NOWASTE

Engine Waste Heat Recovery and Re-Use

**Funding:** European (7th RTD Framework Programme)  
**Duration:** Oct 2011 - Sep 2015  
**Status:** Complete with results  
**Total project cost:** €4,563,912  
**EU contribution:** €2,719,561

**Call for proposal:** FP7-SST-2011-RTD-1  
**CORDIS RCN:** 100789

**Background & policy context:**

The reduction of CO2 emissions from road vehicles is a strategic goal of the EU, and heavy duty vehicles are required to contribute to this objective in a significant way.

One very promising solution is the re-use of the waste heat, which represents approximately 60% of the combustion energy, by transforming it into mechanical or electrical energy thus increasing the overall vehicle energy efficiency directly. Depending on the operational conditions, fuel consumption and hence CO2 emissions can be reduced by between 10% and 15%. Such benefits can be higher in the case of a hybrid or hybrid-like power train where it is possible to store and then use the generated energy subsequently when most convenient.

Heat re-use can be performed by means of a thermodynamic cycle (e.g. organic or non-organic Rankine cycles) using the waste heat as a source of energy, as is already being developed for application in large stationary applications. The adoption of such technology in the automotive domain requires specific R and D activities to develop the components and identify the most appropriate system architectures and level of integration in order to achieve sustainable costs and the required level of reliability.

**Objectives:**

The NOWASTE project aims to develop such an engine waste heat recovery and re-use system for automotive applications and demonstrate its feasibility within both a purpose-built test rig and a vehicle demonstrator.

The future emission regulations and the increasing prices of fossil fuels are the main drivers for the research and development towards fuel efficient powertrains in all domains of transportation.

The internal combustion engine (ICE) will be the principal powertrain concept for the upcoming decades, especially when it comes to road transportation. Even if the efficiency of the ICEs has increased within the last years, around 30 - 50% of the fuel indicated energy is still lost via waste heat and could be partly recovered through thermodynamic cycles as the Rankine, Brayton or Stirling cycles. However, preliminary studies have shown that for a heavy duty diesel application the Rankine cycle offers the highest potential.

The transformation of medium temperature heat into mechanical energy and then into electricity can be performed by means of a thermodynamic cycle typically with an efficiency rate ranging from 10 up to 20% depending on the temperature level, on the thermodynamic cycle selected, and on the specific technology adopted.

In the heavy-truck domain, this technology enables the overall vehicle efficiency to be increased by up to 20% in theory.

However, to achieve this goal, a new generation of components and systems should be developed for automotive applications which are fully compliant in terms of dimensions, energy, weight, cost, and
environmental constraints. Then, smart solutions should be identified to integrate the heat re-use system with the engine, the exhaust line and other vehicle subsystems in order to minimise the impact on vehicle performance and cooling drag.

Finally, the waste heat recuperation and re-use is complementary to power-train hybridisation being more effective for medium and high average cruising speeds. Therefore, the purpose of the NOWASTE project is to improve the vehicle fuel economy increasing the overall vehicle energy efficiency from 12 to 15 % thanks to an innovative system capable of recovering and re-using the waste heat by transforming it, by means of a thermodynamic cycle, into mechanical energy. Considering as reference a vehicle with an high level of electrification the mechanical energy will be then transformed into electrical energy, hence contributing positively to the overall energy balance (i.e. el

Methodology:

The key points of the NOWASTE project are:

- definition of a reference mission;
- selection of the most appropriate architecture following an in-depth technology screening;
- innovative heat rejection system minimizing the cooling drag and the impact on the front end;
- development of specific heat exchangers to maximize the heat recuperation efficiency;
- integration with the exhaust system;
- validation of the developed system initially on a test rig and then on vehicle demonstrator based on a hybrid power train;
- evaluation of the system applicability on various power-trains for heavy duty trucks via simulation.

Target Performance:

- fuel economy: >12% fuel consumption reduction at vehicle level on a reference mission;
- cost (for the OEM):
- weight: < 150 kg.

Parent Programmes:

**FP7-TRANSPORT** - Transport (Including Aeronautics) - Horizontal activities for implementation of the transport programme (TPT)

**Institute type:** Public institution

**Institute name:** The European Commission

**Funding type:** Public (EU)

Lead Organisation:

**Centro Ricerche Fiat - Societa Consortile Per Azioni**

**Address:**
Strada Torino, 50
10043 ORBASSANO (TO)
Italy

**Organisation Website:**
http://www.crf.it

**EU Contribution:** €847,162

Partner Organisations:

**Universite De Liege**

**Address:**
PLACE DU 20 AOUT 7
4000 LIEGE
Belgium

**Organisation Website:**
http://www.ulg.ac.be

**EU Contribution:** €234,780
Volvo Bus Corporation

Address:
Fästningsvägen 1
40508 Gothenburg
Sweden

Organisation Website:

EU Contribution: €752,630

Dell'orto Spa

Address:
Via Raffaello Sanzio 2
20038 Seregno
Italy

EU Contribution: €202,434

Faurecia Sièges D'automobile

Address:
2 RUE HENNAPE
92000 NANTERRE
France

Organisation Website:
http://www.faurecia.com

EU Contribution: €198,636

Avl List Gmbh

Address:
Hans-List-Platz
8020 Graz
Austria

Organisation Website:
http://wwwavl.com

EU Contribution: €483,919

Technologies:
Energy efficiency
Waste heat recovery system

Development phase: Validation

Key Results:

Project results:

The first project year at the beginning was dedicated to investigate into advanced cycle topologies by numerical simulations in terms of cycle architecture, cooling and heat recovery but also control strategy development with respect to the vehicle and engine environment in combination with the Rankine cycle. The second part of the year was devoted to the development, realisation and validation of the waste heat recovery components. So, after 12 months the objective was to define system architecture and to identify components suppliers for both the engine test rig at Volvo and the on board vehicle testing at CRF.

The main results achieved are the following:
(a) performance investigation of the main Rankine working fluids (both inorganic and organic);
(b) realisation of a Rankine system model (steady state and time dependent) and its integration with
the vehicle thermo management system (VMTS);
(c) definition of engine test rig and the on board vehicle applications and relative border conditions
(working fluid, heat collection and rejection architectures, type of energy recovered, Rankine
components design);
(d) energy management analysis related to some new electrified auxiliaries to be installed on board of
the prototype vehicle;
(e) identification of Rankine components suppliers and main components cost evaluation;
(f) creation of the project website

**Innovation aspects**

The NOWASTE project focuses on the development of a system based on a thermodynamic cycle
(Rankine) and the related components to convert the waste heat into electricity. The key points of the
waste heat recuperation, that also represent the principal challenges of NOWASTE, are:

(a) the development of a thermodynamic cycle and component to re-use the vehicle waste that is
compliant with the automotive constraints;
(b) minimisation of the impact on the vehicle architecture and performance;
(c) cost sustainability;
(d) technology feasibility;
(e) compliance with the current and forthcoming regulations regarding the greenhouse gas emissions
and environmental impact.

---

**Documents:**

- [Objectives (Final report)](#)

**STRIA Roadmaps:** Vehicle design and manufacturing, Low-emission alternative energy for transport

**Transport mode:** Road transport

**Transport sectors:** Freight transport

**Transport policies:** Environmental/Emissions aspects, Decarbonisation

**Geo-spatial type:** Other