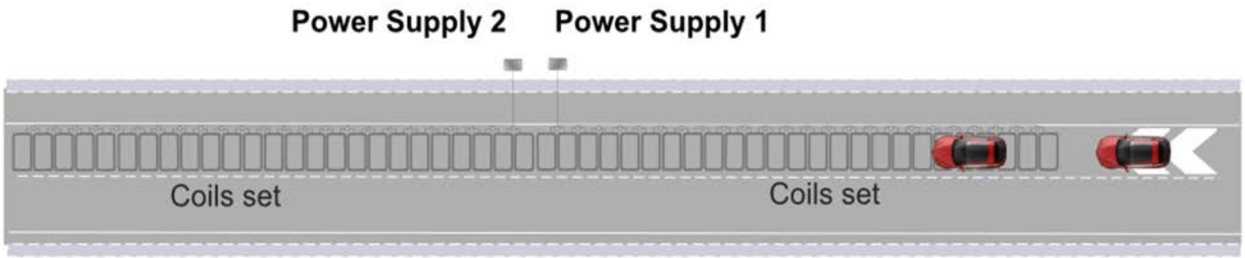
- 200m test track, 20kW, ~150kHz

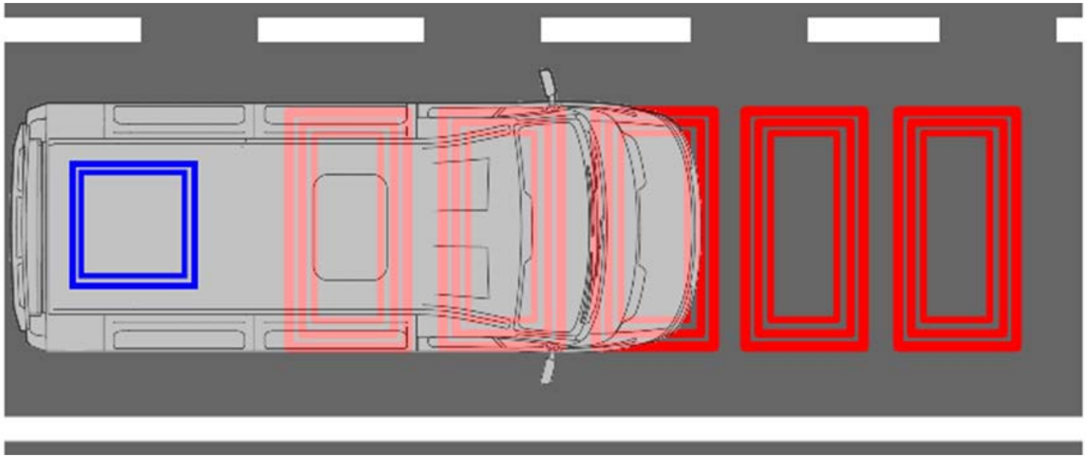


FABRIC prototypes – SAET, IT (II)

Dynamic charging prototype no.2 – Italy (SAET)

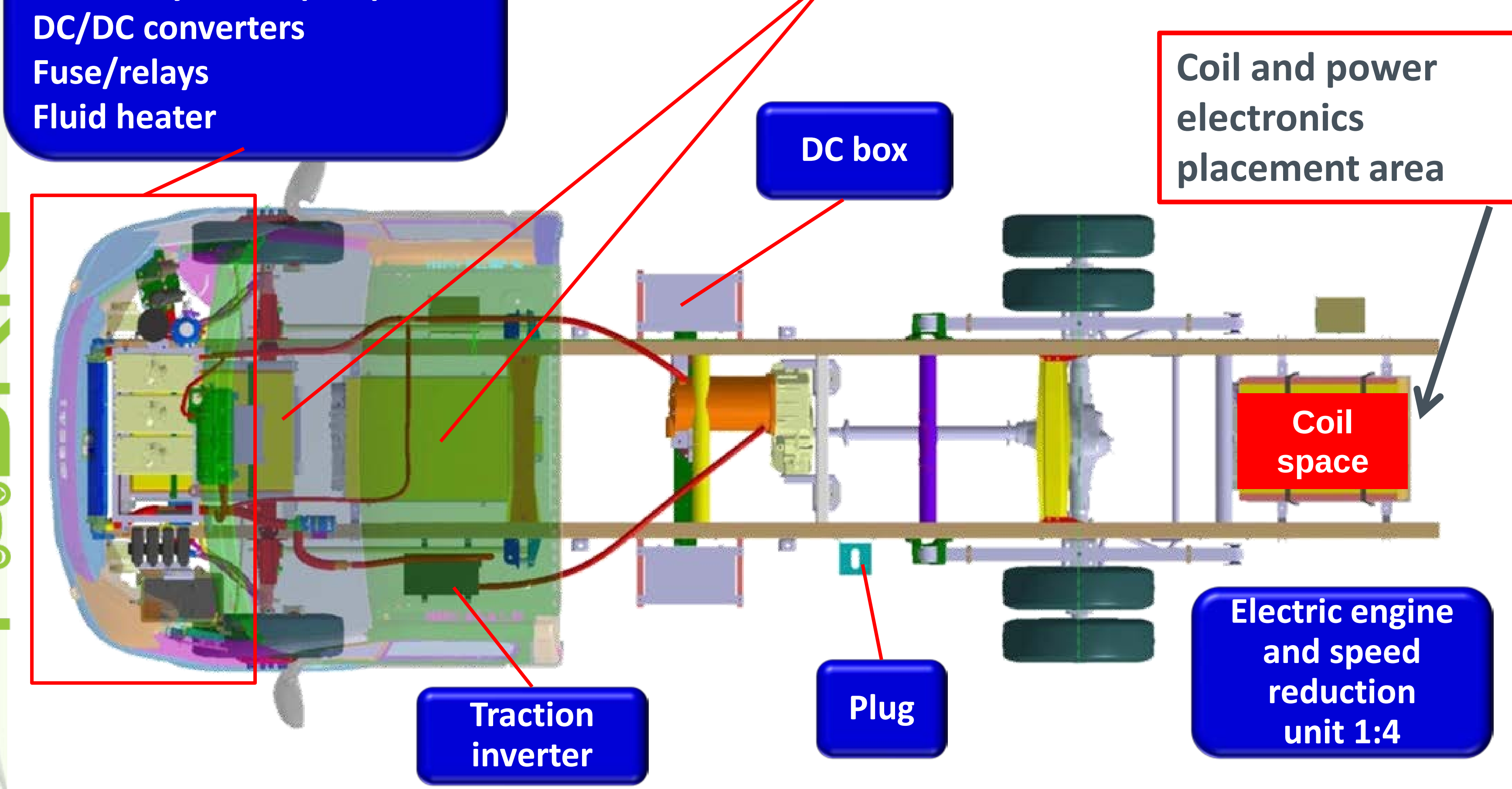
- 50m, 10-150kHz load-resonant power frequency





Source: SAET

FABRIC vehicle prototype – IT



FABRIC prototypes – VEDECOM, FR (III)

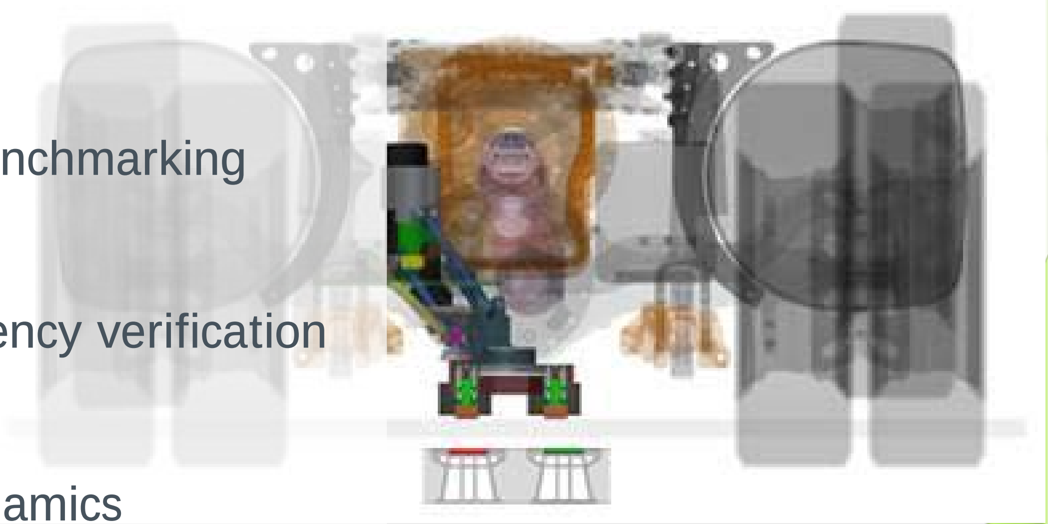
Dynamic charging prototype no3 – France (QUALCOMM, VEDE)

- 100m test track, QUALCOMM charging pads in series, 85kHz, >20kW

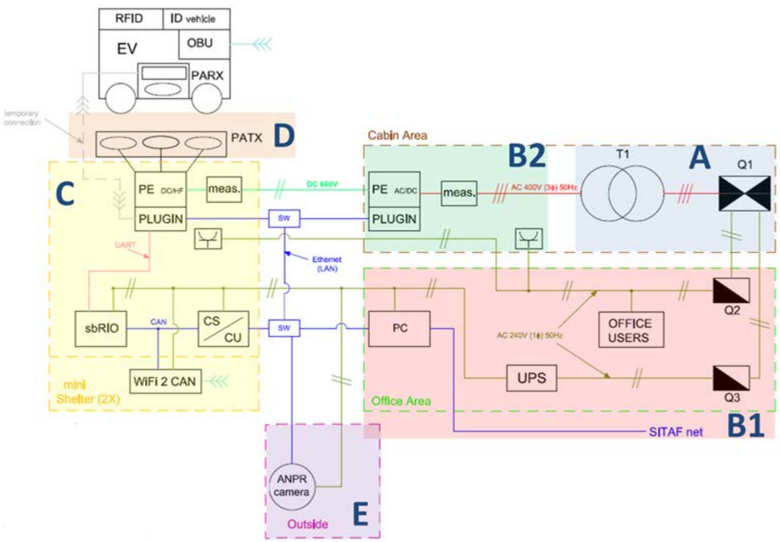
Other prototype testing

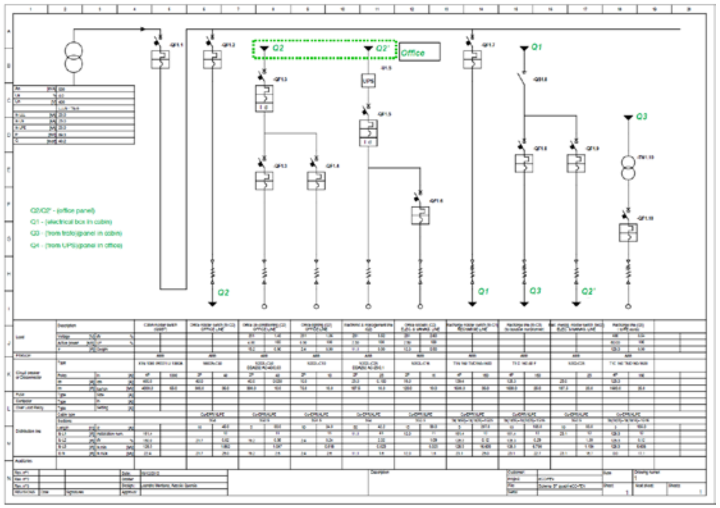
- Volvo GTT ATR/cars test site in Hällered
- Test track for conductive electrical road tests (DC 750V)
- Test track is 435m long, electrified part of the track is 275m.

- Technology evaluation results
- Demo of the track and system
- EM emissions measurements
- Conductive charging technology benchmarking
- Preliminary tests
  - expected power transfer efficiency verification
  - electro dynamic forces
  - electric circuit dynamics
  - overvoltage/under voltage dynamics



Analysis of the grid - SITAF test site (Italy)

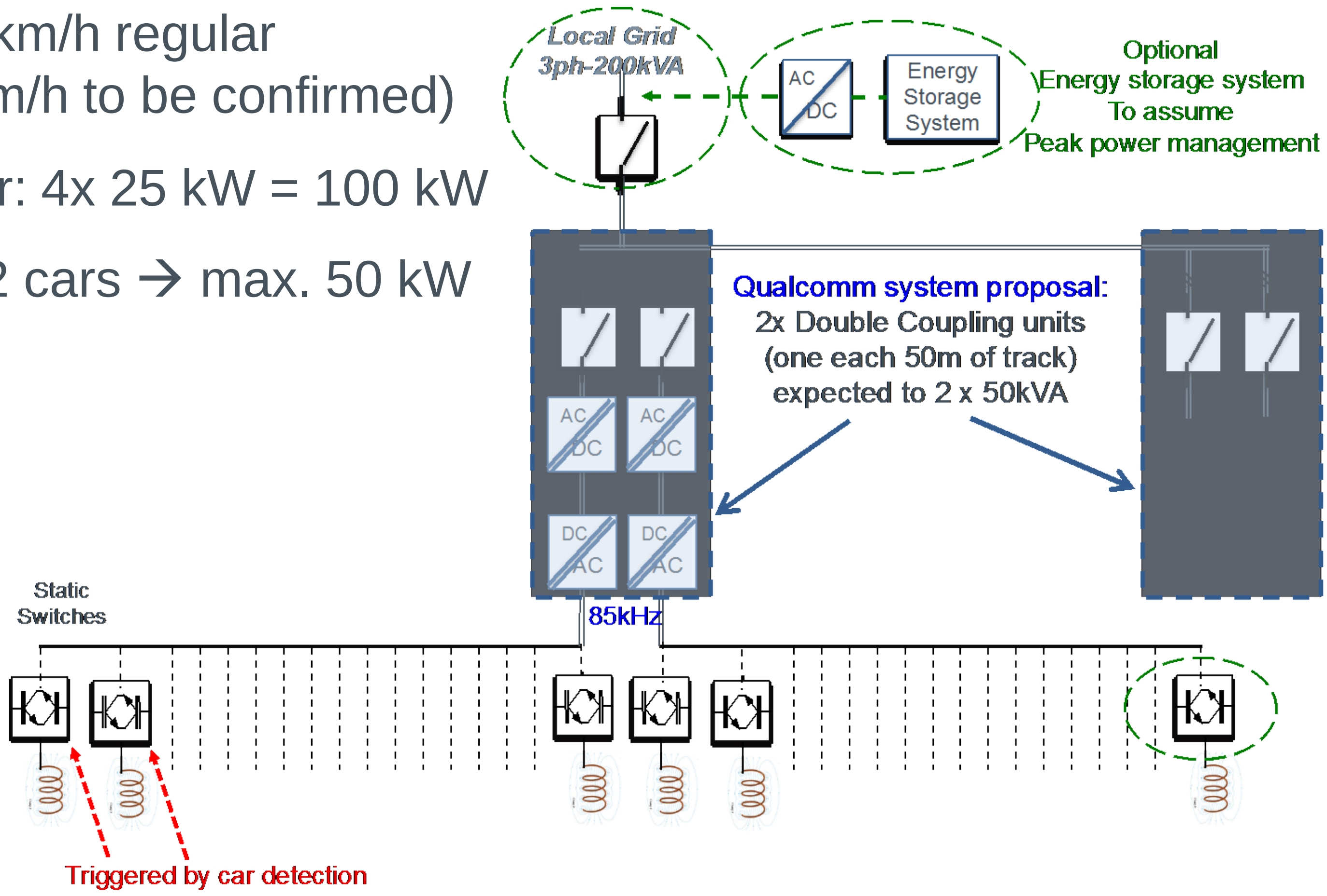




- Speed: to be defined
- Peak power: 25 kW
- Storage foreseen at DC bus (supercaps?)

Analysis of the grid - Satory test site (France)

- Speed: 60 km/h regular
  (up to 90 km/h to be confirmed)
- Peak power: 4x 25 kW = 100 kW
- Tests with 2 cars → max. 50 kW



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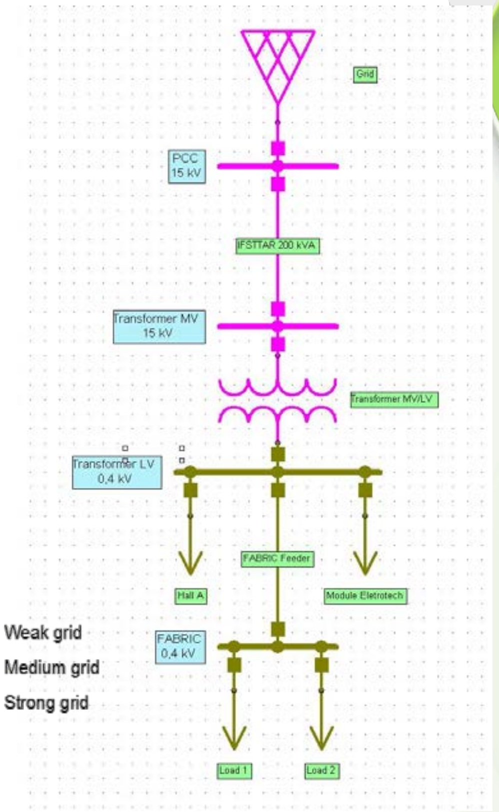
Analysis of the grid – test sites

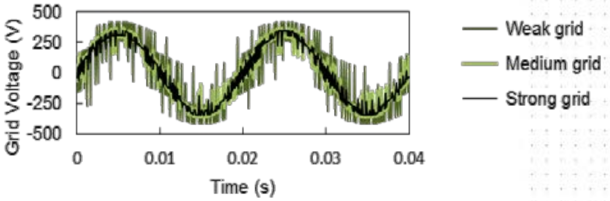


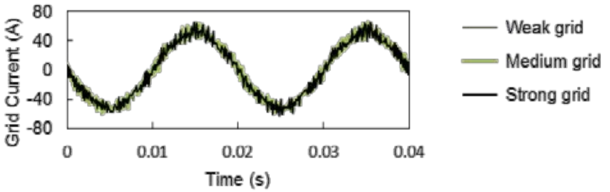
1. Power flow analysis

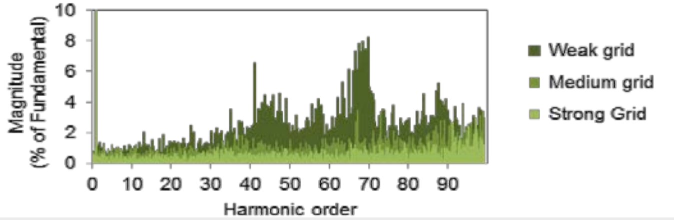
- MV/LV Grid model for each test site
- Result: Max. allowed power:
  - Satory: 100 kW
  - SITAF: 45 kW

2. Harmonics analysis

- Different converter topologies produce different harmonics
- 4 Cases are studied:
  - Diode bridge
  - IGBT (hysteresis control)
  - IGBT (PWM control)
  - IGBT (PWM multi level)







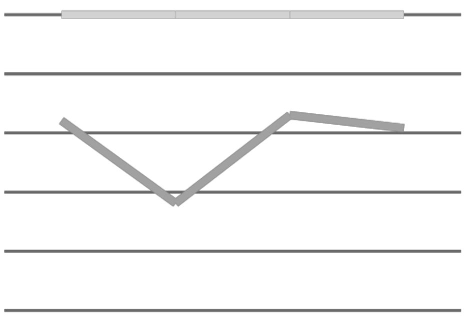
Analysis of the grid – Impact simulation

Parameters:

1. Charging lane length (8km)
2. Vehicle speed & length
3. Minimum headway
4. Traffic (urban/interurban)
5. Maximum charging pad power level (50kW)

Scenario	P	V	h	l	d
Light traffic	0.15	36/108	5/10	5	570/1090
Medium traffic	0.50	36/108	5/10	5	1900/3500
Heavy traffic	0.75	36/108	5/10	5	2600/5000

Charging events are created according to traffic, lane length → Charging events are translated to a power level according to the charging duration →



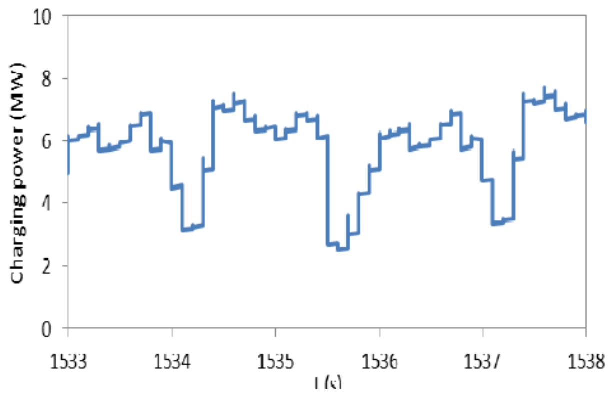
Source: SAET

Analysis of the grid – Impact simulation

Demand analysis

- Substantial amount of switching associated to vehicles passing over charging pads
- Demand fluctuates from 2-8 MW in some seconds
- Unrealistic power jump in the grid load
- Max step 4MW in 100ms

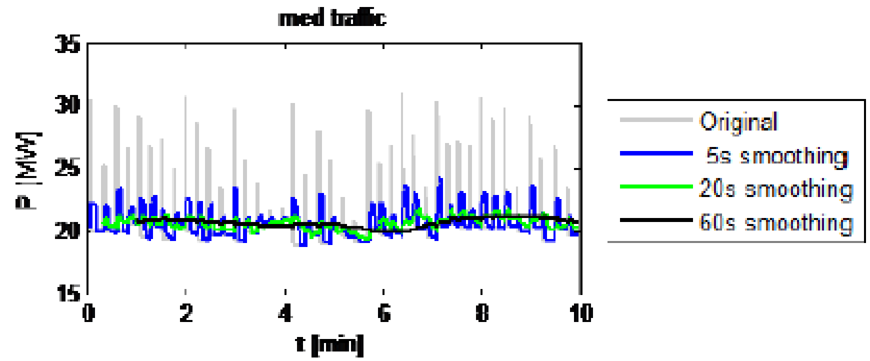
Demand 5s



Analysis of the grid – Impact simulation

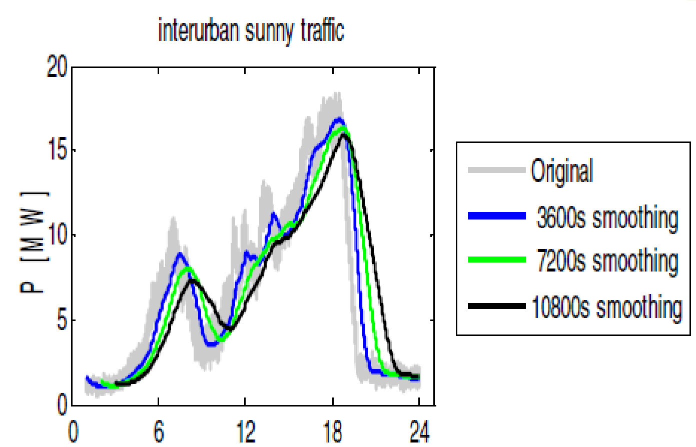
Requirements for Energy Storage System

- Energy Storage System modeled as a low pass filter to reduce fluctuations



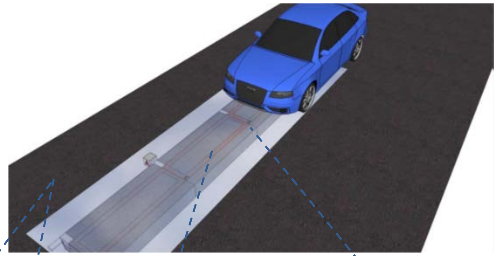
- 5 seconds smoothing window reduces fluctuations substantially
- PSS almost independent of window size and dependant on traffic
- ESS increases linearly with the size of the smoothing window
- Small storage windows help to mitigate high frequency variations
- Larger smoothing windows help to reduce the daily demand peak but it costs!
- Combination of ESS with other methods (load shaping) must be deployed.

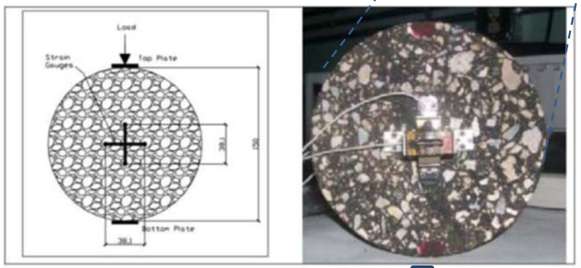
Smoothed demand

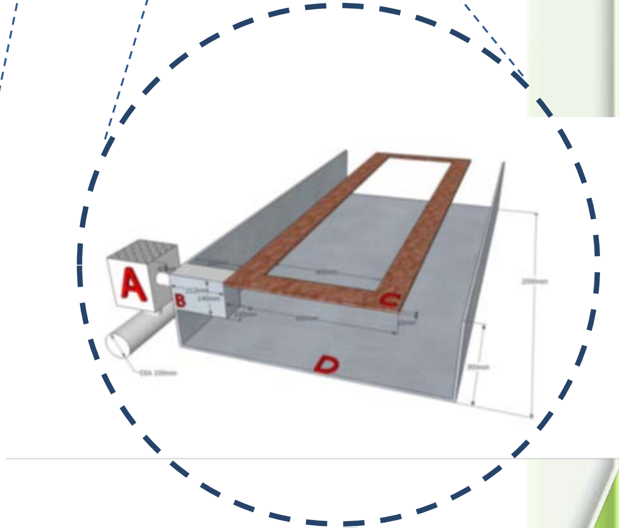


Analysis of the road – test sites

- 1st year:
  - Collection of charging solutions specifications and test sites data
- 2nd year:
  - Core samples analysis and highway road modeling
  - Stress and long term impact analysis



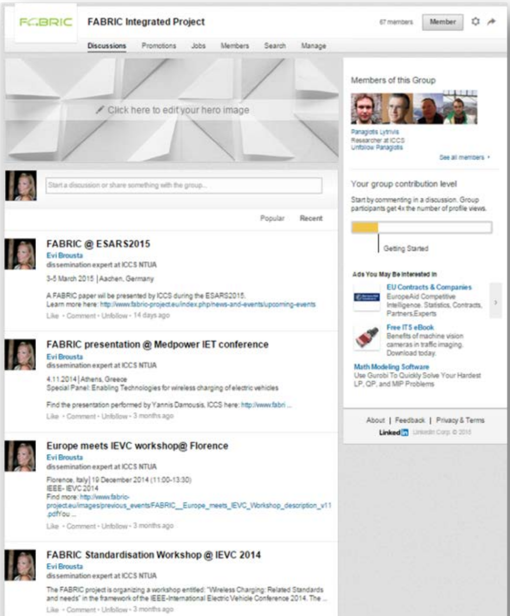




Contact with FABRIC

Website www.fabric-project.eu

LinkedIn group



ERG

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Thank you!

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