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**EUROPEAN COMMISSION**

HORIZON 2020 PROGRAMME - TOPIC H2020-GV-05-2017
Electric vehicle user-centric design for optimised energy efficiency

GRANT AGREEMENT No. 769902

Design OptiMisation for efficient electric vehicles based on a USer-centric approach

# DOMUS – Deliverable Report

## D5.3 - Active Comfort System Description

# 1 Purpose of the document

## 1.1 Document structure

As a remark, the overall aim of WP5 is to define and develop the set of components, sensors and regulation strategies focused at achieving enhanced comfort perception using as little energy as possible by pursuing a user-centered approach, without reducing other aspects of performance such as climate comfort, visibility, HMI, ergonomics, noise and vibration and without compromising safety.
With this aim, the objectives direct towards the following:

- Develop and build advanced active systems, sensors and components aimed at providing a high level of user-centered comfort.
- Develop and implement control logic strategies for both automatic regulation and manual assistance, using optimal energy levels in order to meet the users personalized needs adequately, capable of predicting the evolution of the conditions in the acclimated cabin.
- Develop pre-conditioning strategies and components to allow the vehicle to provide optimal cabin conditions before being un-plugged from the charging grid, and to accumulate thermal energy to be released on-demand during the journey.
- Design the proper Electrical and Electronic architecture to allow for the most effective and energy saving operation of all the new actuations installed in the demonstration vehicle

## 1.2 Deviation from original Description in the Grant Agreement Annex1-Part A

### 1.2.1 Description of work related to Deliverable in GA Annex1 – Part A

The description of various Tasks in the WP5, as described in Grant Agreement Annex1 Part A, are reported to link each of these to the activities about the design and implementation of the overall system configuration for communication, integration, control and power supply, the Deliverable describes.

Task 5.1 Active comfort system (DNTS, IEE, CRF, FAU, IDIADA) M7-M18
The objective of this task is the development of an active system capable of following the indications from both the holistic comfort model and the assessment framework from WP1, in order to achieve the comfort perception expectations while reducing the energy required to a significant extent. The activities of this task divide in three separate interacting subtasks as follows:

SubTask 5.1.1. Sensors set definition
User comfort perception takes into account a wide range of parameters that need to constantly undergo real-time assessment in order to provide adequate directives to each active component in the comfort system in an optimal way from an efficiency perspective. In order to re-adjust the comfort system's performance parameters optimally, in response to real-time changing conditions of the cabin and the occupants, an optimal set of sensors with specifications (data sheets), integrated into control system and validated. The sensors specifications (accuracy, location in the cabin, sensitivity, scale…) will follow outcomes and guidelines from WP1, hence considering also non-traditional parameters in the measurements performed.
Task Outputs: A list of sensors including specifications, supplier and sensor samples with electrical and electronic interface details to integrated in the physical demonstrator.

SubTask 5.1.2. HVAC system redesign
The HVAC system, which is the comfort system that consumes the greatest quantity of energy in a vehicle, will undergo thorough a re-design process in order to adapt it to new functionalities according to the requirements from the holistic comfort model and the assessment framework.
The sizing of the HVAC system follows the revised performance requests that result from operating it together with additional active components also intended to enhance thermal comfort.
The new architecture of the HVAC system resulting from such "design drivers" allows the implementation of the disruptive air diffusion methods and airflow control, matching the holistic comfort model's fundamental requirements.
Task Outputs:

A new HVAC module installed in the cockpit;
A new air diffusion lay-out (air ducts and outlets in the cockpit module) to enhance the capability of controlling air diffusion in the cabin to match the users requirements;
A new HMI at the cockpit module to operate each single actuation (function) implemented in the Active Comfort System;
A fully new electrical and electronic network and components of both for the proper control of all the actuations, with the, as high as possible, level of integration to the vehicle network for proper operation of the entire HVAC system (electric compressor, high voltage PTC heater, new electrical parts, original network data, etc).

Subtask 5.1.3 Additional active comfort components
In order to ensure full use of the indications on how to optimize the energy allotted to provide enhanced comfort perception following a user-centered approach and directly acting on user's conditions (rather than only cabin's), a set of active components will be designed, realized as prototype and validated by bench and vehicle tests that optimally complement the HVAC system's functions.
For that purpose, radiant/contact heating panels, enabling the occupants to feel comfortable at lower air temperatures (Physiological Equivalent Temperature), along with active seats capable of complementing the heating panels with seat heating (seat ventilation function when air conditioning mode is used) are foreseen to be installed in the vehicle cabin.
Task Outputs: descriptions and test-validated samples of interior components including panel heater and active seats in order to enable the DOMUS prototype vehicle to be equipped subsequently.

Task 5.2 User-centered control strategies (IDIADA; COV, CRF, DNTS, FAU, TME, VIF, VOL) M7-M28
The purpose of this task is the design and the implementation of a model-based unified control management software in order to manage the entire Active Comfort System (ACS) and the additional active functions (heated glazed surface, additional high voltage heater for coolant, etc) in accordance with the data measured by the sensors and the user's requests.
To achieve such objective, there will be the need to investigate on the individual contribution of each component on the comfort perceived by the occupants, evaluating cabin and user conditions individually and comparing them with the desired set points.
Moreover, accordingly to the guidelines from the holistic comfort model (WP1)-, the control strategy provides real-time actuation rules in order to achieve the optimal compromise between comfort perception and energy efficiency. It corresponds to the real tangible advantage of adopting the holistic approach from the very early design phases of the whole system. The control logic design focuses on two distinct actuation modes, individually constituting a separate subtask:

SubTask 5.2.1. Auto regulation strategy
When set in "automatic mode" (through the Active Comfort System HMI at the dashboard), the logic will provide, with little user input, all of the performance parameters to each actuator interacting in the cabin, strongly relying on the comfort models developed in order to use the least possible amount of energy while providing the highest level of comfort. It will also consider preconditioning strategies to reduce energy consumption by bringing the car to a good level of comfort before the starting the journey.

SubTask 5.2.2. User-regulation assistance
The Active Comfort System will follow the user's requests, manual input by users through the interactive HMI in the dashboard, designed and realized as a new, vehicle-integrated user interface replacing the climate control panel available in the series car.
A second HMI, also available in the demonstration car, is going to instruct the user on range-increasing driving strategies and triggering new types of eco-friendly behaviors.
The system will suggest how to maximize the driving range, depending on the energy availability and the distance until the end of the journey, while providing eco-routing options through the HMI and a Driving Efficiency Booster (DEB).