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 D6.5	
Deliverable Title	Final exploitation plan	
Scheduled Deliverable Date	2021-03	
Actual (granted) Deliverable Date	2021-05	
Deliverable Type	Report	
Dissemination Level	Public	
Written by	Hansjörg KAPELLER (AIT) Steffen JAHN (HRE-G) Kristian ROSENKRANZ (AVL) Bernd THIERINGER (QPD)	2021-05-14 2021-05-06 2021-05-06 2021-05-04
Checked by	Joško DEUR (UOZ) Joachim BAUMEISTER (IFAM)	2021-05-11 2021-05-11
Approved by	WP Leader (AIT) Coordinator (AIT) Quality Coordinator (HRE-G)	2021-05-14 2021-05-12 2021-05-14
Status	Final 1.0	2021-05-14

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

This deliverable (Final exploitation plan) summarises the main aspects of the QUIET exploitation plan relevant to the developed QUIET components and innovations, and reports about exploitation results (e.g. lectures, workshops, exhibitions etc.) including market developments (focussing on the European Union). The final exploitation plan aims at the exploitation aspects put into practice during the project (e.g. dissemination and advertisement of the project results), and the way in which each project outputs may be used in the future by the consortium members (i.e. how the project partners involved intend to exploit the developed technologies) to ensure the proper exploitation of the project results and to achieve maximum effect of the exploitation process.

This document is broadly divided into three parts:

- Exploitable results of the QUIET project with identification of the different types of results and their potential user groups on partner and/or consortium level,
- Market developments and opportunities,
- Exploitation by project partners with special attention to the exploitation by SMEs and exploitation of research deliverables.

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
EC	European Commission
ER	Exploitable Results
PO	Project Officer
PC	Project Coordinator
GA	Grant Agreement
WP	Work Package
DL	Dissemination Level
RTD	Research and Technology Development
OEM	Original Equipment Manufacturer
SME	Small and Medium-sized Enterprise
BEV	Battery Electric Vehicle
EV	Electric Vehicle
HMI	Human-Machine Interface
HP	Heat Pump
HVAC	Heating, Ventilation, and Air-Conditioning
PCM	Phase Change Material
PEV	Plug-In Electric Vehicle
PHEV	Plug-In Hybrid Electric Vehicle

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

During the continuously active task T6.3 (Exploitation), all QUIET partners were weighing up possible and most promising user preferences with the proposed and developed QUIET solutions. In the context of Horizon 2020 exploitation is defined as the use of results in further research activities, or in developing, creating and marketing a product or process, or in creating and providing a service, or in standardisation activities [1].

This helped to align the exploitation strategy (D6.3) and enabled the generation and completion of the final exploitation plan (as documented in this deliverable D6.5) by the T6.3 leader (AIT) with the involvement and support of the full consortium.

This document is broadly divided into three parts and reports about:

- the exploitable results of the QUIET project,
- the market developments and opportunities (focussing on the European Union),
- the exploitation put into practice during the project by project partners (with special attention to the exploitation by SMEs).

The first part deals with the identification of the different types of results and their potential user groups on partner and/or consortium level. It summarises the main aspects the exploitable results (ER) of the QUIET project (incl. reports about the ERs like lectures, workshops, exhibitions etc.) and the exploitation plan relevant to the developed QUIET components and innovations. The exploitable results of the QUIET project are structured according to the three main research AREAS.

The second part provides a description about the market developments dealing with an updated estimation on the EV market development for Plug-In Hybrid Electric Vehicles (PHEV) and especially for Battery Electric Vehicles (BEV) for which the QUIET project innovations are relevant. Special attention is given in the developments and benefits for suppliers and on opportunities on legislative level, since QUIET could be used to underline any further discussion with legislative stakeholders.

All project partners are in charge of the exploitation of the project results - either jointly or separately. Hence the third part describes the exploitation by the QUIET project partners and the way in which each project output may be used in the future.

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. Exploitable results of the QUIET project

This chapter deals with the types of exploitable results, the exploitable results of the QUIET project and the exploitation plan for the innovations/components developed within the project work packages (WP) WP1 - Vehicle platform data acquisition, WP2 - User-centric design of the e-vehicle, WP3 - New lightweight components with improved thermal performance, WP4 - Integrated technologies for enhanced energy efficiency and comfort and WP5 - Implementation, demonstration and final assessment on vehicle level.

2.1. Development Goals of QUIET

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 following three main areas,

- AREA I: user centric design with enhanced passenger comfort and safety,
- AREA II: lightweight materials with enhanced thermal insulation properties,
- AREA III: optimised vehicle energy management.

AREA I comprises the topics Human-Machine Interface (HMI) and thermal management. The development, implementation and demonstration of an HMI in a realistic operational environment is to enable a highly ergonomic, user-friendly, and comfortable interaction with the EV for the driver together with an enhanced thermal management strategy, especially developed for optimised user-oriented comfort.

AREA II comprises the topics thermal insulation, thermal inertia and light-weight. Novel, foam-based component shell door structures were developed and installed in the demonstrator. The foam elements guarantee better thermal insulation due to low thermal conductivity. Additionally, they absorb vibrations and noise and therefore they increase passenger comfort. Due to the special structure and the used foam materials, the thermal inertia and energy needed for heating and cooling could be reduced. Regarding light-weight the mass of the developed auxiliaries was to be reduced by using the novel lightweight technologies like component shell structures with foam elements, aluminium- and magnesium alloys for seat structure, innovative infrared-heating concept based on a heating powerfilm and a compact Heating, Ventilation, and Air-Conditioning (HVAC) system combined with heat pump and thermal storage based on Phase Change Material (PCM).

AREA III comprises the topics heating as well as cooling and air conditioning.
An innovative, ultra-light radiation-heating concept based on a heating powerfilm was developed and integrated into the validator. Furthermore, a novel cooling system based on the refrigerant R290 (propane), was developed. By using R290 as refrigerant, the efficiency of the AC system could be increased, and the mass of the AC components was reduced. Components like thermal energy storage components with PCM are added in order to support the air conditioning system.

An overview of the three main development areas is given in Figure 1.

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.

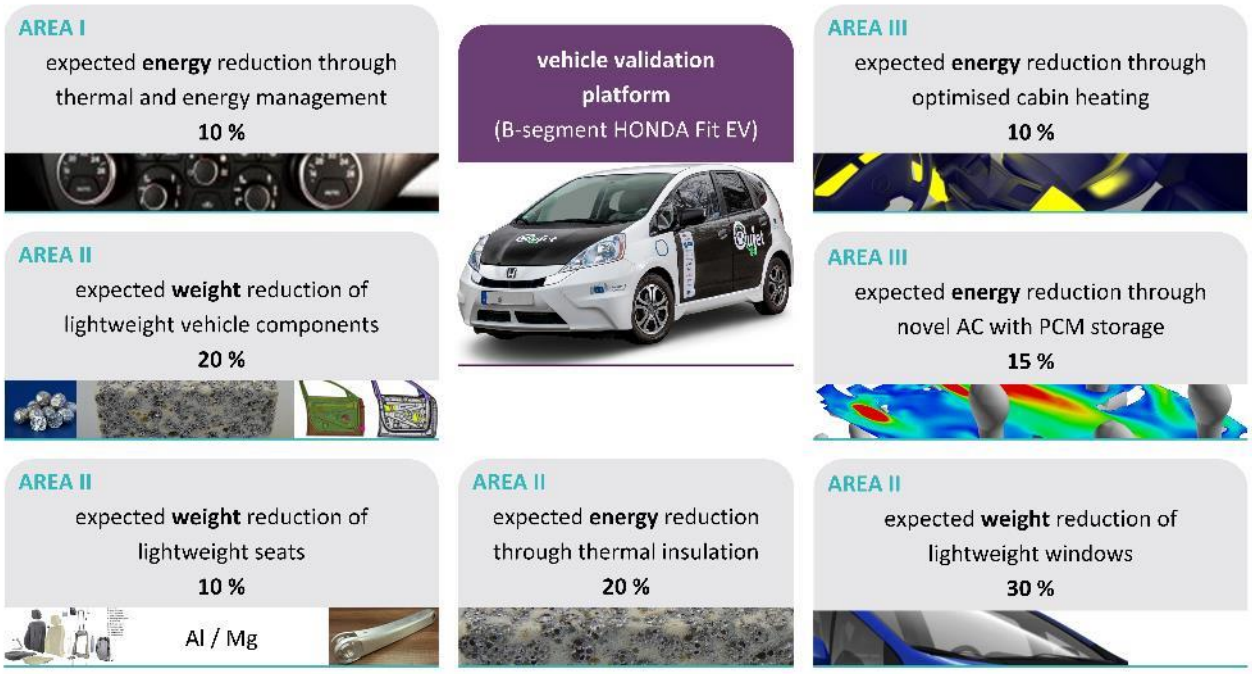


Figure 1: Main development AREAS of QUIET and expected technological results.

2.2. Key exploitable results of QUIET

A total of 12 key exploitable results (ER) are defined in the proposal for QUIET. The exploitable QUIET results, potential user groups and their benefit on end-user are shown in the ensuing tables (Table 2 - Table 5).

Table 2: AREA I - User-centric design of the e-vehicle

Key exploitable results (ER)	Applicator / end-user	Benefit for end-user
ER1: Multi-physical modelling and simulation for efficient vehicle concepts development.	OEMs, Tier 1 and Tier 2	-Reduced development time; -Increased efficiency of components; -Fast investigation of different technologies;
ER2: Development of an intuitive HMI for the thermal management of an electric vehicle.	OEMs, Tier 1 and Tier 2	-Increased thermal comfort for passenger; -Reduced energy consumption of electric vehicle;

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 3: AREA II - New lightweight components with improved thermal performance

Key exploitable results	Applicator / end-user	Benefit for end-user
ER3: Method for the application of lightweight materials in vehicle seats.	OEMs, Tier 1 and Tier 2	-Higher user acceptability of the final product;
ER4: Complex FEM modelling of composite panels and virtual testing process of doors, engine hood and luggage rack.	OEMs, Tier 1 and Tier 2	-Reduced weight; -Increased thermal insulation; -Competitive production costs;
ER5: Composite material made of fibre reinforced materials and a hybrid foam with reduced weight and improved thermal insulation.	OEMs, Tier 1 and Tier 2	-Access to new markets; -New customers; -Reduced weight; -Increased thermal insulation;

Table 4: AREA III - Integrated technologies for enhanced energy efficiency and comfort

Key exploitable results	Applicator / end-user	Benefit for end-user
ER6: PCM devices with improved heating power.	OEMs, Tier 1 and Tier 2	-Leadership in the business field; -Improved thermal energy storage capability;
ER7: Smart Valve Technology for a new, energy-efficient AC cycle, bi-directional and OBD capable.	OEMs & Tier 1	-Compact design; -Smart/intelligent; -Energy efficient; -OBD capable;
ER8: PCM storages as part of heating/cooling system.	Tier 1 and Tier 2	-Energy efficiency increase for heating/cooling;
ER9: Stabilizing temperatures of electric components.	Tier 1 and Tier 2	-Increased lifetime and reduced failure rates of electric components;
ER10: Coupled (1D, 3D and control) modelling of the A/C circuit with integrated PCM and heat pump operation.	OEMs, Tier 1 and Tier 2	-Build-up of complete vehicle thermal management system for future applications of alternative climate-friendly refrigerants;
ER 11: Highly efficient new air conditioning and heating system for electric vehicles.	OEMs, Tier 1 and Tier 2	-Increased energy efficiency and improved thermal comfort of passengers;

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 5: AREA III - Implementation, demonstration and final assessment on vehicle level

Key exploitable results	Applicator / end-user	Benefit for end-user
ER12: System integration into the vehicle; instrumentation; evaluation of systems on vehicle level	OEMs, Tier 1 And Tier 2	Build up and testing of vehicle to validate systems and simulation models

A detailed description on the motivation for each partner concerning their participation in the respective AREAs and the findings that support market entry are described in detail in section 2.5.

Figure 2 depicts a selection of realized key exploitable results i.e. technological results of the QUIET project: e.g. the R290 (propane) safety valve and expansion valve (ER7), the HVAC system and the R290 compressor (ER11), the user-centric designed HMI (ER2), the infrared heating panels (ER11), the PCM thermal storage system (ER6), the lightweight seats (ER3), the door crash beams with advanced pore morphology and the lightweight composite doors (ER5).

Figure 2: Technological results of 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.

2.3. Impact of exploitable results on partners

Each exploitable result (ER) impacts multiple partners of the consortium which is summarized in Table 6.

Table 6: Applicable benefits (indicated by yes) for QUIET consortium partners concerning the exploitable results (ER)

ER	AIT	HRE	AVL	QPD	VEN	UOZ	IFAM	ATT	ECON	RUB	STS	OBR	JRC
1	yes												
2	yes	yes											
3	yes										yes		
4									yes				
5							yes						
6							yes			yes			
7					yes								
8										yes			
9										yes			
10			yes	yes		yes							
11		yes	yes	yes	yes			yes		yes		yes	
12		yes	yes	yes									yes

2.4. Specific exploitation

The exploitation plan for QUIET turns gained know-how, scientific results and its demonstrator into a user optimised EV, which is ready for serial production for mass market. This was achieved by highlighting attributes like: ‘novelty’, ‘user-centrically designed’, ‘highly efficient HVAC system inside’ or ‘guaranteed driving range extension’.

To ensure this, activities during the project followed possible exploitation channels like,

- continuously reporting of exploitation,
- the QUIET website, scientific communication, workshops
- promoting of the QUIET vehicle validation platform,
- exchange with other OEMs.

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.

Reporting of Exploitation

To enable proper reporting of exploitable knowledge reporting templates were created and provided on the QUIET share point OneDrive (see Figure 3 a screenshot of the reporting Excel sheet template). These reporting templates were maintained continuously.

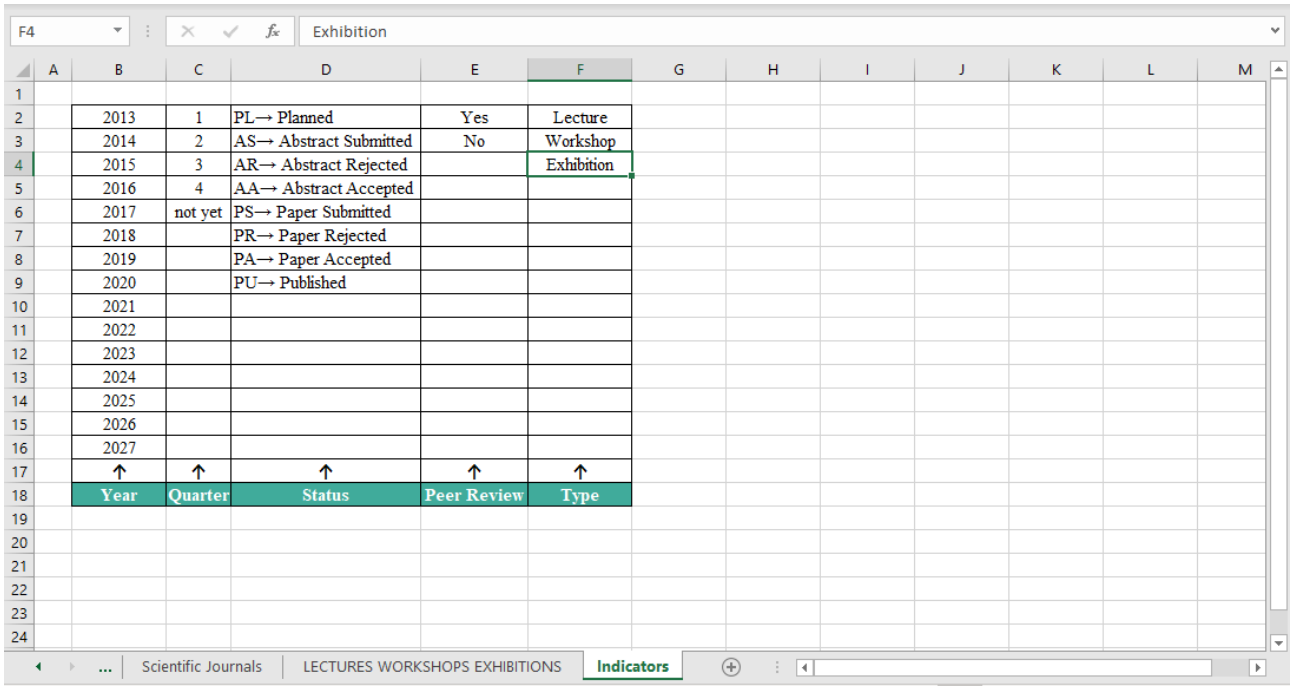


Figure 3: Reporting template (screenshot of Excel sheet) available on QUIET share point OneDrive.

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 held, in spite of the COVID-19 pandemic, numerous lectures, attended on 4 workshops and on 6 exhibitions (Figure 4 is showing the OBR exhibition stand in IAA 2019 highlighting the novel R290 compressor) as reported in Table 7, at which they presented the QUIET project for exploitation purposes. Unfortunately face-to face discussions were diminished through the COVID pandemic since beginning of 2020 to online sessions.

Table 7: Excerpt of reported exploitation activities (Lectures, Workshops & Exhibitions)

LECTURES, WORKSHOPS & EXHIBITIONS						
Name of Event	**Title of Lecture / Topic**	Date	Place	**Type**	**Presenter / Moderator (Inst. short name)**	**Peer-review**
DOMUS Kick-Off	Introduction QUIET project	29/11/2017	Barcelona	Workshop	ŠIMIĆ (AIT)	No
TRA2018	QUIET project highlighted at TRA2018 European Commision's exhibition stand	16/04 until 19/04/2018	Vienna	Exhibition	ŠIMIĆ (AIT)	No
JEC WORLD 2019	Mechanical Characterization of Composite Structures with Adhesive Joints	12/03 until 14/03/2019	Paris	Lecture	TAKÁCS (ECON)	No
EPMA Functional Materials Seminar 2019	Porous Structures for Thermo Management	03/04 until 04/04/2019	Bremen	Lecture	WEISE (IFAM)	No
XVIII. eCon Konferencia – ANSYS User Meeting	QUalifying and Implementing a user-centric designed and EfficienT electric vehicle - The QUIET Project	11/04/2019	Budapest	Lecture	ŠIMIĆ (AIT)	No
NAFEMS World Congress 2019	Analytical Method to Obtain Ply Specific Engineering Constants from Simple Material Tests of NCF Composite Parts	17/06 until 20/06/2019	Quebec	Lecture	KOVACS (ECON)	No
IAA 2019 – New Mobility World	QUIET compressor (R290) highlighted at IAA 2019 on OBR exhibition stand	10/09 until 15/09/2019	Frankfurt	Exhibition	SCHMAELZLE (OBR)	No
SDEWES 2019	Efficient and user-friendly designed electric vehicles: how breakthrough HVAC and other technologies enable enhanced thermal comfort solutions while increasing the driving range	01/10/2019	Dubrovnik	Workshop	ŠIMIĆ (AIT) et al.	No
SDEWES 2019	Integrated technologies for enhanced energy efficiency and comfort	01/10/2019	Dubrovnik	Lecture	ZOTTER (AVL)	Yes
SDEWES 2019	Thermal Management Solutions using Open Porous Metal Structures	01/10/2019	Dubrovnik	Lecture	BAUMEISTER (IFAM)	Yes
SDEWES 2019	Thermal Storage with High Power Outputs Using Phase Change Materials	01/10/2019	Dubrovnik	Lecture	KIESERITZKY (RUB)	Yes
SDEWES 2019	Potential analysis – How to increase the maximum driving range of electric vehicles	01/10/2019	Dubrovnik	Lecture	ŠIMIĆ (AIT)	Yes
IModBatt Workshop	QUalifying and Implementing a user-centric designed and EfficienT electric vehicle QUIET Project	18/10/2019	San Sebastian	Workshop	ŠIMIĆ (AIT)	No
35th INT. CAE CONFERENCE & EXHIBITION	QUIET project highlighted at CAE 2019 on ECON exhibition stand	28/10 until 29/10/2019	Vicenza	Exhibition	KIGLICS (ECON)	No
FSB 100	QUIET project highlighted with a poster during the Project Day Event organized within 100-years celebration of the Faculty of Mechanical Engineering and Naval Architecture	08/11 until 15/11/2019	Zagreb	Exhibition	CVOK, RATKOVIĆ (UOZ)	No
Automotive Aerodynamics & Thermal Management (International Forum 2019)	Qualifying and Implementing a User-Centric Designed and Efficient Electric Vehicle – H2020 Project QUIET	20/11/2019	Manchester	Lecture	ŠIMIĆ (AIT)	No
H2020 RTR	QUIET project highlighted at H2020 RTR19	04/12 until 05/12/2019	Brussels	Lecture	ŠIMIĆ (AIT)	No
QUIET Project Poster	QUIET - QUalifying and Implementing a user-centric designed and EfficienT electric vehicle Permanent poster in JRC Ispra VELA Lab.	from 2019	Ispra JRC VELA lab	Exhibition	Paffumi (JRC)	No
TRA2020 (COVID-19: Conference was cancelled)	QUIET project will be highlighted at TRA2020 European Commision's exhibition stand	27/04 until 30/04/2020	Helsinki	Exhibition	KAPELLER (AIT)	Yes
TRA2020 (COVID-19: Conference was cancelled)	Electric vehicle user-centric design for optimized energy efficiency (This session will be focused on two H2020 European Projects, DOMUS and QUIET)	27/04 until 30/04/2020	Helsinki	Workshop	ŠIMIĆ (AIT) et al.	Yes
STEVE project Webinar: Scenarios of electro-mobility.	QUIET - QUalifying and Implementing a user-centric designed and EfficienT electric vehicle	28/05/2020	Online	Online Lecture	KAPELLER (AIT)	No
6th Annual FAMENA PhD Workshop 2020	Ivan CVOK (UOZ) presentation titled "Model predictive control of a passenger cabin heating and air-conditioning system of an electric vehicle" for PhD Workshop 2020	06/07/2020	Zagreb	Online Lecture	CVOK (UOZ)	No
6th CellMAT – Int. Conference on Cellular Materials	Improvement of the power output of a PCM-based energy storage system using open porous metal foams	07-09/10/ 2020	Online	Online lecture	BAUMEISTER (IFAM)	No
HAZU "Electromobility and Autonomous Vehicles" roundtable	UOZ's effort on the QUIET project were outlined within the online presentation titled "Overview of Electric Vehicles Control Systems, e-Mobility Systems and Autonomous Vehicles" in an roundtable event organized Croatian Academy of Science and Arts	16/11/2020	Zagreb	Online Lecture	DEUR (UOZ)	No
A3PS Eco-Mobility 2020 - VIRTUAL LIVE EVENT	QUIET - QUalifying and Implementing a user-centric designed and EfficienT electric vehicle	19/11/2020	Online	Online Lecture	ŠIMIĆ (AIT) et al.	No
Two-Session-Clustering Workshop QUIET & DOMUS	The clustering workshop has been set up as both projects aim to optimize energy efficiency and to increase the range of electric vehicles by innovative user-centric design.	17/02 and 03/03/2021	Online	Webinar	ŠIMIĆ (AIT) et al.	No

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.

Figure 4: OBR exhibition booth in IAA 2019 highlighting the novel R290 compressor developed for the QUIET project.

QUIET website, scientific communication, workshops

The QUIET website enables the access to results and serves as a platform for internet presentations containing following information, like

- Project scope and targets
- Public events related to the project targets
- Contact information for the public
- Public reports, scientific communication (journals, papers / posters, workshops)
- E-newsletters to subscribe
- Eye minded related media (e.g. promotional video, flyer, posters)

The QUIET website and its contents are live documents, this is the web link to the main page (Home): https://www.quiet-project.eu/

The publication of scientific conference papers and presentations as well as journal papers and promotional documents are highlighted on the project website (e.g. flyer, periodical e-Newsletters, video-trailer).

Figure 5 depicts a sample of the dissemination page where all published QUIET documents are free of charge to interested parties or end-users, respectively, and can be obtained here (link).

The deliverable D6.4 (Summary of published documents) summarises all documents (e.g. journals, papers, flyer, posters etc.) which the QUIET consortium had put into practice and published.

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.

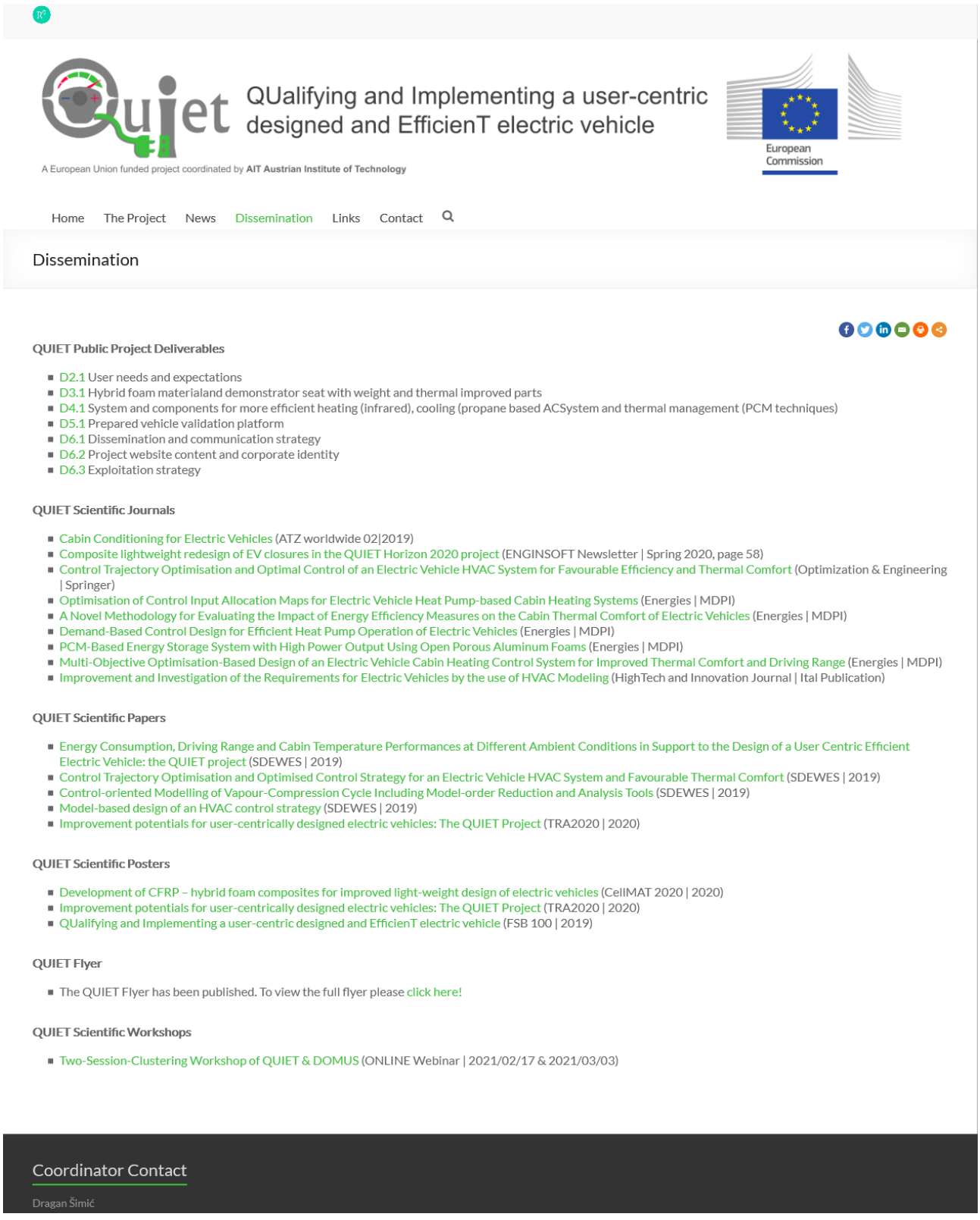
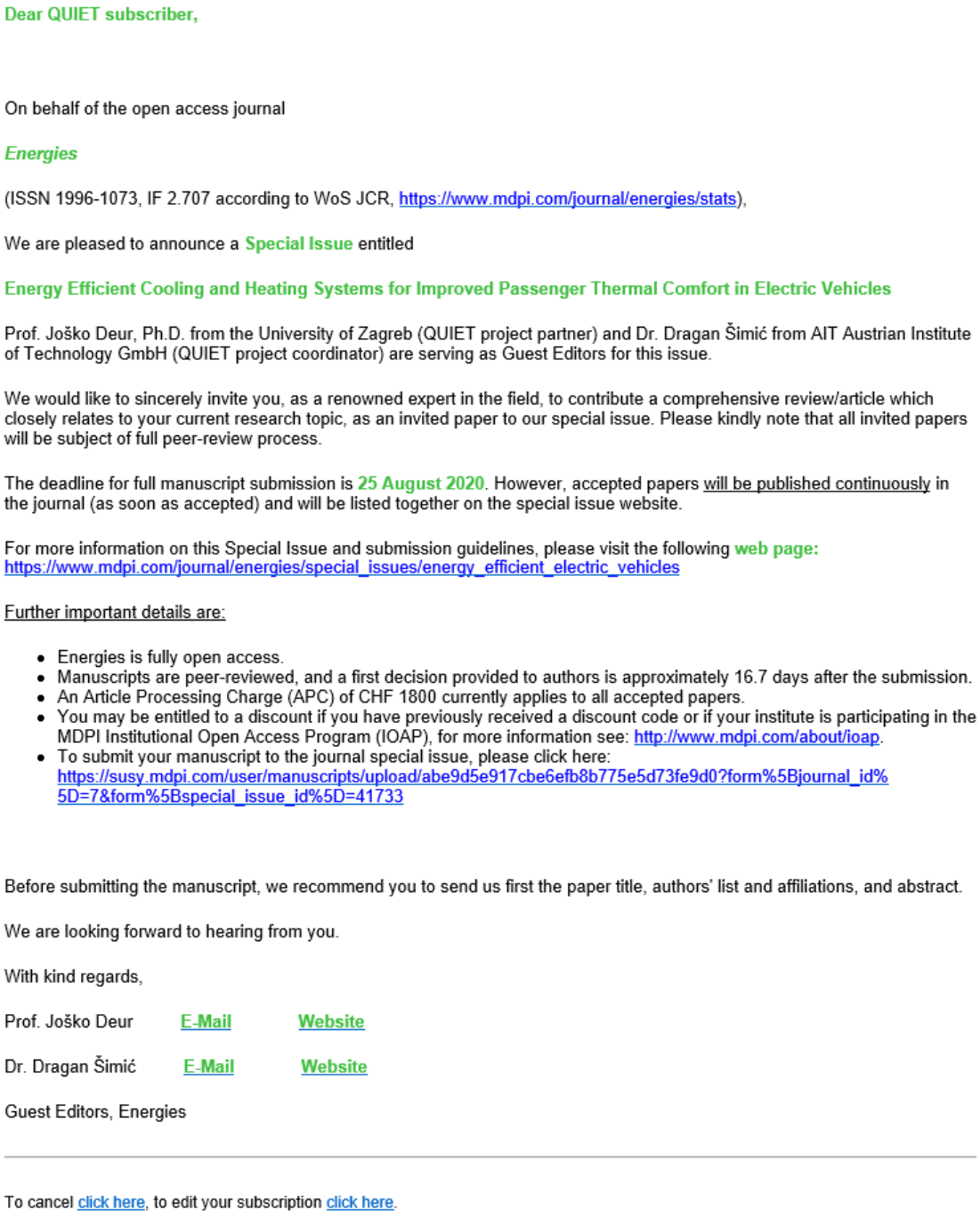


Figure 5: QUIET Dissemination page which enables the access to the project results.

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.

QUIET is issuing newsletters, to disseminate and announce activities planned by the project consortium e.g. newsletters were used to announce Special Issues to increase and strengthen the scientific excellence/reputation of QUIET research partners (cp. Figure 6) or Workshops like the Two-Session-Clustering Online Webinar of QUIET & DOMUS (cp. Figure 7).



Dear QUIET subscriber,

On behalf of the open access journal

Energies

(ISSN 1996-1073, IF 2.707 according to WoS JCR, https://www.mdpi.com/journal/energies/stats),

We are pleased to announce a **Special Issue** entitled

Energy Efficient Cooling and Heating Systems for Improved Passenger Thermal Comfort in Electric Vehicles

Prof. Joško Deur, Ph.D. from the University of Zagreb (QUIET project partner) and Dr. Dragan Šimić from AIT Austrian Institute of Technology GmbH (QUIET project coordinator) are serving as Guest Editors for this issue.

We would like to sincerely invite you, as a renowned expert in the field, to contribute a comprehensive review/article which closely relates to your current research topic, as an invited paper to our special issue. Please kindly note that all invited papers will be subject of full peer-review process.

The deadline for full manuscript submission is **25 August 2020**. However, accepted papers will be published continuously in the journal (as soon as accepted) and will be listed together on the special issue website.

For more information on this Special Issue and submission guidelines, please visit the following **web page:**
https://www.mdpi.com/journal/energies/special_issues/energy_efficient_electric_vehicles

Further important details are:

- Energies is fully open access.
- Manuscripts are peer-reviewed, and a first decision provided to authors is approximately 16.7 days after the submission.
- An Article Processing Charge (APC) of CHF 1800 currently applies to all accepted papers.
- You may be entitled to a discount if you have previously received a discount code or if your institute is participating in the MDPI Institutional Open Access Program (IOAP), for more information see: http://www.mdpi.com/about/ioap.
- To submit your manuscript to the journal special issue, please click here:
https://susy.mdpi.com/user/manuscripts/upload/abe9d5e917cbe6efb8b775e5d73fe9d0?form%5Bjournal_id%5D=7&form%5Bspecial_issue_id%5D=41733

Before submitting the manuscript, we recommend you to send us first the paper title, authors' list and affiliations, and abstract.

We are looking forward to hearing from you.

With kind regards,

Prof. Joško Deur E-Mail Website

Dr. Dragan Šimić E-Mail Website

Guest Editors, Energies

To cancel click here, to edit your subscription click here.

Figure 6: Screenshot of the Newsletter to announce QUIET's Special Issue entitled "Energy Efficient Cooling and Heating Systems for Improved Passenger Thermal Comfort in Electric Vehicles".

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.

Two-Session-Clustering Workshop of QUIET & DOMUS (Online – TEAMS)

On 17th of February 2021 and 3rd of March 2021, the Horizon 2020 project DOMUS will hold a two-session Clustering Workshop together with the Horizon 2020 project QUIET. The clustering workshop has been set up as both projects aim to optimize energy efficiency and thus to increase the range of electric vehicles via innovative user-centric design. New cabin components, systems and control strategies will be developed and demonstrated in an A and B segment car.
Both projects will present their progress and will highlight the similarities and differences in their approach during the workshop.

The Clustering workshop has been divided into two sessions:

Session 1 (on the 17th of February)
During this session, the different methodologies applied by both projects in order to fulfil the same objectives will be discussed and analyzed.

Session 2 (on the 3rd of March)
During this session, breakthrough technologies at component level will be discussed. Additionally, there will be discussions with invited speakers from the H2020 projects BIOMOTIVE and FITGEN about alternative solutions at component level related to EVs.

Interested? Please find the official invitation to the workshop and the agenda (last four pages) here.
You can register for one or both sessions via the link in the invitation or by clicking here.

- Please note you will need to register to the workshop to receive the official confirmation as well as the Teams link(s) for the session(s). The official confirmation will be sent via an Outlook Calendar invitation.

To cancel click here, to edit your subscription click here.

Figure 7: Screenshot of the Newsletter to announce the webinar "Two-Session-Clustering Workshop of QUIET & DOMUS".

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.

Promoting of the QUIET vehicle validation platform (video, flyer)

A promotional video about QUIET was developed in month 40/41 by the partner HRE-G. The video trailer is aligned for the broad public and aimed to be shared through social media channels like YouTube, but is also suitable to be used for scientific conferences or fair booths. The already completed video is soon available on the QUIET website and will be announced via the E-Newsletter to all QUIET subscribers.

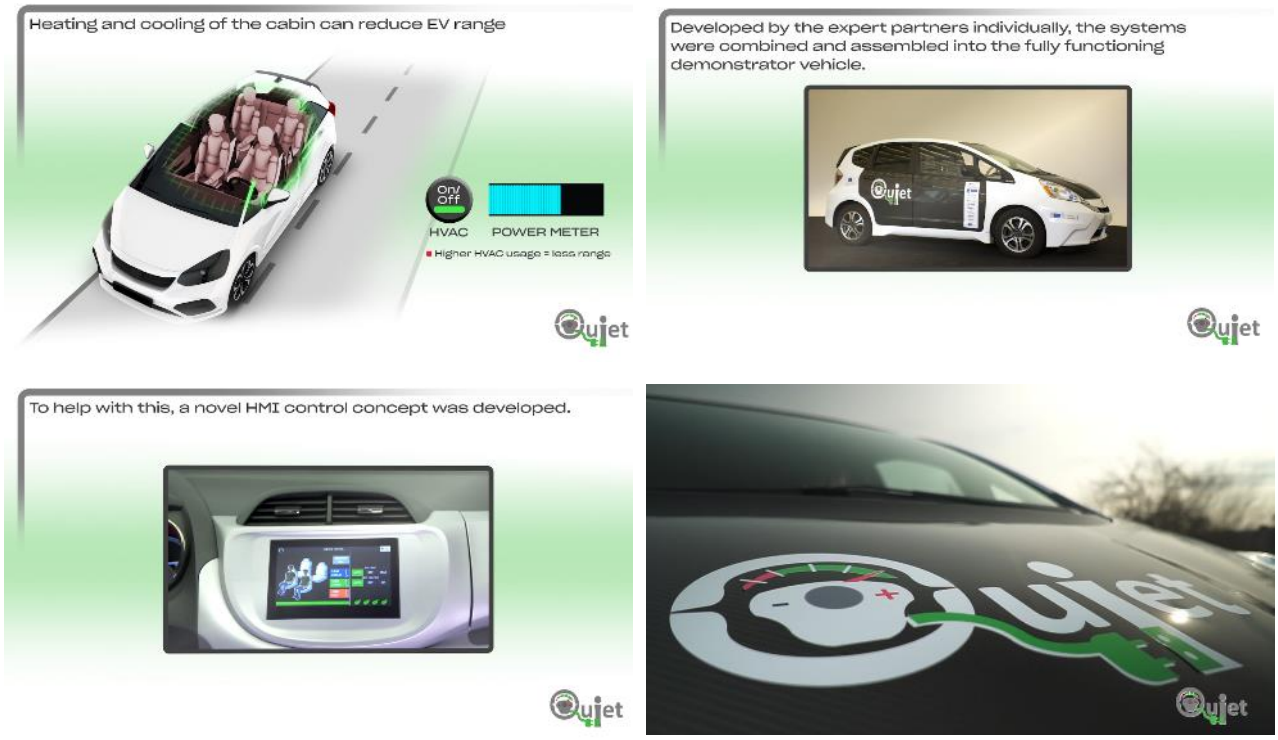


Figure 8: Samples of the QUIET video.

Project brochures such as a flyer will aim for a uniform appearance with a high recognition value and are referred on the project website, which provide comprehensive information source kept up to date on a regular basis. The intention of the project brochures is to keep interested groups informed. They will be delivered/posted at virtual (due to COVID 19-pandemic) conferences, local and global fairs. The QUIET flyer contains the main characteristics of the project, such as its motivation, objectives, the principal message, results and partners. It has been designed to transmit ideas graphically. Figure 9 depicts a sample of the QUIET flyer which can be downloaded from the QUIET website (link).

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.

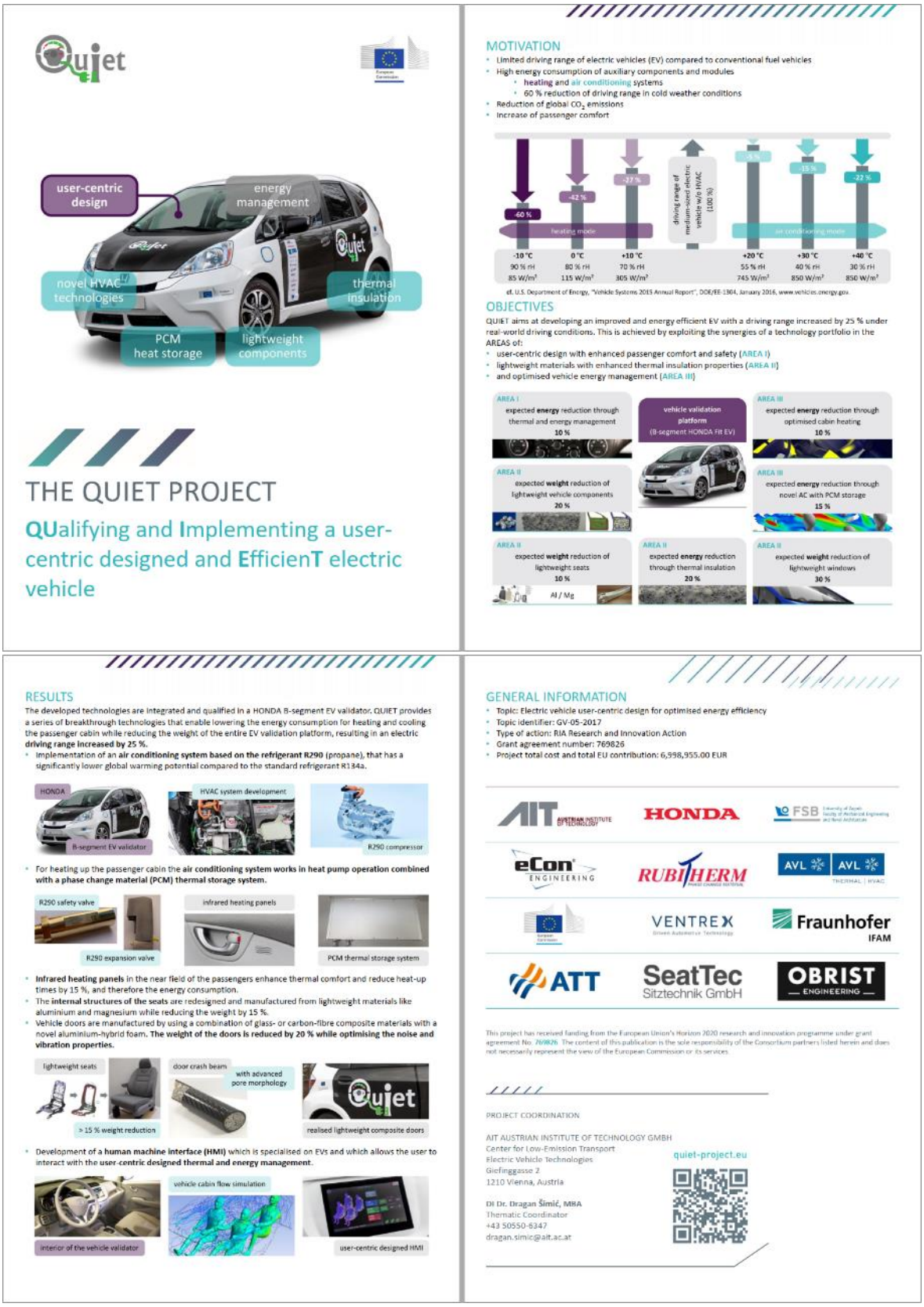


Figure 9: Sample of the QUIET flyer to promote the EV validator.

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.

Exchange with other OEMs

With the chance to develop a vehicle with all the modifications integrated, each participating partner got possibilities to get in contact directly with interested parties like end-users or OEMs. During discussions and negotiations e.g. with different thermoplastic glazing providers (Task 3.1: Lightweight windshield components with improved thermal performance) a further cooperative partnership between the Task 3.1 involved members and the OEM Covestro Deutschland AG could be established after the end of the QUIET project (contact has been made). As reported in deliverable D3.2 (Lightweight vehicle components (glasses, door, engine hood, trunk lid, etc.)), Covestro Deutschland AG offered sample polycarbonate sheets to QUIET which they already had on stock from previous R&D projects, since Covestro Deutschland AG is very interested and encouraged in gaining benefits using their glazing in a real automotive application as for the QUIET demonstrator, see Figure 10.

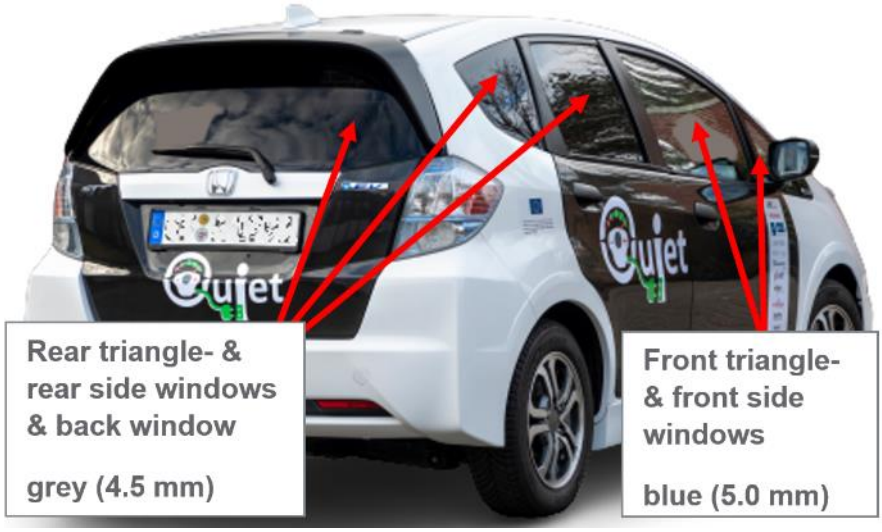


Figure 10: PC windows with enhanced thermal properties implemented in the QUIET demonstrator.

2.5. Exploitation plan for each partner

Motivation

The exploitation plan was developed by considering the consortium findings about the user preferences and the details of the proposed QUIET innovations/solutions and was elaborated in close collaboration with the dissemination and communication planning. Technological results were exploited by protection and subsequent licensing or via sales of components and systems developed in the project. Other results and solutions were sought to be exploited through consulting contracts and research and development collaborations with third parties.

Table 8 shows the QUIET exploitable results embedded in the plan for final exploitation.

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 8: QUIET exploitable results (ER) and the plan for final exploitation

Key exploitable results	Plan for exploitation / route for partners
ER1: Multi-physical modelling and simulation for efficient vehicle concepts development.	-Follow-up projects with industry by AIT; -Applicable in automotive engineering solutions; -Scientific publications by AIT;
ER2: Development of an intuitive HMI for the thermal management of an electric vehicle.	-Follow-up projects with industry by AIT; - HRE will spread the demonstrated QUIET technologies into the global Honda R&D organisation;
ER3: Method for the application of lightweight materials in vehicle seats.	-Follow-up projects with industry by AIT, STS;
ER4: Complex FEM modelling of composite panels and virtual testing process of doors, engine hood and luggage rack.	-Follow-up projects from industry for ECON; -Know-how potential and publications at ECON; -Multiphase applications for industry and scientific partners;
ER5: Composite material made of fibre reinforced materials and a hybrid foam with reduced weight and improved thermal insulation.	Follow-up projects with industry by IFAM; -Applicable in all transportation industry (not only automotive); -Scientific publications by IFAM;
ER6: PCM devices with improved heating power.	-Follow-up projects with industry by IFAM; -Scientific publications by IFAM and RUB;
ER7: Smart Valve Technology for a new, energy-efficient AC cycle, bi-directional and OBD capable.	-Follow-up projects/business with OEM and Tier 1 by VEN;
ER8: PCM storages as part of heating/cooling system.	-Get a PCM hot/cold storage market ready for EVs together with project partners; -Scientific publications by RUB;
ER9: Stabilizing temperatures of electric components.	-Generalize concept of thermal equilibration with PCM and develop tailored solutions for EVs and other applications; -Scientific publications by RUB;
ER10: Coupled (1D, 3D and control) modelling of the A/C circuit with integrated PCM and heat pump operation.	-Expansion of the existing AVL technology portfolio for new customer projects; -Offering new technologies developed in the project; AVL, QPD; -Scientific publications by UOZ;

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.

ER 11: Highly efficient new air conditioning and heating system for electric vehicles.	-Technology demonstration on vehicle and subsystem level; AVL, QPD, ATT, VEN, OBR, RUB, HRE;
ER12: System integration into the vehicle; instrumentation; evaluation of systems on vehicle level	-Technology demonstration on vehicle level; AVL, QPD, HRE; -Scientific publications by UOZ;

The implementation of this plan is guaranteed by helping procedures to create, manage and report research results (e.g. notification of partners of any publication or disclosure) and to establish measures to characterise project outputs.

Intellectual Property Rights

With the combination of an (for automotive application up to now) unusual refrigerant R290, a heat pump system, the integration of heat accumulation, infrared heating and other details, AVL and QPD are enrolling protection of these new ideas in order to provide the basis for patent applications.

Ownership of results and collaboration beyond QUIET

The GA foresees that each beneficiary takes measures to ensure 'exploitation' of its results using them in further activities (by each beneficiary and beyond the QUIET project).

During the Close Down meeting the consortium partners expressed their interest in the exploitation of the demonstrator-car (i.e. full functionality of the vehicle for the 3months after project termination and usage of the vehicle for demonstration within the next two years) as follows:

- QPD interested in displaying the QUIET vehicle demonstrator.
- UOZ is interested in future research and test activities concerning the functioning the QUIET vehicle demonstrator.
- OBR is interested regarding further test activities.
- HRE-G is interested in further tests and in displaying the QUIET vehicle demonstrator.
- AIT is interested in proceeding tests with the QUIET vehicle demonstrator after project termination and in further research collaboration.

All partners that are interested in the further exploitation of the demonstrator-car agreed and can participate the setup for the upcoming joint ownership agreement.

AIT (Research Partner), HRE-G (OEM) and OBR (Tier 2 SME) expressed their consent to intensify possible cooperation's also after the QUIET project ending.

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. Market developments

Recent market analysis indicates that plug-in electric vehicles (BEV and PHEV) are becoming a relevant player in the overall passenger vehicle market as the numbers [2] in Table 9 are forecasting.

Table 9: Updated estimated global EV market development (PHEV and BEV [2])

	2018	2020	2022	2024	2026	2028	2030
Sold vehicles (1000 units)	1,300	2,000	2,800	4,000	6,200	9,000	12,000
Global market share (%)	2.6	4.0	5.6	8.0	11.9	16.1	20.0

Looking at the absolute numbers, the large markets for passenger vehicles and therefore electric vehicles are in China and USA. However, due to the relatively high share of EV, Europe is also highly attractive (see comparison listed in Table 10, [2], [3]).

Table 10: List of the ten countries with the most EV sales in 2019 [2], [3]

Country	BEV (1000s)	PHEV (1000s)	EV (1000s)	Percentage of global sales	EV market share
China	834	226	1060	50.45 %	4.90 %
United States	242	85	327	15.54 %	2.10 %
Germany	63	45	109	5.17 %	3.00 %
Norway	60	19	80	3.7 9%	55.90 %
United Kingdom	39	37	75	3.58 %	2.80 %
Netherlands	62	6	68	3.21 %	15.10 %
France	43	19	61	2.92 %	2.80 %
Canada	32	19	51	2.42 %	3.00 %
Sweden	16	25	41	1.94 %	11.40 %
Japan	21	18	39	1.85 %	0.90 %
Others	121	71	192	9.13 %	1.20 %
Total	1533	568	2102	100 %	2.5 % - 3.06 %

Apart from the market perspective, the automotive OEM are strongly committed to enhance the share of electrified vehicles in their portfolio. For example, Honda announced that in the major markets the share of BEV and FCEV will rise to 40% by 2030 and finally to 100% in 2040 [4].

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.

3.1. Developments for suppliers

In the changing automotive industry, the suppliers are expected to play a bigger role in the value chain [5]. In practical terms, the suppliers are expected to receive larger scopes for development, increasing their responsibility and therefore their share of the value added. To become attractive partners for the vehicle OEM, it is beneficial for the suppliers to have own technologies in their portfolio. The developed solutions of QUIET can therefore be used to increase the competence of European suppliers. The gained knowledge and experiences are therefore a welcome asset.

3.2. Opportunities for legislative level

As can be seen from the previous technical report, R290 is still unregulated for the use in automobile air conditioning systems. The achieved results from QUIET could be used to underline any further discussion with legislative stakeholders.

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. Exploitation by project partners: plan for final exploitation (future use)

According the 12 key exploitable results (ER) introduced in chapter 2.2 consortium partners have various interests in exploiting. The partner-related benefits (as structured in Table 6) and gained from the execution/exploitation of QUIET, are reported here in the following subchapters.

4.1. QUIET partners exploitable results – OEM partner

4.1.1. HRE-G

HRE (OEM) is a R&D subsidiary of the global Honda Motor, Ltd. It is acting as European facility to research European trends and technologies, in order to facilitate more attractive products for European and also world-wide customers of Honda vehicles. HRE will use the results for the QUIET project to advance research in the areas of energy efficient vehicle systems. The demonstrated European technologies from the QUIET project will be spread into the global Honda corporation, spreading the gained know-how and the capabilities from the European project partners.

ER2: Development of an intuitive HMI for the thermal management of an electric vehicle

Progress during QUIET:

The findings from the user study were a valuable input to R&D activities within Honda. Sharing the results of the feedback of European customers was initiated and will be continued in the following months with the relevant R&D departments.

Path to market / future use:

By discussing the solutions and the evaluation results within Honda, the gained knowledge from the QUIET project will be directly fed into the global development departments.

ER11: Highly efficient new air conditioning and heating system for electric vehicles.

Progress during QUIET:

The findings from the bench test of the new VTMS system were discussed in an early stage with the global development departments. As these test data were early available, intermediate findings could be transferred before the final vehicle build-up was initiated.

Path to market / future use:

As the data were discussed directly with the development departments, the gained know-how was directly transferred to the relevant peer groups.

ER12: System integration into the vehicle; instrumentation; evaluation of systems on vehicle level

Progress during QUIET:

From the viewpoint of an OEM, having the full vehicle perspective is essential. After finalisations, all detailed findings for each sub system can be put into the context of the final OEM product. Especially for the discussion with management, having a complete and fully functional demonstrator is a valuable asset. After the end of the project, the demonstrator will be used to showcase the capability to fulfil several in-house requirements and specifications. In addition to ER11, a more appealing dissemination and a more holistic demonstration can be achieved to illustrate the benefits of the newly developed solutions of QUIET.

Path to market / future use:

By using the demonstrator vehicle, it will be possible to enhance the communication of the project results. Testing the demonstrator according to in-house requirements will allow HRE to convince the Honda development departments from the advantages and the potential of the innovation from 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.

4.2. QUIET partners exploitable results – Industrial partners (incl. SMEs)

4.2.1. ATT (Tier 1, SME)

ER11: Highly efficient new air conditioning and heating system for electric vehicles.

Progress during QUIET:

ATT brought in specialised knowledge in the field of innovative heating concepts using electrically conductive surface coatings and demonstrating them on vehicle and subsystem level.

Path to market / future use:

After the modification, the demonstrator vehicle now shows the new HVAC- and heating-system with all its components developed from the project partners: the new heat pump system developed from AVL, integrating the components from OBR, VEN and RUB and the infrared heating panels from ATT. The whole system is operated by the control unit from AIT and the control logic from UOZ.
Together with all other new developed components as the weight reduced seats, doors and closures and the glazing the modified vehicle was evaluated at HRE and JRC. The tests confirmed the AVL bench tests on system level and are now the base for the exploitation of the system performance and the efficiency increase.

ATT improved its knowledge regarding their electrically conductive coating on surfaces therefore being more competitive on the market. QUIET provided a platform to show the benefits of infrared radiation heating for thermal comfort in a B-segment vehicle.

4.2.2. STS (Tier 1, SME)

STS is an innovative company and provider of highly specialized seats and interior components for the automotive industry.

ER3: Method for the application of lightweight materials in vehicle seats

Progress during QUIET:

STS was able to adapt their technologies and production regarding lightweight seats with improved thermal and user-centric properties.

Path to market / future use:

Follow-up projects with industry partners and deepening relationships.

4.2.3. AVL (New) / QPD (Tier 1, SME)

AVL (New) – formerly qpunkt GmbH (Terminated) – and AVL Thermal & HVAC (formerly QPD) are innovative engineering service provider in the fields of thermal management, computational fluid dynamics, test bed engineering, testing on component-, system- and vehicle-level, design, and acoustics.
AVL/QPD expanded the existing AVL technology portfolio for new customer projects and will offer new technologies regarding efficient air conditioning developed and demonstrated on subsystem and vehicle level in this project.

ER10: Coupled (1D, 3D and control) modelling of the A/C circuit with integrated PCM and heat pump operation

Progress during QUIET:

Here an externally switched heat pump system for a BEV was developed from the concept. Using simulation tools, the layout of the system was fixed and the necessary dimensions and performance of the components were determined to achieve the expected results.

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.

Path to market / future use:
AVL/QPD expanded the existing AVL technology portfolio for new customer projects offering the new technologies developed in the project.

ER11: Highly efficient new air conditioning and heating system for electric vehicles.

Progress during QUIET:
Technology demonstration on vehicle and subsystem level achieved.

Path to market / future use:
One way to increase the driving range of a BEV under summer and winter condition is to increase the efficiency of the heating and air-conditioning system of the vehicle. A heat pump system is a good method to increase the efficiency for heating compared to standard HV PTC heaters. In this project we used R290 (propane) as refrigerant. This has additional advantages from the operating bandwidth to lower temperatures compared to standard refrigerants like R134a or 1234yf.

ER12: System integration into the vehicle; instrumentation; evaluation of systems on vehicle level

Progress during QUIET:
Technology demonstration on vehicle level achieved.

Path to market / future use:
Integrating a new system in an existing vehicle is always a challenge. Already in the early concept phase intense discussions with the project partners were started to optimize all components to fit into the vehicle. The packaging work, the layout and routing of the system and all necessary supports and fixations were designed with CAD tools. All necessary sensors were installed and the vehicle with the new system was commissioned and prepared for evaluation.
Showing the vehicle with the integrated heat pump system is a very good advertisement to start the discussion with future customers if you quote for development projects.
Having test results from vehicle tests which confirm the prediction from simulations may also open doors.
Therefore, the QUIET project is a very good way to show the portfolio of AVL / AVL Thermal & HVAC in the development of automotive thermal systems.

4.2.4. RUB (Tier 2, SME)

ER6: PCM devices with improved heating power

Progress during QUIET:
RUB is an expert for developing high-quality PCM solutions. During the project RUB improved their knowledge about PCM techniques enabling the extension of their customer field to serve a PCM hot/cold storage market ready for EVs together with the project partners.
Several scientific publications have been carried out (for details see deliverable D6.4: Summary of published documents [6] as well as Figure 5 and Table 7).
Path to market / future use:
The results found at component level are very interesting not only for automotive applications but also for other industry sectors. They will in the next stage be published in parts on the Rubitherm website as well as discussed in an upcoming issue of the newsletter of the RAL Quality Association PCM which addresses companies and researchers worldwide working with PCMs.

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.

ER8: PCM storages as part of heating/cooling system

Progress during QUIET:

PCM hot/cold storage made market ready for EVs together with project partners.

Several scientific publications have been carried out (for details see deliverable D6.4: Summary of published documents [6] as well as Figure 5 and Table 7).

Path to market / future use:

Project partners for manufacturing the heat/cold storage will be identified. Potential customers will be asked to define the specific conditions in their vehicle (for example regarding power, storage capacity, and available space). Concepts will be created with manufacturing partners and upon approval from customers put into action.

ER9: Stabilizing temperatures of electric components

Progress during QUIET:

Generalizing the concept of thermal equilibration with PCM and developing tailored solutions for EVs and other applications. Several scientific publications have been carried out (for details see deliverable D6.4: Summary of published documents [6] as well as Figure 5 and Table 7).

Path to market / future use:

The implementation follows the answer of ER8 but additionally other industry branches will be identified that have use of high power thermal storages and individual solutions will be developed upon customer request.

ER11: Highly efficient new air conditioning and heating system for electric vehicles

Progress during QUIET:

Technology demonstration on vehicle and subsystem level achieved.

Path to market / future use:

Based on the system-design the heat pump was firstly evaluated on the system test bench at AVL in Graz. There the necessary oil amount for the system was determined and tests of the refrigerant cycle and the whole system with all its water circuits was installed and tested.

The performance of the system and input for the operating strategy were determined. This was also used as input for the commissioning of the vehicle and the preparation of the vehicle tests.

Vehicle tests were performed at HRE, AIT and JRC. The evaluation of the results is still ongoing. Upon receipt of a positive feedback regarding the implementation of a PCM in the air conditioning and heating system in the EV collaboration partners will be identified that want to incorporate the storage in their HVAC system and have the potential to introduce the final product into the automotive market.

4.2.5. OBR (Tier 2, SME)

ER11: Highly efficient new air conditioning and heating system for electric vehicles.

Progress during QUIET:

OBR have significant expertise in thermal management solutions and used their gained know-how to enhance the development of cooling circuits and compressors using the novel refrigerant propane and broaden their customer base and number of projects together with OEMs and Tier 1 industry.

The OBR patents „THS“ (Twin Hole System, Patent Application Number: DE 10 2017 105 175 B3) and „CBS“ (Compensation Bore System, Patent Application Number: DE 10 2017 110 913 B3) were applied for the QUIET scroll compressor (Figure 4) and examined successfully with the innovative refrigerant R290.

Technology demonstration on vehicle and subsystem level achieved.

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.

Path to market / future use:
From OBR point of view the development of an R290 eScroll is fitting perfectly into company history and philosophy. OBR is known for natural refrigerants (e.g. R744) and eScroll developments in general. This project is combining both, natural refrigerant (R290) and latest, high-end eScroll design including a passive (OBR patented) backpressure system suitable for a full-envelope application in Air-Conditioning, Heat-Pump and Battery cooling. The QUIET project strengthened the position of OBR in both fields by using and advertising that in various marketing activities towards clients as OEM's, Tier1's and Tier2's as well in SAE working groups. The R290 experience of OBR is also shown on various exhibitions. R290 is well installed now on platforms of OBR [7].

4.2.6. VEN (Tier 2, SME)

ER7: Smart Valve Technology for a new, energy-efficient AC cycle, bi-directional and OBD capable

Progress during QUIET:
During the project VEN got in touch with the needs of safety valves in refrigerant system the first time. Together, with the partners we thought about needs and possibilities which are necessary to ensure the safety. Technology demonstration on vehicle and subsystem level achieved.
Path to market / future use:
After the definition of the delivery of scope for that project, VEN did a market research and customer interviews to get a better feeling about the state of the art and the market demand. Therefore, VEN used the developed basis and knowledge to design a Pressure Relief Valve for R744 according to customer specification and the standard DIN SPEC 74110. Next planned milestones are the design validation 2021 and start of production in the coming years.
To put in a nutshell, the QUIET project was an eye opener for VEN and delivered the basis to strengthen the existing portfolio of VEN in the field of refrigerant systems [8].

4.2.7. ECON (technology organisation, SME)

ER4: Complex FEM modelling of composite panels and virtual testing process of doors, engine hood and luggage rack

Progress during QUIET:
ECON offered expertise in solving problems ranging from simple analyses to complex assignments in the field of stress and deformation simulation and lifetime predictions, computational fluid dynamics, and 1D system simulations.
ECON exploited the Know-how potential of QUIET.
Several scientific publications have been carried out by ECON (for details see deliverable D6.4: Summary of published documents [6] as well as Figure 5 and Table 7).
Path to market / future use:
Follow-up projects from industry for ECON and multiphase applications for industry and scientific partners. ECON will profit from the increase of knowledge about thermal and safety aspects in EVs and will do follow-up projects together with industry partners.

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.

4.3. QUIET partners exploitable results – Research partners

The abovementioned industrial organisations were supported with the deep expertise of the following research institutes and universities.

4.3.1. AIT

ER1: Multi-physical modelling and simulation for efficient vehicle concepts development

Progress during QUIET:

Applicability in automotive engineering solutions demonstrated.

Several scientific publications have been carried out (for details see deliverable D6.4: Summary of published documents [6] as well as Figure 5 and Table 7).

Path to market / future use:

AIT will disseminate the results of this project in continuative customer and research projects. Scientific publications will increase the visibility of AIT and helps to raise the attractiveness of AIT as research partner in the field of electric mobility. -

ER2: Development of an intuitive HMI for the thermal management of an electric vehicle

Progress during QUIET:

Technology demonstration on vehicle and subsystem level achieved.

Path to market / future use:

Follow-up projects with industry partners and deepening relationships.

ER3: Method for the application of lightweight materials in vehicle seats

Progress during QUIET:

Technology demonstration on vehicle and subsystem level achieved.

Future use:

Follow-up projects with industry partners and deepening relationships.

4.3.2. UOZ

ER10: Coupled (1D, 3D and control) modelling of the A/C circuit with integrated PCM and heat pump operation

Progress during QUIET:

UOZ increase their reputation as a high-quality university dealing with the optimization of energy management strategies in electric vehicles.

Several scientific publications have been carried out (for details see deliverable D6.4: Summary of published documents [6] as well as Figure 5 and Table 7).

Future use:

Further research projects and scientific publications will strengthen the scientific excellence of UOZ.

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.

4.3.3. IFAM

ER5: Composite material made of fibre reinforced materials and a hybrid foam with reduced weight and improved thermal insulation

Progress during QUIET:

Technology demonstration on vehicle and subsystem level achieved.

Several scientific publications have been carried out (for details see deliverable D6.4: Summary of published documents [6] as well as Figure 5 and Table 7).

Path to market / future use:

As a research institute IFAM will exploit the results on the lightweight materials in future research projects with industrial partners. IFAM has continuous co-operations with various OEMs. IFAM will also use the research results as background knowledge for future publicly funded projects. Furthermore, IFAM has extensive activities regarding electric mobility concepts (battery technology, test of electric systems of cars, hub motor concepts) and in functional materials like highly-conductive polymer-based composites.

ER6: PCM devices with improved heating power

Progress during QUIET:

Technology demonstration on vehicle and subsystem level achieved.

Several scientific publications have been carried out (for details see deliverable D6.4: Summary of published documents [6] as well as Figure 5 and Table 7).

Path to market / future use:

IFAM experiences currently a large increase in industrial interest in metal foam heat exchanger structures for HVAC applications not only in the automotive sector. It plans to exploit the results of the QUIET-project on the thermal energy storage systems in future research projects with industrial partners. IFAM has continuous co-operations with various OEMs. IFAM will also use the research results as background knowledge for future publicly funded projects. Furthermore, IFAM has extensive activities regarding electric mobility concepts (battery technology, test of electric systems of cars, hub motor concepts) and in functional materials like highly-conductive polymer-based composites.

4.3.4. JRC

ER12: System integration into the vehicle; instrumentation; evaluation of systems on vehicle level

Progress during QUIET:

JRC increased experience in testing of EVs under real-world driving conditions.

Several scientific publications have been carried out (for details see deliverable D6.4: Summary of published documents [6] as well as Figure 5 and Table 7).

Future use:

The gained additional knowledge in testing EVs enable future developments and recommendations regarding new test procedures and -standards, especially related to the vehicle driving range in cold and hot ambient conditions.

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

Deliverable D6.5 dealt with the identification and structuring of the exploitable results (ER) gained during the project duration according their different types. The documented final exploitation plan aimed at the exploitation aspects put into practice during the project, and the way in which each project outputs may be used in the future by the consortium members.

For SMEs there are 2 major benefits in working in projects like QUIET:
One is to develop new technologies and systems together with other experts and due to ongoing creative discussions in the team there are chances to find new ways.
The other is that, compared to the daily business where we are normally working in customer projects, the gained results can be used in presentations also for the acquisition of future projects.
Normally the content of SME's work is strictly confident and cannot be used in presentations. Here the exploitation of the results is wanted, and this is a big advantage for SMEs. They can directly use this project for discussions with OEM and other customers, describing the target, the way chosen, the scope of work and also the results for a fruitful discussion. By means of the results achieved in this project, QUIET partners will be able to expand their existing technology portfolio. The involved companies will be able to offer new technologies regarding energy efficient air conditioning solutions, which have been developed and demonstrated on subsystem and vehicle level in this project. An efficient HVAC system is one of the key factors for the increase of driving range and hence for the customer acceptance of battery electric vehicles. The results of this project will serve as benchmark data, which are public and therefore can be disclosed and officially shown to customers.

The analysis of the EV market developments in section 3 shows that the QUIET project remains relevant. The ten largest markets were showing promising development forecasts. Using the developed QUIET technologies in a B-segment vehicle (like the QUIET demonstrator) will serve the markets, reduce costs, and make the technologies available to the broader public.

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. Bibliography

[1] http://www.iprhelpdesk.eu/glossary/exploitation

[2] IEA, "Global EV Outlook 2020," 2020. [Online]. Available: https://www.iea.org/reports/global-ev-outlook-2020. [Accessed 28 August 2020]

[3] McKinsey & Company, "McKinsey Electric Vehicle Index: Europe cushions a global plunge in EV sales," 2020. Online available [Accessed 28 August 2020]: https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/mckinsey-electric-vehicle-index-europe-cushions-a-global-plunge-in-ev-sales#

[4] https://hondanews.eu/eu/en/corporate/media/pressreleases/332197/summary-of-honda-global-ceo-inaugural-press-conference

[5] Wolf Dieter Hoppe, Klaus Schmitz, (Arthur D. Little) (20th-21th Feb 2018). Preparing for a radically changing automotive ecosystem. Werkstoffplusauto 2018, Stuttgart, Germany

[6] QUIET D6.4

[7] https://www.obrist.at/engineering/compressor-expander-technology/

[8] https://www.ventrex.com/en/solutions/filling-evacuation-and-special-valves

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.

7. 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-G**	Honda R&D Europe (Deutschland) GmbH	Germany
3	**AVL**	AVL List GmbH	Austria
4	**QPD**	AVL Thermal and HVAC 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