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# Parked Electric Vehicle's Cabin Temperature Management Using Photovoltaic Powered Ventilation

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**Abstract**

**This paper presents how the electric vehicle roof integrated photovoltaic (PV) powered ventilation can be used for controlling the climate of the car. In this work, a fully-functional Renault Zoe electric car has been used to conduct experiments for PV powered ventilation. These experiments have been part of a wider research project of testing electric vehicles of the Edinburgh Napier University's Transport Research Institute. The present work illustrates performance evaluation of electric car ventilation, when roof-mounted PV modules were used to operate DC powered fans for ventilation. It was found that the motor-fan selection for removing the warm air from cabin space is of important (i.e. motor-fan operating points have to be near to the maximum power points of PV modules under varying solar radiation). In this article, experimental results are presented and analysed.**

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*Keywords:* Photovoltaic (PV) ventilation, Electric cars, PV electro-mechanical system.

## 1. Introduction

The electric vehicle penetration is increasing rapidly. To reduce the power demand on the electric vehicle battery, energy efficiency should be considered. The electric car energy efficiency can be enhanced by decreasing the load of the auxiliaries of the car (e.g. ventilation, which contributes a large share percentage of energy use). The load reduction of the car auxiliaries can be helpful for electric cars as well as, fossil fuel based cars. The car auxiliaries are responsible for the consumption of larger percentage share of the overall car energy use. Car roof integrated PV modules can be used to power directly the ventilation system using DC motor-fan(s) [1-3]. It can help in reducing cabin / interior temperature of the car. Ford Motor Company has introduced C-MAX Solar Energi Concept, for sun-powered plug-in hybrid electric vehicle and Fresnel lens based PV modules can help in charging of hybrid vehicle [4]. It [4] has not considered PV modules only for car ventilation / auxiliary load. A Renault Zoe electric car has

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been used to conduct experiments for PV powered ventilation [1]. This paper examines a simple technique for ventilation in vehicles using PV powered motor-fan, when the car is parked in an open space directly open to the sun. When a vehicle is parked in the open space under clear sunshine, the car cabin temperature rises steeply and can reach up to $60^0$C. It was observed during the experiment at the Napier Edinburgh University. PV arrays are directly used for powering water pumping and propeller systems through DC motor-centrifugal pump / load [5-11]. There is a possibility for use of car roof mounted PV array for powering directly coupled PV powered DC moto-fan systems for car ventilation [1]. This work is examining role of directly PV powered DC motor-fan system for reducing the car cabin temperature and increasing the energy efficiency of the electric car.


Fig 1: Car used for the carrying out the experiment

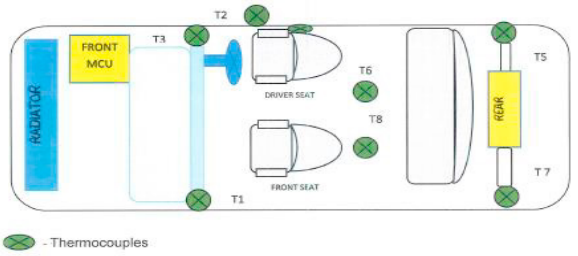


Fig 2. The thermocouples positions in the car

## 2. Experimental Setup

For the PV powered ventilation system experiments, the Renault Zoe electric car was used, and it was parked at Edinburgh Napier University's Merchistion campus (UK).

Thermocouples were placed inside the car to quantity temperatures inside the cabin. A schematic diagram of the thermocouples placed in this car is shown in Fig.2 [1]. Thermocouple locations are given in Table 1

Table 1: Thermocouple locations in the car [1]

| Thermocouples | Placement | Position |
|---|---|---|
| T1 | Front Side | From left edge –23 cm<br>Above the vehicle floor - 80 cm |
| T3 | Front Side | From the right edge - 24 cm<br>Above the vehicle floor - 80 cm |
| T6 | Vehicle Roof | From the right edge - 16 cm<br>Above the vehicle floor -102 cm |
| T8 | Vehicle Floor | From the left edge - 34 cm<br>Above the vehicle floor - 120 cm |
| T5 | Backside | From the right edge - 16 cm<br>Above the vehicle floor -102 cm |
| T7 | Backside | From the left edge - 33 cm<br>Above the vehicle floor -102 cm |
| T2 | Outside | Above the vehicle floor - 98 cm |

The PV module and other instrumentation details are provided in Table 2:

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