

FABRIC

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Agenda

- Project Overview
- Timeline
- Research Activities
- Research Results
- Industrialisation and Next Steps

Project Overview

FABRIC: FeAsiBility analysis and development of on-Road charging solutions for future electric vehiCles

Project Overview

FABRIC	FeAsiBility analysis and development of on-Road charging solutions for future electric vehiCles			
EC Call	GC.SST.2013-1 “Feasibility analysis and technological development of on-road charging for long term electric vehicle range extension”			
	Type of action	Project budget	EU Funding	Project Start-End
	Research & Innovation	€ 9 m	€ 6.5 m	1 January 2014
Partners	ICCS, CRF, SCANIA, VOLVO, VeDeCom (Renault), SAET, ERTICO, AMET, ATA, CEA, CIRCE, ENIDE, FKA, TUB, HITACHI, KTH, MECT, POLITO, QIE, SaNeF, TRL, TNO, TECNO, UNIGE-DITEN, IREN			

Project Overview

FABRIC	FeAsiBility analysis and development of on-Road charging solutions for future electric vehiCles
Target & Deliverables	Range extension of EVs via dynamic wireless charging. Development and testing of three dynamic wireless charging prototypes. Feasibility analysis for large scale deployment of the technology.
Overall Approach	<pre>graph LR; subgraph Analysis; A1[User needs ICT WP2.2 Charging WP3.2]; A2[Tech benchmarking ICT WP2.3 Charging WP3.3]; A3[Integration feasibility SP4 – WP4.2]; A4[Other factors SP5 – WP5.2]; end; subgraph Design; D1[Requirements ICT WP2.2 Charging WP3.2 GRIDT4.4.2 ROADT4.5.3]; D2[Use cases SP4 – WP4.3]; D3[Test scenarios SP4 – WP4.3]; end; subgraph Development; Dev1["- Specification - Architecture - Design ICT WP2.4 Charging WP3.2 GridWP4.4 Road WP4.5"]; Dev2[Development to bridge the technological gaps ICT WP2.6 Charging WP3.6 GridWP4.4 Road WP4.5]; end; subgraph Evaluation; E1["- Evaluation methodology - Test site needs SP4 – WP4.7 T4.7.1"]; E2[Component verification ICT WP2.7 Charging WP3.7 GRIDWP4.4 ROADWP4.5]; E3[System validation SP4 – WP4.6-WP4.7]; end; subgraph Impact_Demo [Impact & Demo]; I1[Impact assessment System feasibility SP5]; I2[Exploitation SP1 – WP1.5]; I3[Dissemination SP1 – WP1.4]; end; Analysis --> Design; Design --> Development; Development --> Evaluation; Evaluation --> Impact_Demo;</pre> <p>The Overall Approach is structured into five sequential stages, each with specific tasks and work packages (WPs) or system phases (SPs):</p> <ul style="list-style-type: none">Analysis:<ul style="list-style-type: none">User needs (ICT WP2.2, Charging WP3.2)Tech benchmarking (ICT WP2.3, Charging WP3.3)Integration feasibility (SP4 – WP4.2)Other factors (SP5 – WP5.2)Design:<ul style="list-style-type: none">Requirements (ICT WP2.2, Charging WP3.2, GRIDT4.4.2, ROADT4.5.3)Use cases (SP4 – WP4.3)Test scenarios (SP4 – WP4.3)Development:<ul style="list-style-type: none">Specification, Architecture, Design (ICT WP2.4, Charging WP3.2, GridWP4.4, Road WP4.5)Development to bridge the technological gaps (ICT WP2.6, Charging WP3.6, GridWP4.4, Road WP4.5)Evaluation:<ul style="list-style-type: none">Evaluation methodology, Test site needs (SP4 – WP4.7, T4.7.1)Component verification (ICT WP2.7, Charging WP3.7, GRIDWP4.4, ROADWP4.5)System validation (SP4 – WP4.6-WP4.7)Impact & Demo:<ul style="list-style-type: none">Impact assessment, System feasibility (SP5)Exploitation (SP1 – WP1.5)Dissemination (SP1 – WP1.4)

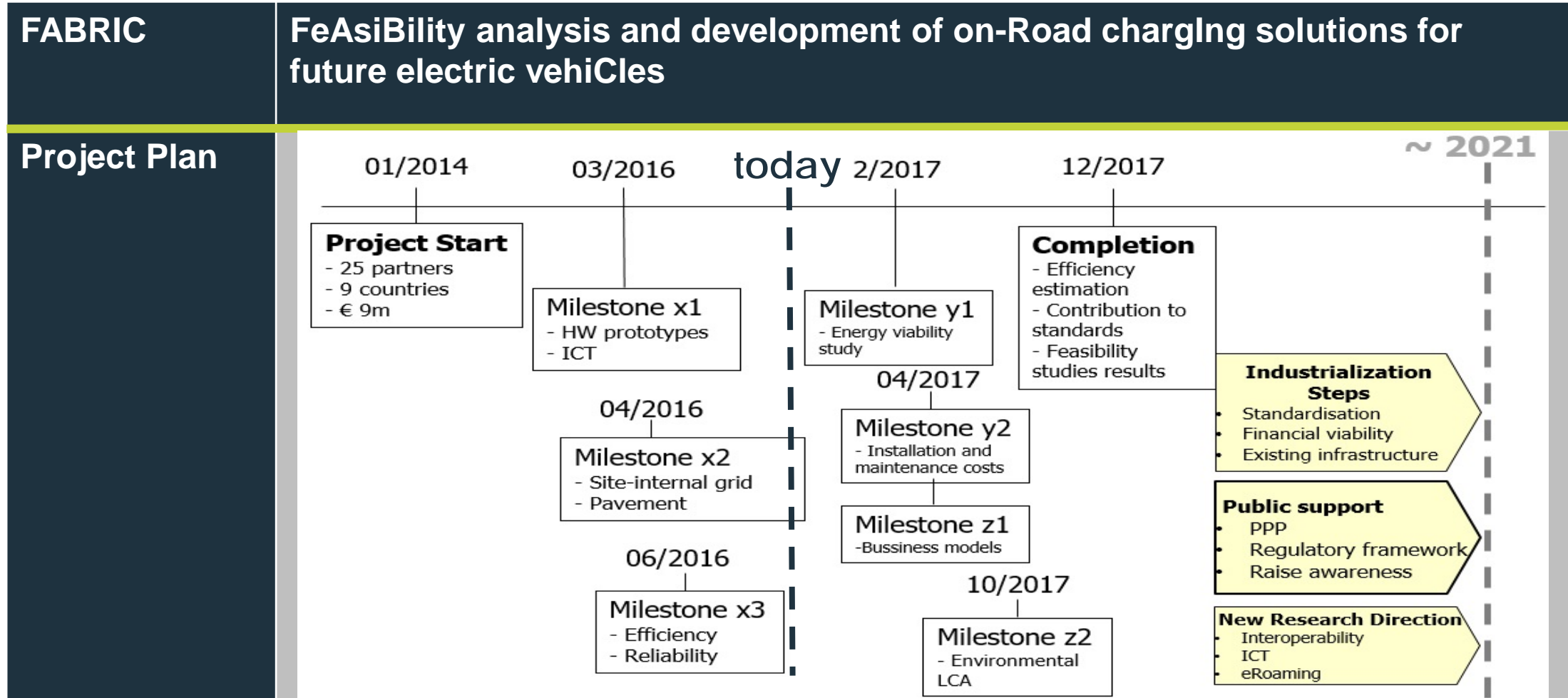
FABRIC		FeAsiBility analysis and development of on-Road charging solutions for future electric vehicles	
Project Structure (WP, SP,...)	Name	Short Description	Deliverables (major ones)
SP1	-Project Management	-Operational and technical management, dissemination and standardization activities	-Website/Collaboration platform -Dissemination, exploitation plan -Leaflets, posters, events,
SP2	-ICT solutions	-Review of ICT SotA relevant to dynamic charging and development of ICT for the operation of the dynamic charging prototypes	-User needs and reqs -Functional architecture and specs -ICT for HMI, lane alignment and load balancing and verification
SP3	-Charging solutions	-Review of existing solutions and development of hardware prototypes	-SotA and gap/interoperability analysis -Architecture/specifications -Prototypes 1-3 and verification
SP4	-Integration, infrastructure and testing	-System use cases and testing scenarios, preparation of test sites and tests conduct. Analysis of results.	-Use cases and test scenarios -Italian and French test site road and grid adaptations -Tests and results analysis
SP5	-Assessment	-Socioeconomic, environmental and sustainability analysis for dynamic charging technology deployment.	-LCA/LCC evaluation of e-roads -Technical specs for e-road construction, maintenance & operation -Effect on the grid. -CBA and business models -...



Timeline

FABRIC: : FeAsiBility analysis and development of on-Road charging solutions for future electric vehiCles

Timeline



Research Activities

FABRIC: FeAsiBility analysis and development of on-Road charging solutions for future electric vehiCles

Research Activity 1 - Dynamic wireless charging prototypes

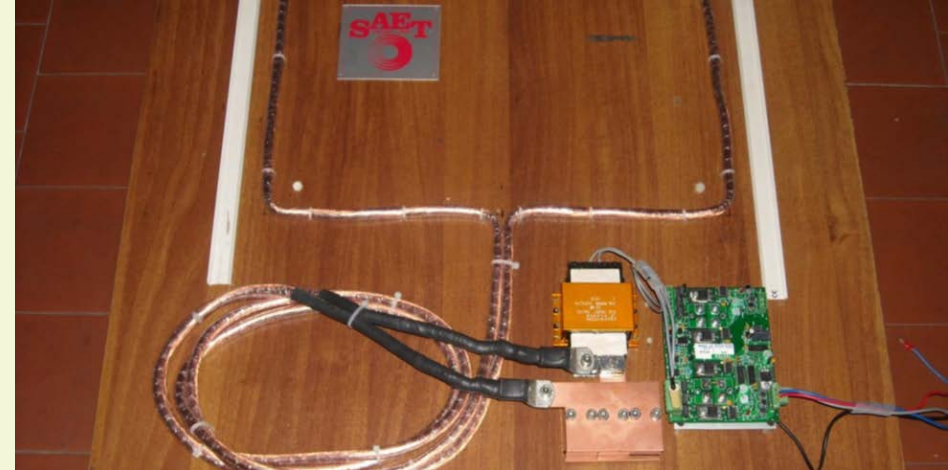
Approach

- Develop the necessary power transfer coils and supporting hardware for dynamic charging.
- Develop the ICT necessary for the operation of the systems (control, HMI, charging management).
- The solution allows charging on-the-go, opportunistic and dynamic. This allows for much more frequent charging especially in urban environments.
- The FABRIC approach can be considered novel in the following ways:
 - It is applied on passenger vehicles (not just buses or heavy vehicles)
 - It aims for higher speeds (60-90km/h) than other implementations
 - Both new prototypes and adaptation of existing and tested static wireless charging technology (QC HALO)
- TRL-level: initial 3, approached 7

Research Activity 1 - Dynamic wireless charging prototypes

Activities and Status

- Three wireless charging prototypes were developed (~20kW, at 85kHz):
 - VEDECOM in France evolving QUALCOMM HALO static charging pads
 - POLITO in Italy
 - SAET in Italy
- Replication process for the charging pads is ongoing (QC pads delivered).



Research Activity 2 - E-roads construction

Approach

- Two “e-roads” are being constructed in FABRIC for the testing of the prototypes.
- This involves:
 - SotA review on existing implementations
 - Road and grid adaptation guidelines and specifications
 - Road and grid adaptations at the test sites
- At Satory site a cement trench was constructed that hosts the pads under custom-made removable covers
 - Advantages: easy access and replacing of pads, reusable track
 - Disadvantages: costly, not representative of real road implementations
- At Susa site the pads are being embedded in the pavement
 - Advantage: representative (to a degree) of real roads
 - Disadvantage: possibly destructive process for the pads, not possible to rearrange them after embedment.

Research Activity 2 - E-roads construction

Activities and Status

- Guidelines and specifications for e-roads were delivered.
- Test track in Satory is completed.
- Test track in Susa is nearing completion.
- Tests are expected to start in October. Preliminary testing is already taking place at both sites.



Research Activity 3 - EVs adaptation

Approach

- Secondary coils will be installed under EVs to receive the energy from the road coils.
- Extensive electrical, electronic and mechanical adaptations to facilitate the solution were necessary.
- Integration of ICT and HMI for facilitating the dynamic charging process.
- 2 different passenger vehicles will be used:
 - Renault Kangoo (French pilot – 2 vehicles)
 - IVECO light duty vehicle (Italian pilot)

Research Activity 3 - EVs adaptation

Activities and Status

- Electrical and communication architectures were modified.
- A custom suspension was devised for IVECO vehicle to control the coils' airgap.
- Custom mounting solutions were developed for both vehicle types.
- The vehicles are ready for testing.



Research Activity 4 - Feasibility studies

Approach

- Societal perspectives towards on-road charging.
- LCA/LCC evaluation of e-roads on environmental and cost impact.
- Technical specifications for construction, maintenance and operations of e-roads.
- Assessment of impact on the grid of large-scale deployment.
- Assessment of maturity, reliability, efficiency and stability of the supply chain.
- Cost-benefit analysis and business models of large-scale deployment.
- Deployment scenario analyses for achieving environmental targets, standardization and harmonization.

Research Activity 4 - Feasibility studies

Activities and Status

- The main bulk of the feasibility studies will begin from the second half of 2016 and will run through 2017.
- A preliminary feasibility assessment examined several large-scale deployment scenarios based on actors' requirements and available FABRIC deliverables.
- Currently the following activities are taking place:
 - Integrated LCA/LCC system for evaluation of E-roads
 - Technical specifications of construction, maintenance and operations of E-roads
- The corresponding reports may contribute as guidelines to decision makers, city authorities, the industry and stakeholders.

Research Results

FABRIC

Research Result 1 – Charging prototypes (VEDE)

Achievement

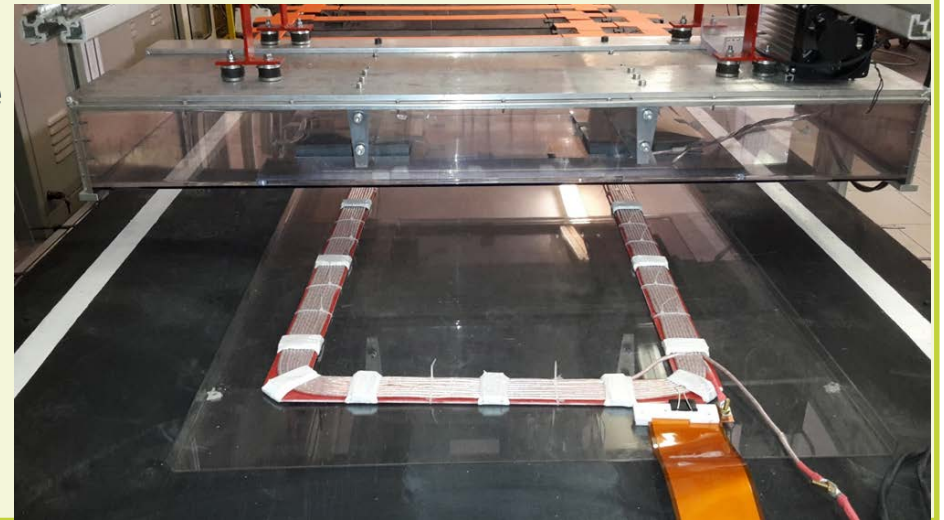
- Evolution of QUALCOMM HALO static charging pads for dynamic charging.
- Novelty:
 - Higher power transfer comparing to the static solution (>20kW)
 - New proprietary communication/control protocols (Confidential)
- Improvement vs current charging technologies
 - New scenarios of use (opportunistic, on the go) especially in urban environment
 - Higher speeds than the ones tested so far for wireless dynamic charging (aiming for 90km/h)
- Intellectual property generated
 - QUALCOMM patents for dynamic charging pads



Research Result 2 – Charging prototypes (POLITO & SAET)

Achievement

- Evolution of ECOFEV technology by POLITO to support dynamic wireless charging. Higher power transfer rate.
- Novel components to increase efficiency and reduce cost (Confidential).
- Novel design by SAET. Different electrical architecture and physical design.
- Different solutions but interoperable (The vehicle will have the same secondary coil, developed by POLITO).
- Potential of improvement vs current technology:
 - Potential patents for POLITO regarding the novel components



Research Result 3 – ICT for dynamic charging

Achievement

- Three ICT “modules” were developed:
 - Charging management: A solution for real time load balancing in the charging lane to ensure the secure grid operation, make sure that demand is lower than supply and distribute appropriately the supply among the charging EVs.
 - HMI for guiding and informing the driver before, during and after charging.
 - Lane keeping system that utilizes the HMI and guides the driver in order to minimize misalignment and maximize charging efficiency.
- Proprietary software, different for the two pilots.
- Several publications at IEEE transactions /conferences
- Improvement could be expected if driving was done automatically in the charging lane



Research Result 4 – 2 Test tracks (e-roads)

Achievement

- Two test tracks were constructed:
 - Satory (100 m) integrating VEDECOM solution
 - Susa (>100 m) integrating POLITO/SAET solutions
 - Grid adaptations to support the charging load
 - Custom made covers for Satory to withstand EV weight
- Improvement over current technology
 - Longer tracks than the SotA in wireless dynamic charging
 - Reusable track for testing new pads (Satory)
 - Testing at higher speeds



Industrialisation and Next Steps

Fabric

Next Steps

Industrialisation

- System TRL-Level initial:3, current: 6, expected: 7
- Further steps for industrialization
 - Solution 1 (Vedecom/Qualcomm): charging pads are TRL 9 (for static charging)
 - Solution 2 (POLITO) charging pads are TRL 5-6
 - Solution 3 (SAET) charging pads are TRL 4-5
 - ICT ranges TRL 3-9. Standardization is non-existent. Proprietary software is used for communication of grid actors with the CIOs, hindering the plug and play proliferation of the technology. Automated driving and existing lane keeping solutions could be used for power transfer efficiency maximization.
- Industrialization possible based on impact assessment on existing infrastructure (road, grid) and after a viability study (efficiency, current and projected manufacturing cost, installation and maintenance costs etc).
- Authorities will play a crucial role due to the high infrastructure adaptation costs.

Next Steps

Implementation

- Need for direct investment or incentives by authorities and government on modernizing the grid and making sure that it can cover the future needs of electromobility including the special characteristics of dynamic wireless charging (high frequency of high-power, low-energy peaks).
- Standardisation efforts should include dynamic wireless charging.
- Regulations regarding the physical characteristics of the installations and safety levels.

New research directions:

- Synergies with developers of conductive solutions, to investigate how to utilize the same electric infrastructure and grid connection systems.
- Promote communications research focusing on security and reliability.
- Advance eRoaming, to achieve seamless transition between existing charging networks thus improving drastically the business potential outlook.

Thank you for your attention

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