Project Title:

QUalifying and Implementing a user-centric designed and EfficienT electric vehicle

Project Acronym: **QUIET**

GA: **769826**

Topic: **Electric vehicle user-centric design for optimised energy efficiency**

Topic identifier: **GV-05-2017**

Type of action: **RIA Research and Innovation action**

Deliverable No.	QUIET D5.1	
Deliverable Title	Prepared vehicle validation platform	
Deliverable Date	2019-03	
Deliverable Type	Report	
Dissemination Level	Public	
Written by	Steffen JAHN (HRE)	2019-05-27
Checked by	Joško DEUR (UOZ) Leo GÖTZ (STS)	2019-05-28 2019-05-28
Approved by	WP Leader (HRE) Coordinator (AIT) Quality Coordinator (HRE)	2019-05-29 2019-05-29 2019-05-29
Status	Version 1.2	2019-05-28

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 769826. The content of this publication is the sole responsibility of the Consortium partners listed herein and does not necessarily represent the view of the European Commission or its services.

Publishable Executive Summary

WP5 is the final step in QUIET, dealing with on-vehicle implementation, demonstration and final assessment of novel solutions developed in WP2-WP4. In the first phase of WP5, a Honda Fit EV car was prepared for conversion into the QUIET demonstrator vehicle. Deliverable D5.1 (Prepared vehicle validation platform) documents the preparation of the vehicle itself and the organisational steps to ensure a smooth integration of the novel solutions.

This preparation covers different areas. In the organisational field, a detailed system integration role distribution was created to define a clear communication path for defining systems interfaces and responsibilities.

For the hardware preparation, the demonstrator vehicle was prepared according to the requirements of the project consortium. This include the removal of the original A/C system and the complete HVAC unit. Furthermore, seats and interior components were removed to create ample space for the subsequent installation tasks. To ensure valid evaluations results from the final QUIET demonstrator, the performance of the demonstrator vehicle was compared to the baseline measurement car using HRE-G's chassis dyno.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 769826. The content of this publication is the sole responsibility of the Consortium partners listed herein and does not necessarily represent the view of the European Commission or its services.

Table of Contents

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 769826. The content of this publication is the sole responsibility of the Consortium partners listed herein and does not necessarily represent the view of the European Commission or its services.

List of Figures

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 769826. The content of this publication is the sole responsibility of the Consortium partners listed herein and does not necessarily represent the view of the European Commission or its services.

List of Tables

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 769826. The content of this publication is the sole responsibility of the Consortium partners listed herein and does not necessarily represent the view of the European Commission or its services.

Abbreviations and Nomenclature

Table 1: List of Abbreviations and Nomenclature.

Symbol or Shortname	Description
AER	All Electric Range
DL	Dissemination Level
EC	European Commission
ECU	Electronic Control Unit
EV	Electric Vehicle
GA	General Assembly
HMI	Human Machine Interface
HVAC	Heating, Ventilation, Air conditioning
PO	Project Officer
PC	Project Coordinator
SC	Steering Committee
T	Task
WP	Work Package

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 769826. The content of this publication is the sole responsibility of the Consortium partners listed herein and does not necessarily represent the view of the European Commission or its services.

1. Introduction

QUIET aims at developing an improved and energy efficient electric vehicle with increased driving range under real-world driving conditions. This is achieved by exploiting the synergies of a technology portfolio in the areas of: user centric design with enhanced passenger comfort and safety, lightweight materials with enhanced thermal insulation properties, and optimised vehicle energy management.

The developed technologies will be integrated and qualified in a Honda B-segment electric vehicle validator. Among these, a novel refrigerant for cooling, combined with an energy-saving heat pump operation for heating, advanced thermal storages based on phase change materials, powerfilms for infrared radiative heating, and materials for enhanced thermal insulation of the cabin have been investigated. Further focus has been put on lightweight glazing for windows, as well as light metals like aluminium or magnesium for seat components. Optimized energy management strategies, such as pre-conditioning and zonal cooling/heating the passenger cabin as well as user-centric designed cooling/heating modules represent further contributors in enhancing the thermal performance of the vehicle.

1.1. Description of the deliverable – Goals

In WP5 the results of the technology development work packages WP2-WP4 merge together to create the QUIET demonstrator vehicle.

WP5 is the final step in QUIET. At the first phase of this WP, a Honda Fit EV car was prepared for conversion into the QUIET demonstrator vehicle. Deliverable D5.1 (Prepared vehicle validation platform) documents the preparation of the vehicle itself and the organisational steps to ensure a smooth integration of the novel solutions.

As demonstrator platform, a separate Honda Fit EV was prepared by HRE-G. Having a separate vehicle available allows to conduct a back-to-back comparison between the baseline vehicle and the QUIET demonstrator during the final evaluation at the end of the project (Figure 1).

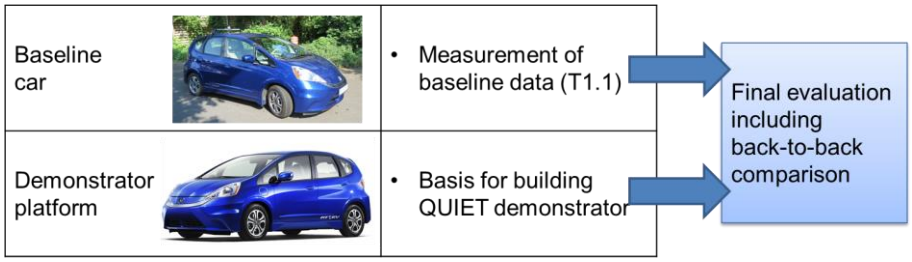

Figure 1: Usage of cars in QUIET

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 769826. The content of this publication is the sole responsibility of the Consortium partners listed herein and does not necessarily represent the view of the European Commission or its services.

2. Organisation

2.1. Roles and responsibilities

The preparation of the demonstrator platform is closely linked to the following implementation phase in T5.2. The work at HRE-G needs to be aligned to the needs of the other QUIET consortium partners. Before starting the actual preparation of the vehicle, responsibilities and interfaces needed to be defined. A RASIC chart (Table 2) was created in cooperation with the responsible project partners. For each main system, roles were allocated:

- **R**esponsible
- **S**upport
- **C**onsulted

Table 2: RASIC chart for integration phase in T5.2

Item	Loca-tion	HRE	QPD/ QPA	STS	AIT	ECON	VEN	OBR	ATT	RUB
Installing seats sub-assy	**HRE**	S		R						
Installing HMI touchscreen and ECU	**HRE**	S			R					
Installing closures sub-assy	**HRE**	S				R				
Installing IR panels & trim	**HRE**	S							R	
Installing instrument panel	**HRE**	R								
Installing HVAC sub-assy	**QPD**	S	R							
Installing PCM storage	**QPD**	S	R							S
Wiring HVAC system	*tbd*	S	R		S				S	
Start-up HVAC	*tbd*	S	R		C		C	C	C	C

As general rule, the responsible partner for each system is the respective task leader. HRE supports each installation step from the overall vehicle point-of-view.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 769826. The content of this publication is the sole responsibility of the Consortium partners listed herein and does not necessarily represent the view of the European Commission or its services.

2.2. Mechanical interfaces

The newly designed HVAC system shall be integrated seamlessly into the demonstrator platform. All new systems have therefore to be compatible to the surroundings of the Honda Fit EV and other novel systems, which are being developed by other project partners. To fix these interaction point, interfaces were identified for the main systems and responsibilities were distributed among the project partners.

For the seats, closures and glazing, it was defined to use the fixation points of the original Honda Fit EV components. This ensures a direct installation of the new components into the vehicle.

For the novel HVAC system, the situation is more complex, because the components of the HVAC system and the powertrain thermal management are distributed over the vehicle and are also highly integrated.

The modified heater and blower unit shall remain within their original packaging envelope beneath the instrument panel. Both units shall also retain their original mounting point, which allows a straight installation into the demonstrator platform. For the integration of the HVAC subsystems, the responsibility for packaging lies at T5.2, which is under the lead of QPD/QPA. The exact design of the mountings for radiators, compressor, PCM storage and its related fluid lines will be handled within this task. To assist the design phase, QPD/QPA can resort to the CATIA data, which were distributed in T1.1.

Additional to the HVAC itself, the new HMI touchscreen needs to be installed safely in the demonstrator car. In cooperation with AIT, HRE will create a mechanical interface to integrate the HMI touchscreen into the Honda Fit EV instrument panel. During this step, HRE-G will create a modified trim panel which shall fill the gaps, which are caused by the obsolete HVAC controls, in order to create an appealing interior design. Additional to this visible interface, the new HVAC ECU as well as HMI ECU need to be fixed securely in the new demonstrator car. The control interfaces between the added ECUs and the vehicle will be created in T5.2. This will also require custom-made mounting brackets.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 769826. The content of this publication is the sole responsibility of the Consortium partners listed herein and does not necessarily represent the view of the European Commission or its services.

3. Hardware Preparations

After clarifying responsibilities and mechanical interfaces between the vehicle and the novel systems (cp. Chapter 2), the actual hardware preparation was finally ready to start.

Before defining a suitable preparation scope of the demonstrator platform, the sequence of installation needed to be defined. After consultation with QPD, it was decided, that the novel heat-pump HVAC system shall be installed first. This system will be the most complex and the most interlinked system of the demonstrator vehicle. Therefore, all other integration steps shall follow after successful installation and start-up of that system (Figure 2).

Figure 2: Work flow for demonstrator build-up

As described in chapter 1.1, a separate Honda Fit EV car was prepared for the use as demonstrator platform. Using a separate car as demonstrator car bears certain risks. It had to be checked that the car, which is used as demonstration platform car, matches the baseline figures, which were measured with the dedicated measurement car. To prove this, the AER of the demonstrator platform was evaluated on the HRE-G chassis dyno and compared to the data of the baseline car. As illustrated in Figure 3, the demonstrator platform achieves 99% of the range of the baseline car. Both vehicles are therefore very similar regarding their achievable driving range.

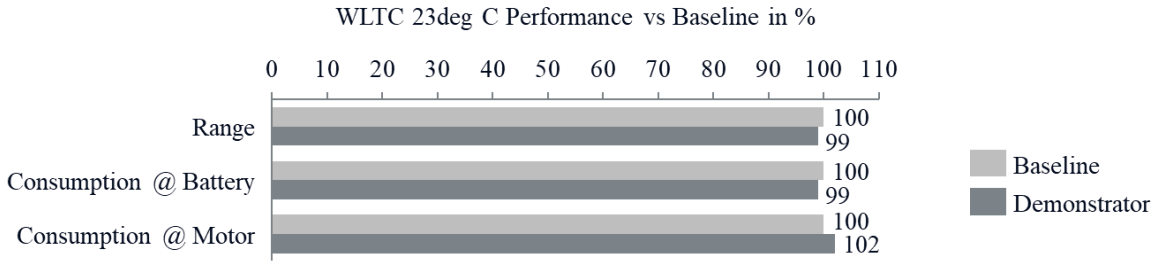

Figure 3: Range comparison of baseline car and demonstrator platform

Based on these findings, it is safe to use the selected car as demonstrator platform in the QUIET project.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 769826. The content of this publication is the sole responsibility of the Consortium partners listed herein and does not necessarily represent the view of the European Commission or its services.

After it was proven, that the chosen car is fit for its purpose, the hardware work was started.

As defined in the above mentioned RASIC, the required scope of hardware removal was discussed with the responsible partners, which were defined in Table 2. Initially, all components which were relevant for the installation of the HVAC system were defined. After discussion with QPD, several components were removed from the car. On the one hand, obsolete systems of the HVAC were removed completely:

- Electric A/C Compressor
- A/C lines
- HVAC ECU and controls

Figure 4: Engine bay of the Honda Fit EV without A/C components

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 769826. The content of this publication is the sole responsibility of the Consortium partners listed herein and does not necessarily represent the view of the European Commission or its services.

In order to prepare for the installation of the HVAC components in T5.2, further components were removed to increase accessibility:

- Instrument panel and other interior trim parts
- Front seats

Figure 5: Prepared Honda Fit EV after component removal

For easier handling of the platform vehicle, the instrument panel incl. steering wheel and column were temporarily reinstalled.

In parallel to the preparation at HRE-G, interior components were prepared at ATT. During the course of the project, HRE-G provided selected interior trim parts to ATT for further analysis. These components were disassembled and assessed regarding their usability for the installation of infra-red heating panels.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 769826. The content of this publication is the sole responsibility of the Consortium partners listed herein and does not necessarily represent the view of the European Commission or its services.

4. Technical support

Control specifications

To assist the start of T5.2, the collection and distribution of technical descriptions was started. To define appropriate control interfaces between the platform car and the novel systems, a detailed knowledge of carry-over systems is needed.
Involved project partners were receiving information, which are needed to control these unchanged carry-over systems. On the other hand, the available data from the vehicle itself were discussed with the system responsible persons. These data can be valuable parameters for the operation of the newly developed systems.

Especially important is the interface between the new heat-pump system and the carry-over HVAC- and blower unit. The new HVAC system will be integrated around components of the original system of the Honda Fit EV. A documentation of the operations modes of the carry-over actuators and components was created and shared with the relevant project partners.

Hardware research

Additionally, HRE-G was supporting the selection of appropriate HONDA components, which can be used to convert the existing HVAC unit into the novel heat-pump system. Requests were posted by QPD to HRE-G which looked for suitable components and provided the parts to QPD. This support will continue throughout the duration of T5.2.

Safety concept

In its role as OEM, HRE will be responsible for the overall safety concept of the demonstrator car. For this task, HRE relies on the input of each system responsible partner. The safety concept needs to be created using the actual final design and implementation of each newly developed system of the demonstrator car. This means, that the safety concept will be finalised along the running time of T5.2. During T5.2 HRE-G will be in constant exchange with the respective project partner to iteratively adjust the actual implementation and the safety concept to each other. Until D5.2, HRE will finish the safety concept for the entire demonstrator car. With this safety concept, it will be possible to operate the vehicle safely on the chassis dynos at JRC and HRE-G.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 769826. The content of this publication is the sole responsibility of the Consortium partners listed herein and does not necessarily represent the view of the European Commission or its services.

5. Conclusions

Different areas were covered to prepare the vehicle validation platform. In the organisational field, responsibilities were distributed to the project partners. Mechanical interfaces were discussed and defined for the main demonstrator systems.

In order to hedge the choice of platform car, the AER was compared to the baseline vehicle of D1.1. As no significant differences were measured, the actual hardware preparation could be started.
Obsolete systems were removed in order to create enough space for the subsequent integration of the novel systems of QUIET.

Finally, the described tasks have led to a ready prepared vehicle, which can now be transferred to QPD for the HVAC installation tasks of T5.2.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 769826. The content of this publication is the sole responsibility of the Consortium partners listed herein and does not necessarily represent the view of the European Commission or its services.

6. Acknowledgment

European Union's Horizon 2020 research and innovation programme

This project has received funding from the European Union's Horizon 2020 research and innovation programme under **grant agreement** No. **769826**. The content of this publication is the sole responsibility of the Consortium partners listed herein and does not necessarily represent the view of the European Commission or its services.

Project Partners:

The author(s) would like to thank the partners in the project for their valuable comments on previous drafts and for performing the review.

Participant No	**Participant short name**	**Participant organisation name**	**Country**
1 Coordinator	**AIT**	AIT Austrian Institute of Technology GmbH	Austria
2	**HRE**	Honda R&D Europe (Deutschland) GmbH	Germany
3	**QPA**	AVL qpunkt GmbH	Austria
4	**QPD**	qpunkt Deutschland GmbH	Germany
5	**VEN**	VENTREX Automotive GmbH	Austria
6	**UOZ**	University of Zagreb	Croatia
7	**IFAM**	Fraunhofer Institute for Manufacturing Technologies and Advanced Materials IFAM	Germany
8	**ATT**	ATT advanced thermal technologies GmbH	Austria
9	**ECON**	eCon Engineering Kft.	Hungary
10	**RUB**	Rubitherm Technologies GmbH	Germany
11	**STS**	SeatTec Sitztechnik GmbH	Germany
12	**OBR**	Obrist Engineering GmbH	Austria
13	**JRC**	Joint Research Centre - European Commission	Italy