



**SEVENTH FRAMEWORK
PROGRAMME
FP7-SME-2011-1**



Project Title: A Platform Power Management System and Low Voltage Drive Train for Hybrid and Electric Vehicles

Project Number: Safedrive [243470]

Final Report Additional Information

Project Start Date: 1/08/10

Duration: 41 Months

Project Coordinator: Angel Aghili

Project Coordinator organisation: AVERE

Project co-funded by the European Commission within the Seventh Framework Programme		
Dissemination level		
PU	Public	
PP	Restricted to other programme participants (including Commission Services)	
RE	Restricted to a group specific by the consortium (including Commission Services)	
CO	Confidential, only for members of the consortium (including Commission Services)	X

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1.0 THE CONSORTIUM

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2.0 SAFEDRIVE DISSEMINATION MATERIAL

Project Logo



Video

Follow link

<http://www.youtube.com/watch?v=PWsa3a8TQYI>

Project Website

<http://www.safedrive-fp7.eu>

The project website provides information to the general public and potential customers (see website screen shots below).

Safe DRIVE
ADVANCED HYBRID POWERTRAINS

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A Platform Power Management System and Low Voltage drive Train for Hybrid and Electric Vehicles

The project proposes the research and development of a platform, low voltage power management system and motor drive. The low voltage technology will enable SVEs to reduce their battery mass, volume and cost, through the use of large capacity cells with greater energy densities.

In addition the elimination of lethal voltages will significantly improve the safety of a vehicle during an accident. The power management technology will include customisable performance and efficiency functions with an open standard architecture developed specifically to support SVEs. In addition we will develop a scalable high torque drive motor. This will have a high efficiency and will be suitable for high volume manufacture.

- Open platform power management system
- Modular drive motor topology
- Customisable performance and efficiency
- Low voltage drive train
- Low cost technology topology
- European hybrid and electric vehicle industry
- Cost benefits for European SVE manufacturers

Latest News

The final SAFE DRIVE dissemination will be presented at EVS 27 Barcelona from the 17th to 20th of November 2013. The final prototype of the motor will be showcased in the project...

[Read More](#)

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Project Funded by the European Union Seventh Framework Programme
(FP7-2464-2008-2) under grant agreement 242470


Safedrive Website page

The following pages are accessible to the public:

- [Home page](#)
- [Consortium](#)
- [New & Events](#)
- [Contact us](#)


Safedrive Banner

The banners was distributed the consortium partners for use at trade fairs. The banner is fully transportable and it has the following dimensions: 0.8 x 1.8M



Safe DRIVE
ADVANCED HYBRID POWERTRAINS


A Platform Power Management System and Low Voltage Drive Train for Hybrid and Electric Vehicles



The project will develop a low voltage control, power management, and motor drive platform for SME vehicle manufacturers. The low voltage technology will enable SMEs to reduce their battery mass, volume and cost through the use of larger capacity cells with greater net energy densities. The elimination of lethal voltages will significantly improve the safety of electric drivetrains. The power management technology will include customisable performance and efficiency functions with an open standard architecture developed specifically to support SMEs. Drive will be from a scalable high torque, high efficiency drive motor to a new topology suitable for high volume manufacture.

- Open platform power management system
- Modular drive motor topology
- Customisable performance and efficiency
- Low voltage drive train
- Low cost technology topology
- European Hybrid and electric vehicle industry
- Cost benefits for European SME manufacturers

www.safedrive-fp7.eu



Project Funded by the European Union Seventh Framework Programme (FP7-SM4-2008-2) under grant agreement n° 244281/2

Safedrive project banner



Banner Photograph

Project poster



An FP7 funded project to develop a Low Voltage Full Series Hybrid or Pure Electric Drivetrain for use by members of AVERE (The European Association for Battery, Hybrid and Fuel Cell Vehicles)



SAFEDRIVE is a project funded under the European Union Framework Programme 7 (FP7) with the aim of providing the members of the European Association for Battery, Hybrid and Fuel Cell Vehicles, AVERE, with a Full Series Hybrid Vehicle Drivetrain, which may also be used in a Pure EV. This drivetrain is modular and scalable, and can be adapted to suit a wide range of vehicles, from small cars to heavy goods and utility vehicles. The project will also deliver to members a 'design toolbox' that allows computer configuration and simulation of a particular vehicle and drivetrain implementation, and a standard vehicle controller electronics package that is configured by the toolbox. Details of the project and consortium can be found at <http://www.safedrive-fp7.eu/>.

The SAFEDRIVE consortium brings together technology providers, vehicle builders, the academic sector and AVERE, The European Association for Battery, Hybrid and Fuel Cell Vehicles) as both the pan-European association, and two national associations (AVERE France and E'Mobile Switzerland). AVERE is the beneficiary of this project, on behalf of its members. Other partners of the project consortium can be found on the project website <http://www.safedrive-fp7.eu/>

The SAFEDRIVE project is now a little over half way through its 36 month duration, and we are entering the testing and evaluation phase. So far progress has been very good, parameters that were uncertain at the start are now known, and there has been excellent correspondence between theory and measurement so far. We hope that that trend will continue.

Whilst this is a large project for AVERE and some of the smaller partners, in reality, it is only a small, but hopefully a significant, contribution to the field. We hope to be able to demonstrate both the viability of low voltage drivetrains at power levels of several tens of kiloWatts, and the functionality of a Full Series Hybrid Drivetrain (which of course can be used directly in pure electric vehicles if so desired) in a vehicle which is fully comparable to its IC engined sisters, and at a cost base that AVERE member companies can use commercially in the near future.

The consortium will be working actively to find further partners for the full commercialization phase, and we hope that this technology will become an important part of the automotive scene within a very short period.

Acknowledgements

To all members of the SAFEDRIVE consortium.

Core technologies being developed

- Split-Pi DC-DC converters
- Mutually Coupled (MC) motors
- Dynamic Vehicle Controller
- Vehicle configuration toolbox

Benefit of the technology

- Low cost direct drive motor with switching electronics
- Reduction in battery size is significant giving cost and weight savings
- Lower voltages than other hybrid drive systems in current use,
- European SME manufacturers of Electric and Hybrid vehicles.

Markets:

- Specialist vehicles
- City utility vehicles
- Sports cars
- Large commercial vehicles
- Results and Discussion



Project Funded by the European Union Seventh Framework Programme (FP7-SME-2008-2) under grant agreement n° 243470

www.safedrive-fp7.eu

In partnership with:



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Red

Project Flyer outer pages

The updated Safedrive flyer was distributed at the Geneva motor show 2013 and previously at IAMF and EVS26. The design will be reused at the EVS27 event in Barcelona – 17th to 22nd Novembers 2013

Project Consortium Partners

AVERE

AVERE
FRANCE



Safe DRIVE

ADVANCED HYBRID POWERTRAINS

SAFEDRIVE: an FP7 funded project to develop a Low Voltage Full Series Hybrid or Pure Electric Drivetrain for use by members of AVERE (The European Association for Battery, Hybrid and Fuel Cell Vehicles)



SAFEDRIVE is a project funded under the European Union Framework Programme 7 (FP7) with the aim of providing the members of the European Association for Battery, Hybrid and Fuel Cell Vehicles, AVERE, with a Full Series Hybrid Vehicle Drivetrain, which may also be used in a Pure EV. This drivetrain is modular and scalable, and can be adapted to suit a wide range of vehicles, from small cars to heavy goods and utility vehicles. The project will also deliver to members a 'design toolbox' that allows computer configuration and simulation of a particular vehicle and drivetrain implementation, and a standard vehicle controller electronics package that is configured by the toolbox. Details of the project and consortium can be found at <http://www.safedrive-fp7.eu/>

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Project Flyer (inside pages)



Safe DRIVE
ADVANCED HYBRID POWERTRAINS

The SAFEDRIVE consortium brings together technology providers, vehicle builders, the academic sector and AVERE, The European Association for Battery, Hybrid and Fuel Cell Vehicles) as both the pan-European association, and two national associations (AVERE France and E'Mobile Switzerland). AVERE is the beneficiary of this project, on behalf of its members. Other partners of the project consortium can be found on the project website <http://www.safedrive-fp7.eu/>

Core technologies being developed

- Split-Pi DC-DC converters
- Mutually Coupled (MC) motors
- Dynamic Vehicle Controller
- Vehicle configuration toolbox

Benefit of the technology

- Low cost direct drive motor with switching electronics
- Reduction in battery size is significant giving cost and weight savings
- Lower voltages than other hybrid drive systems in current use,
- The project results will benefit European SME manufacturers of Electric and Hybrid vehicles.

Markets:

- Specialist vehicles
- City utility vehicles
- Sports cars
- Large commercial vehicles

Results and Discussion

The SAFEDRIVE project is now entering the final phase of its 36 month duration, and approaching the testing and evaluation phase. So far progress has been very good, parameters that were uncertain at the start are now known. There has been excellent correspondence between theory and measurement so far. Power conversion efficiency exceeds 98%, we await with interest results for the motor efficiency.

Whilst this is a large project for AVERE and critical for some of the smaller partners, We hope it will make a very significant contribution to the field. Our aim is to demonstrate both the viability of low voltage drivetrains at power levels of several tens of kiloWatts, and the functionality of a Full Series Hybrid Drivetrain (which of course can be used directly in pure electric vehicles if so desired) in a vehicle which is fully comparable to its IC engined sisters. The plan is to develop the technology at a cost base that AVERE member companies can use commercially and competitively in the near future.

The motor design (for which European patents have now been granted) is focused on the use of low cost raw materials, (Aluminium and ferrites) and is a radical alternative to the use of expensive and supply-restricted rare earth magnets.

The consortium will be working actively to find further partners (and investors) for the full commercialization phase, and we hope that this technology will become an important part of the automotive scene within a very short period and a benchmark of what small teams can achieve.

Acknowledgements

To all members of the SAFEDRIVE consortium.

3.0 THE GENEVA MOTOR SHOW 2013



Robert Kybird (exploitation manager) at the press briefing



The Safedrive motor on display

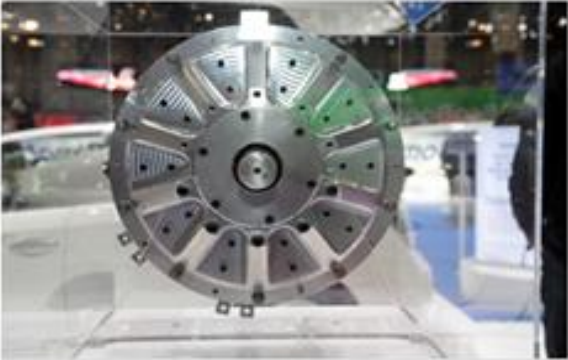
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ELEKTRO-MOTOR "SAFEDRIVE" - E'MOBILE



3 kW/600 RPM electric motor "Safedrive"

1/3



The EC funded project SAFEDRIVE develops a particularly energy efficient, low voltage drivetrain working at power levels of only several tens of kilowatts for Full Series Hybrid or Electric Vehicles. The motor design is focused on the use of low cost raw materials and uses no rare earth magnets.

[PHOTOS GALLERY](#)

THE meeting of the motor industry

From 7th - 17th March 2013, in Geneva

Safedrive Motor on the official Geneva motor show website

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http://www.e-mobile.ch/index.php?pid=de,1,171

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Verband e'mobile

Information u. Beratung

Der Verband e'mobile engagiert sich für die Markteinführung von effizienten Strassenfahrzeugen und Treibstoffen aus erneuerbaren Quellen.

Seine Fachstelle befasst sich mit allen Fragen rund um Elektro- und Plug-in-Hybridfahrzeuge.

Dienstleistungen

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- > Ihr Banner auf e'mobile

Pressefotos

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Safedrive bei e'mobile am Autosalon Genf

High (RGB, 900 Dpi, 700 KB)
Low (RGB, 72 Dpi, 100 KB)

Safedrive bei e'mobile am Autosalon Genf

High (RGB, 300 Dpi, 700 KB)
Low (RGB, 72 Dpi, 70 KB)

Safedrive bei e'mobile am Autosalon Genf

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Low (RGB, 72 Dpi, 90 KB)

Lampo 3 von Protoscar bei e'mobile am Autosalon Genf

High (RGB, 300 Dpi, 3,2 MB)
Low (RGB, 72 Dpi, 130 KB)

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Publikationen

Tankstellen

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Safedrive disseminated on the Emobile website

Information and Publications – provided at the Geneva motor show



Introduction to Mutually Coupled Motors

MUTUALLY COUPLED ("MC") motors are a new patented form of traction motor, meeting two main design aims;

ULTRA HIGH TORQUE	Sufficient to directly drive road wheels, without any reduction gearing, with fully competitive performance
NO PERMANENT MAGNETS	No NEODYMIUM or other rare earth materials: all materials are cheap and readily available.

MC motors have an axial flux, multiple disc format, with some physical similarities to Permanent Magnet axial flux machines, some control aspects similar to Field Wound DC motors, and some theoretical aspects similar to switched reluctance motors.

Aluminium is used both as the structural material and the conductors: there are no 'coils' or 'windings'. Magnetic material mass is minimised, held within the aluminium/composite structure.

Both rotors and stators are electrically powered, and the motor incorporates electronic commutation. Externally there are two DC power connections, similar to a DC motor (with extra control connections for regeneration and reverse motion).

The torque is proportional to the square of current (I^2) and the terminal voltage is the product of current and rotational speed ($U \cdot \omega$). This gives a very 'soft' voltage characteristic that makes it easy for the drive electronics, producing very high torque at low speed, but enabling high speed cruising at relatively low voltages.



The display motor is the second prototype developed under the 'SAFEDRIVE' FP7 funded project. It contains 1/6th of a full motor 'stack', and for test purposes the frame is of larger diameter. The rotors and stators are full 'pre-production' scale.


The drive electronics are based on 'Split-Pi' DC-DC converters, which are high frequency MOSFET based, and already delivering 98% power efficiency. For the SAFEDRIVE project these are configured as a 64 kW (86PS) controller, taking inputs from main batteries, ultra-capacitors and IC motor/generator or fuel cell.

The SAFEDRIVE test vehicle is a front wheel drive small van, one motor per front wheel, shaft drive.

The system works at low voltage: the main batteries can be 12-15 cell Lithium series packs, thus the highest voltage in the vehicle when parked is below 60V and can borrow from the safety record of familiar 48 VDC vehicles. Split-Pi handles all battery charging and power distribution, delivering a variable DC voltage to the MC motors.

Green Energy Technologies Ltd (UK) is the exploitation manager for the project and point of contact for all interest: +44 (0)845 6432194 robert.kybird@gmail.com



Introduction to Mutually Coupled Motors

Target specification of MC1200 motor

The display motor shown contains 1/6th of the active material of the full motor being developed under the FP7 SAFEDRIVE project. The full motor is derived by 'stacking' five more sets of active material in an axial direction. The final housing will be smaller in diameter. The specification below is for the FULL MOTOR. It is of course subject to normal developmental change, but so far all parameters set theoretically are being fully met.

TORQUE	1200	Nm	Continuous rating liquid cooled version 10 second rating air cooled version Essentially flat torque to maximum speed if electrical power is available, controller dependant in practical use
VOLTAGE	120	VDC	At 145 kph
CURRENT	320	A	At 1200 Nm, low speed configuration
ROTATIONAL SPEED	1500	RPM	Design figure for maximum road speed, not technology limit
MASS ACTIVE MATERIALS	38	kg	Mass of conductors and magnetic material
TARGET MASS TOTAL MOTOR	< 65	kg	Including casing, shafts, bearings, commutation and rotary power transfer electronics
DIAMETER	385	mm	
AXIAL LENGTH	<200	mm	Excluding shaft and mounting
ROTOR POWER COUPLING			Inductive coupler

4.0 SAFEDRIVE DISSEMINATION

AVERE

The European Association for Battery, Hybrid and Fuel Cell Electric Vehicles – founded in 1978 in order to promote the widespread use of electric vehicles in Europe and Africa - is a non-profit making organisation and European network of predominantly national associations whose members include Users, NGOs, Associations, Interest groups, Public Bodies, Research & Development Entities, Vehicle & Equipment Manufacturers and Electricity Utilities.

Today, its main objective is to champion the use of Battery, Hybrid and Fuel Cell Electric Vehicles as the principal means of powering personal, fleet and freight transportation.

In this manner, AVERE is leading the way to a green and sustainable mobility.

To achieve this objective, AVERE has several activities such as:

- Dissemination,
- Participation in European and multilateral projects,
- Lobbying,
- Research and development,
- Monitoring,
- Networking,
- Facilitating studies by means of working groups,
- Collaborating with other international bodies with common interests,
- Organising conferences.

AVERE's mission also includes:

- Supporting collaboration between its members in Scientific and Technological Innovation
- and
- Representing the interests of the Electric Drive Industry and Research & Development institutions to the European Commission with respect to the development of clean vehicles.

AVERE has already participated in several European projects funded by the FP7, two of which are currently in progress:

1. MERGE evaluates the future impact of the interoperability of electric vehicles and electric distribution network
2. SAFEDRIVE is the conception of a new type of electric drive train for electric vehicles.

AVERE operates not only at a European level but also at regional, national & international levels:

With AVERE – covering Europe and Africa, EVAAP - Asia Pacific, and EDTA – Americas; the 3 organisations form the World Electric Vehicle Association (WEVA).

Periodically, AVERE, EVAAP and EDTA hold International Electric Vehicle Symposia.

In 2012, it will be the 26th EVS which will take place in Los Angeles, CA on May 6-9. The EVS27 will take place in Barcelona in 2013.

AVERE regularly participates in many national and regional events, conferences and workshops.

AVERE represents not only Electric 4-wheelers but has also a special involvement in Electric two-wheelers; particularly with its role as an Operating Agent of the Annex XI of the Electric and Hybrid Vehicle Implementing Agreement of the International Energy Agency (IEA).

In 2011, a new bureau has been elected for the next three years to take AVERE forward into a new era of Transport. ●

Composition of the bureau:



Philippe AUSSOURD,
President (France)

Pietro MENGHA, Vice President (Italy)
Angel AGHILI, Vice President (Spain)
Joeri VAN MIERLO, Vice President (Belgium)

Laurence DRUET, Treasurer (Spain)



Karine SBIRRAZZUOLI,
Secretary General (Brussels)

AVERE

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www.europeanenergyinnovation.eu

Safedrive article in European Energy Innovation magazine (August 2011)

Ev 130 Science and Technology Committee: Evidence

researcher on motors and electronic drive components within the SAFEDRIVE FP7 project which is developing hybrid vehicle technology. He has other recent technical and commercial interests in wind turbines and LED lighting.

REFERENCE MATERIAL (obtainable from the SMEIA website)

1. The Economic Failure of the Patent System, by John Mitchell.
2. Joint submission of SMEIA and the East of England SMART Club to the Willetts R.I. review, by Martin Lawrence and Tim Crocker.

February 2012

**Written evidence submitted by The Aerospace, Aviation & Defence Knowledge Transfer Network
(AAD KTN)**

BACKGROUND TO AAD KTN

AAD KTN is a single overarching network for the Aerospace, Aviation and Defence sectors spanning Government, Industry and Academia with the principal aim of promoting and enabling innovation in the UK.⁵⁹ The AAD KTN is funded by the Technology Strategy Board (TSB) and has around 3000 members. Aerospace, Aviation and Defence as combined sectors employ close to 500,000 people through some 9,000 organisations in the UK. Aerospace continues to be a UK success story being first in Europe and second only to the USA in terms of turnover;⁶⁰ Aviation contributes some £8.8 billion to the UK economy;⁶¹ Defence industries' success lie in their ability to export leading edge technology valued on average at £5 billion per year.⁶² The growth of global air traffic over the past 50 years has been substantial and forecasts indicate that it will continue at some 5% per annum.

The majority of the KTN activity takes place through 13 National Technical Committees (NTCs) and by having the custodianship of the National Aerospace Technology Strategy (NATS).⁶³ The NTCs are forums facilitated by the AAD KTN which are focused around key technology themes with experts from industry, academia and government with a remit to advise on future R&T priorities that should be invested in. The National Aerospace Technology Strategy represents the UK national aerospace technology plan developed and delivered by a multi-stakeholder forum comprising of industry and university representatives, alongside government departments and agencies.

Since 1 March 2011, the KTN's remit extended into aviation related activities and now has six priority themes:

- National Aerospace Technology Strategy.
- Autonomous Systems.
- Aviation and the Natural Environment.
- Maintenance Repair and Overhaul (MRO).
- Passengers and Security.
- Introduction of Biofuels to the airport infrastructure.

The KTN is also host to two pan-KTN programmes working across Space and Defence communities. In Space the KTN is the custodian of the National Space Technology Strategy (NSTS) and in Defence the KTN is catalysing Science and Technology connectivity between the MoD and non-defence communities. These programmes attract a further membership of around 3,000.

The AAD KTN's response the questions posed by the Science and Technology Committee is as follows:

1. What are the difficulties of funding the commercialisation of research, and how can they be overcome?

1.1 From the various interactions with our membership the KTN believe the funding landscape within the UK has become complicated to navigate with a vast portfolio of initiatives. Ranging from the SME focused assistance through to the recently re-badged SMART scheme now delivered by the TSB to the Regional Growth Fund, aimed at generating employment, operated by the Department for Business, Innovation and Skills. The KTN can spend much time assisting organisations, large and small, in understanding this landscape explaining how all the support mechanisms fit together. There is a need for the landscape to be presented to the SME, the entrepreneur in such a way that it is able to articulate its need and identify the mechanism to assist them more easily.

⁵⁹ www.aeroktn.co.uk

⁶⁰ UK Aerospace Industry Survey 2010.

⁶¹ *What is the contribution of Aviation to the UK Economy*, Oxera Report, 2009.

⁶² UK Aerospace Industry Survey 2010.

⁶³ <https://connect.innovateuk.org/web/national-aerospace-technology-strategy-nats/overview>

Safedrive mentioned in the UK House of Commons