

# ReFreeDrive



## Rare Earth Free e-Drives featuring low cost manufacturing

[www.refreedrive.eu](http://www.refreedrive.eu)

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# Project Overview

## General Figures

**Title:** Rare earth free e-Drives  
featuring low cost manufacturing

**Acronym:** ReFreeDrive

**Grant Agreement No:** 770143

**Topic:** GV-04-2017

**Project Total Costs:** 5,999,131.25€

**Total EU Contribution:** 5,999,131.25€

**Project Coordinator:**



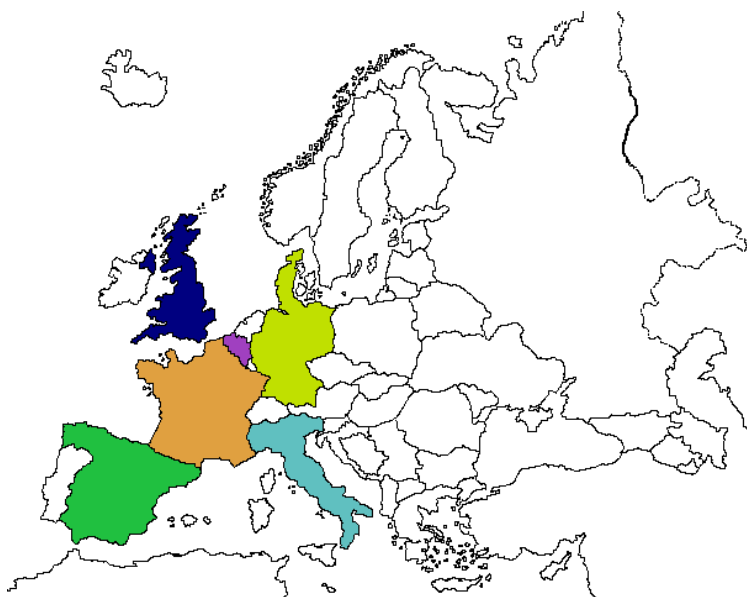
**EGVI**  
European Green  
Vehicles Initiative



# Project Overview

## Project Partners and Locations

ReFreeDrive Consortium is composed of 13 partners in six European countries



3

UNITED KINGDOM



Motor  
Design  
Limited



European  
Copper Institute  
Copper Alliance

1

FRANCE



1

BELGIUM



6

ITALY



1

SPAIN



1

GERMANY



University of L'Aquila  
Research Group on Electrical Machines  
Power Converter and Electrical Drives



# Project Overview

## Project Objectives

- To develop **rare earth-free traction technologies** beyond their current state-of-art, with a strong focus on industrial feasibility for mass production, targeting lower costs with higher specific torque and power density.

The target motor solutions for traction are:

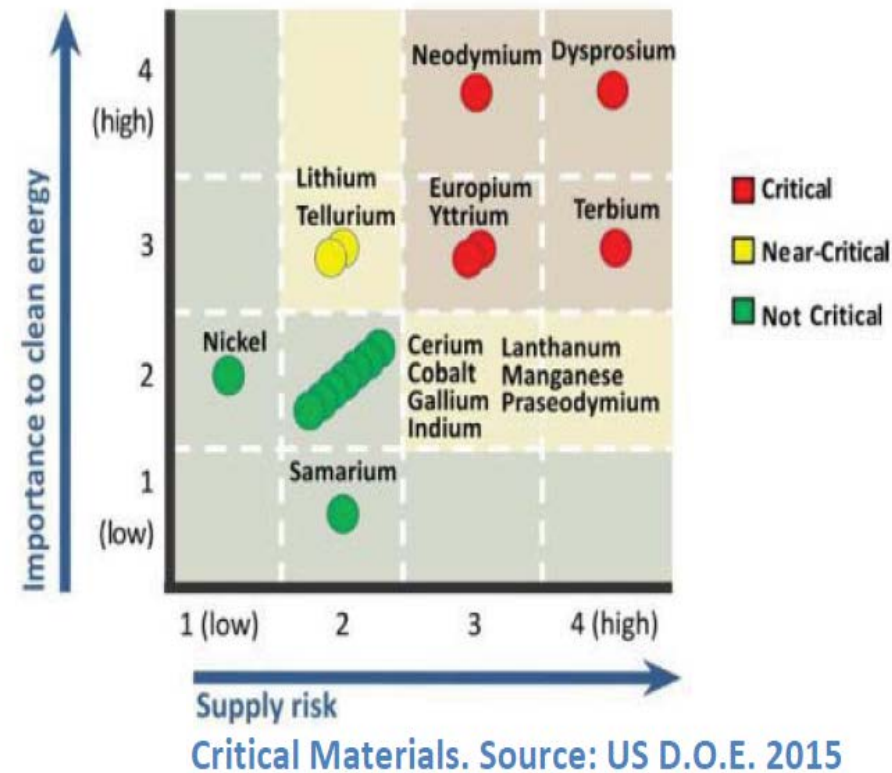
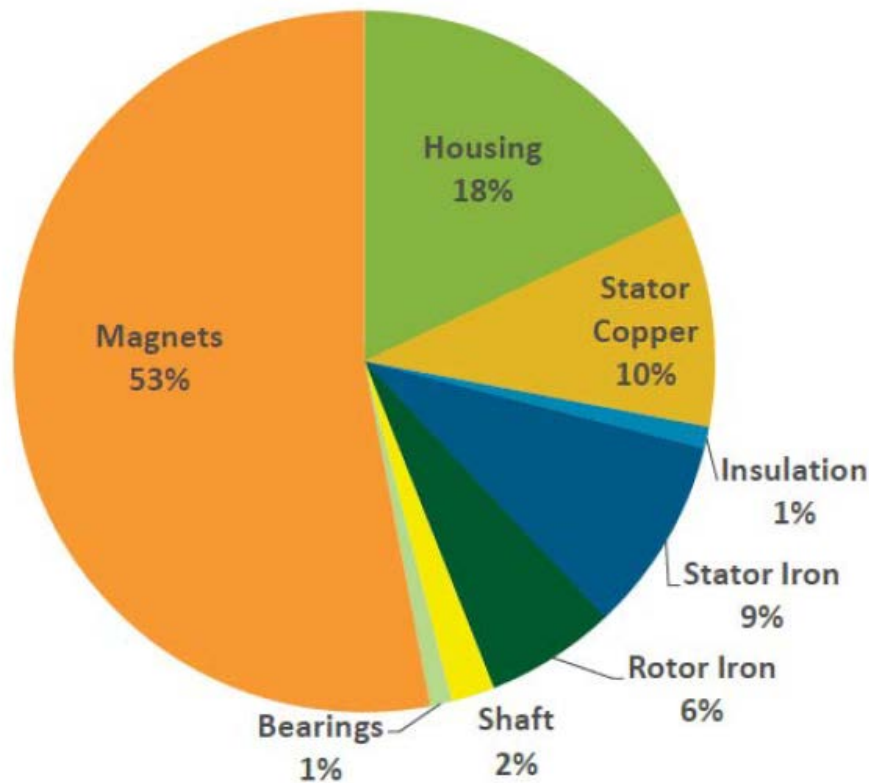
- **copper rotor induction machines**
- **synchronous reluctance machines**  
(pure or assisted by low-cost PM)



# Project Overview

Motivations 1) to avoid costs associated to RE Magnets

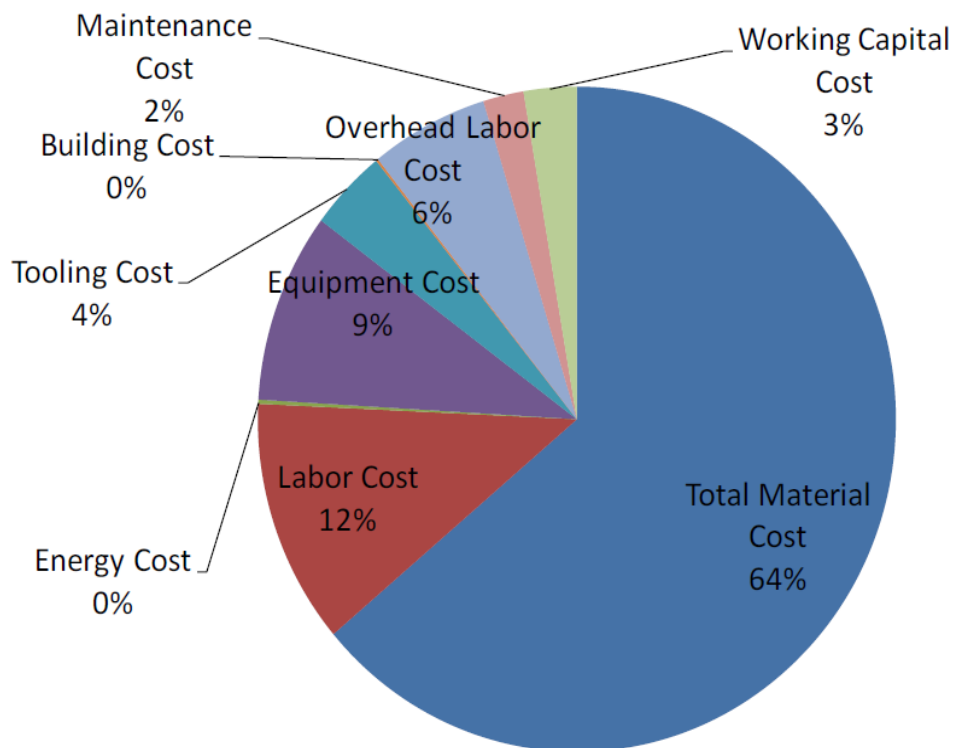
Cost Breakdown:  
IPM Electric motor for EV (2014)



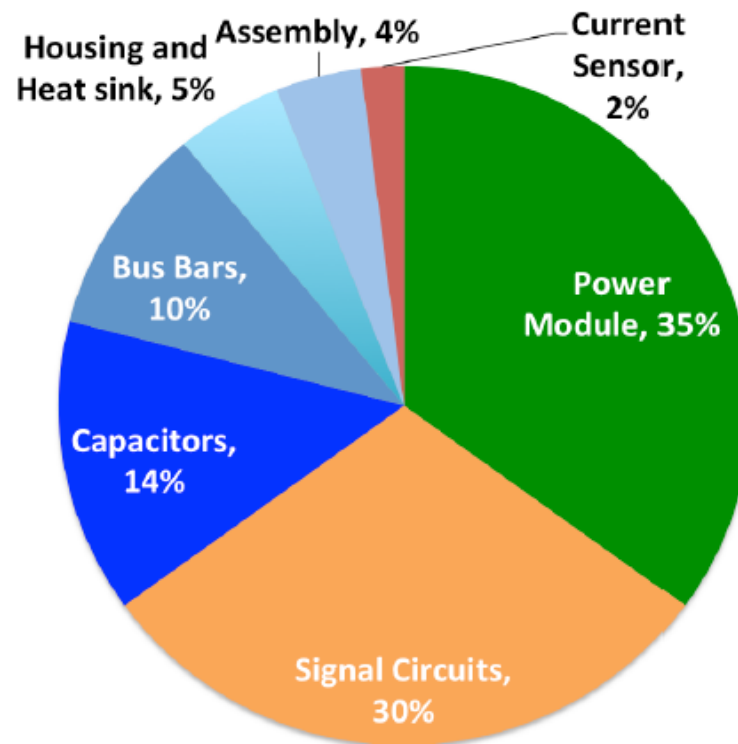
# Project Overview

Motivations 2) to reduce the costs associated with IM, Sync Rel and related Power Electronics

Cost Breakdown:  
IM Electric motor for EV (2014)



Cost Breakdown:  
Power Electronics for EV (2014)





# Project Overview

## Project Expected Outcomes & Exploitation

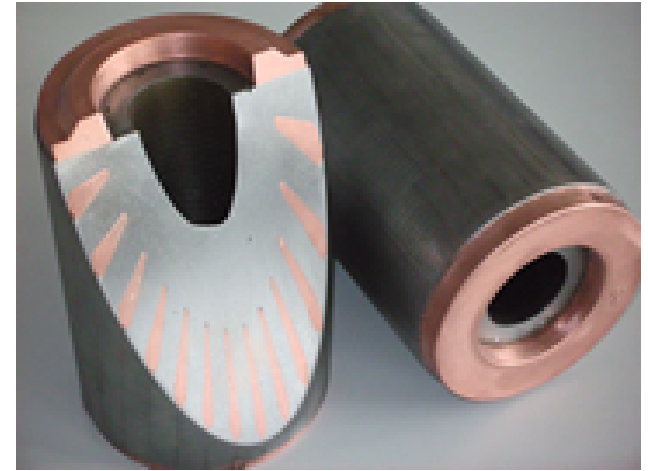
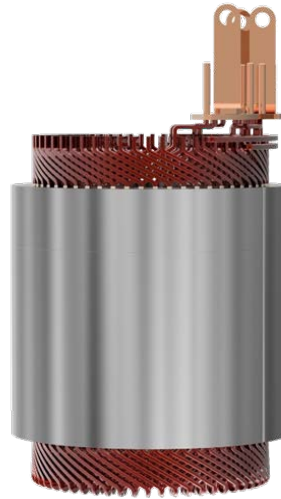
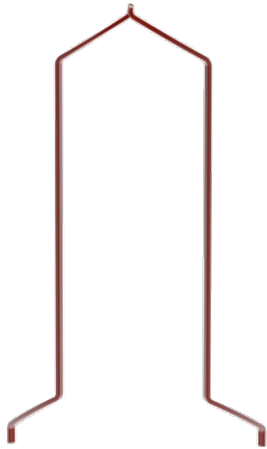
- This project will develop new e-Drives for electric vehicles focusing on the design and development of prototypes for the 75kW and 200kW cases, of two different technologies (IM, SR).

Some of the most relevant results are listed here:

- **Integrated Induction Machine** design with fabricated copper rotor and with die cast copper rotor
- **Integrated Synchronous Reluctance Machine** design, Permanent magnet assisted and pure synchronous reluctance
- **Cooling system design** for low cost high efficiency motors
- Design of suitable advanced **motor control algorithms** for ReFreeDrive motors
- **Design of advanced medium/high power density electric drives** integrated with the electric motor
- **Design oriented to scalability** to reduce costs for mass production

# Project Overview

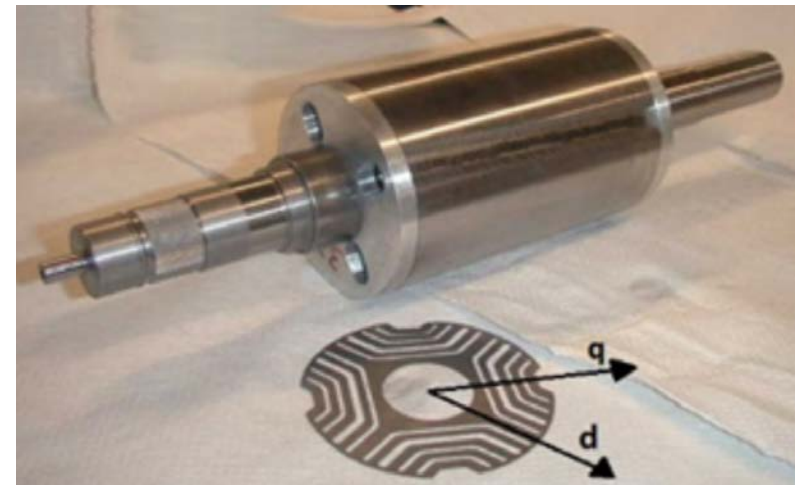
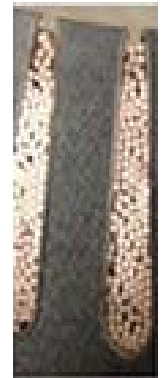
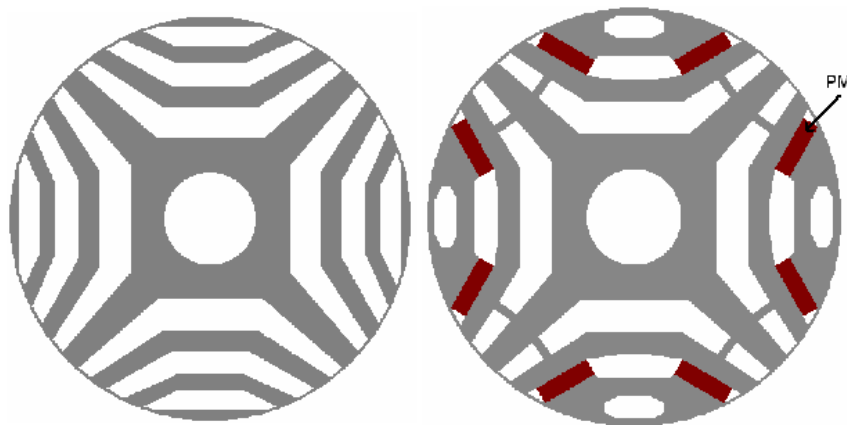
Main aspects under investigation: induction machines





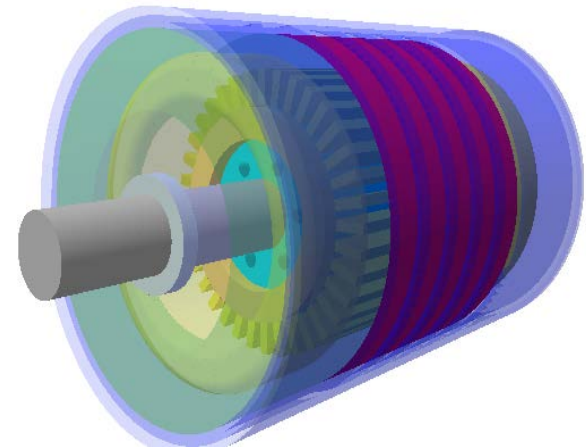
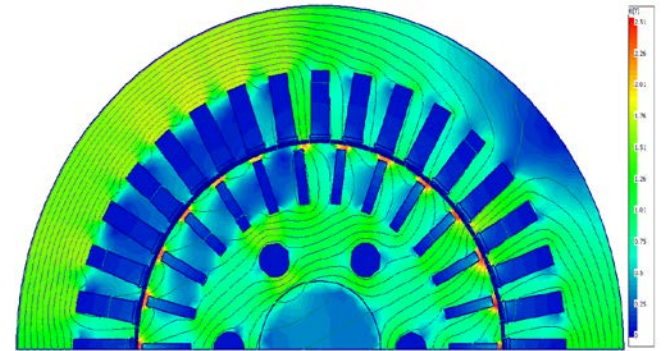
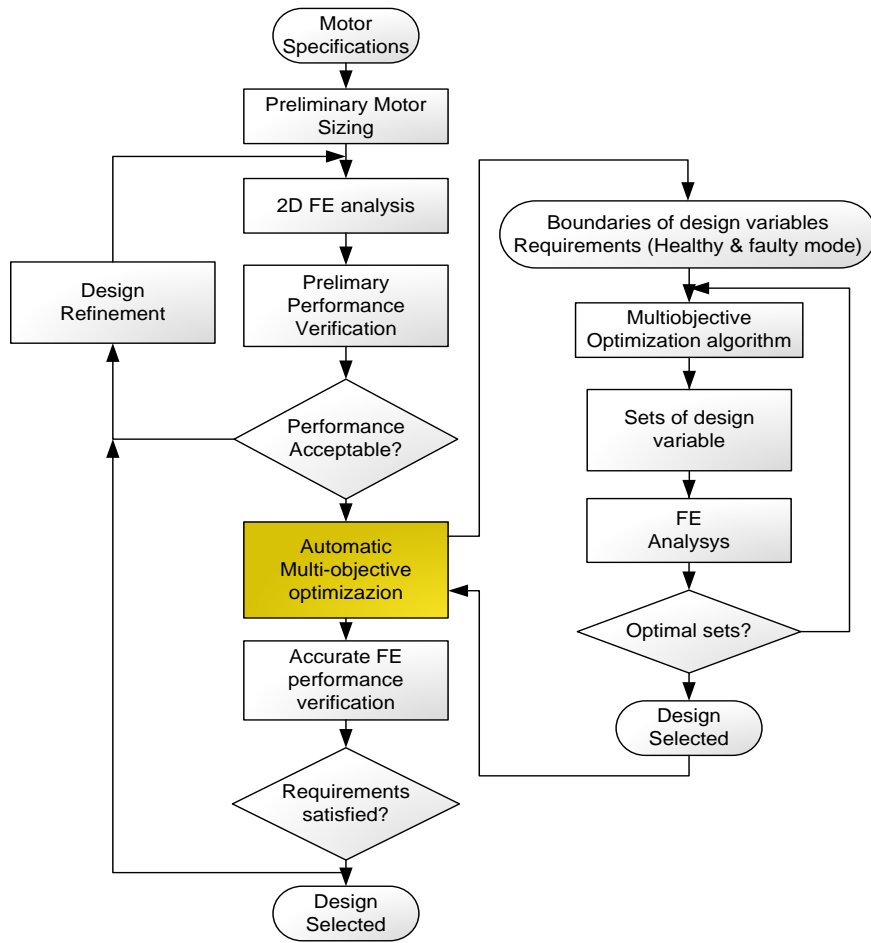
# Project Overview

Main aspects under investigation: Sync Rel Machines



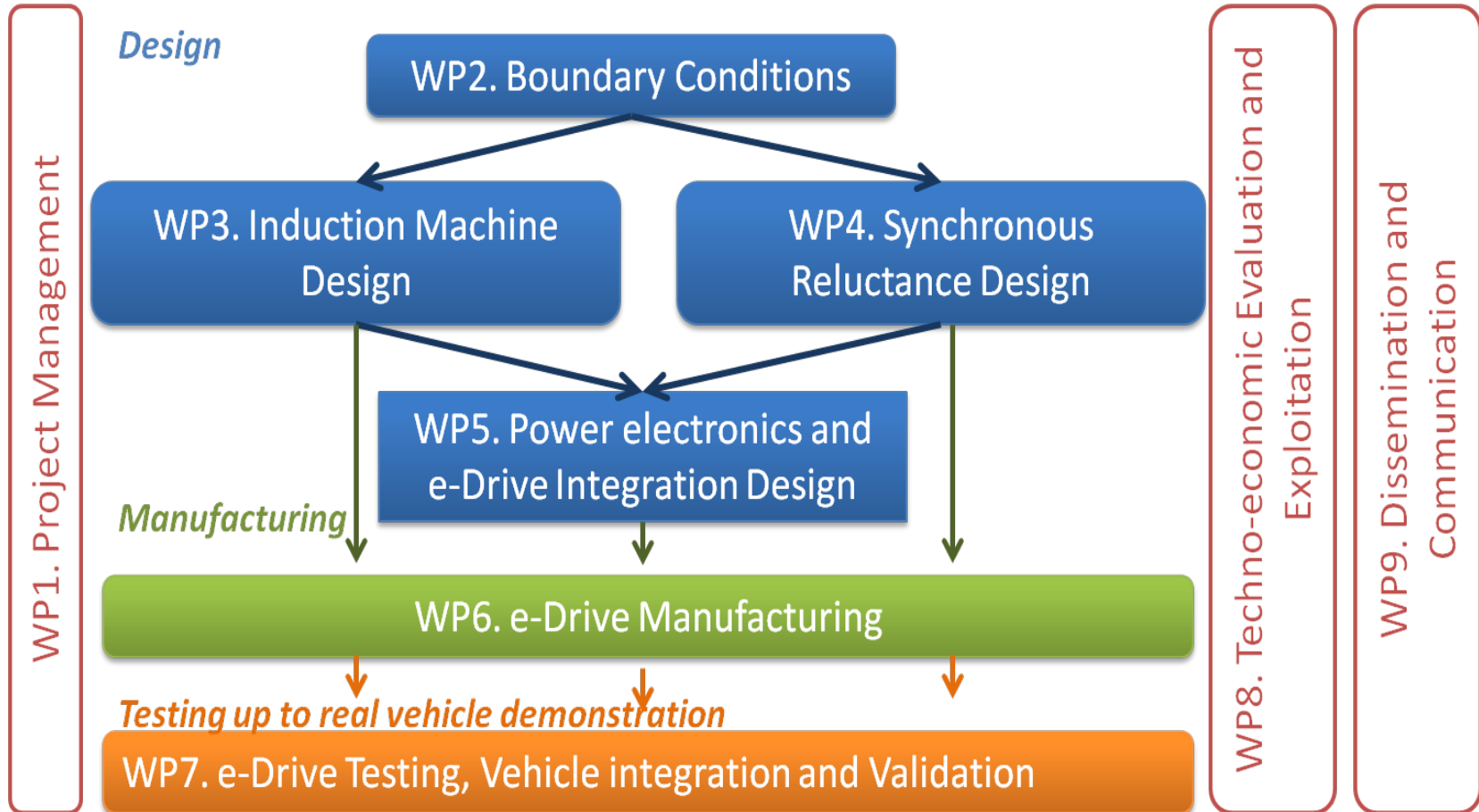
# Project Overview

## Design and optimization



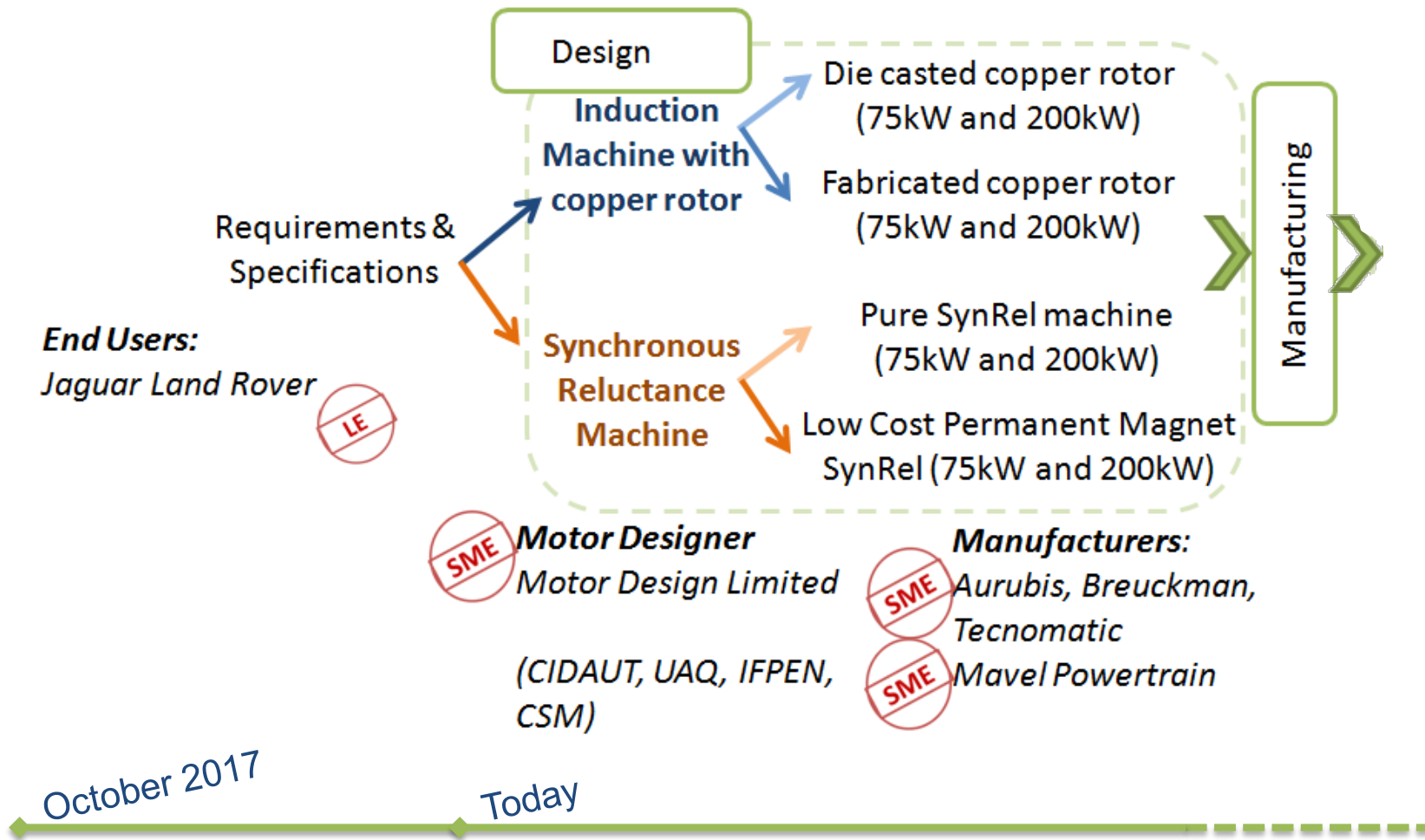
# Project Overview

## WP Structure



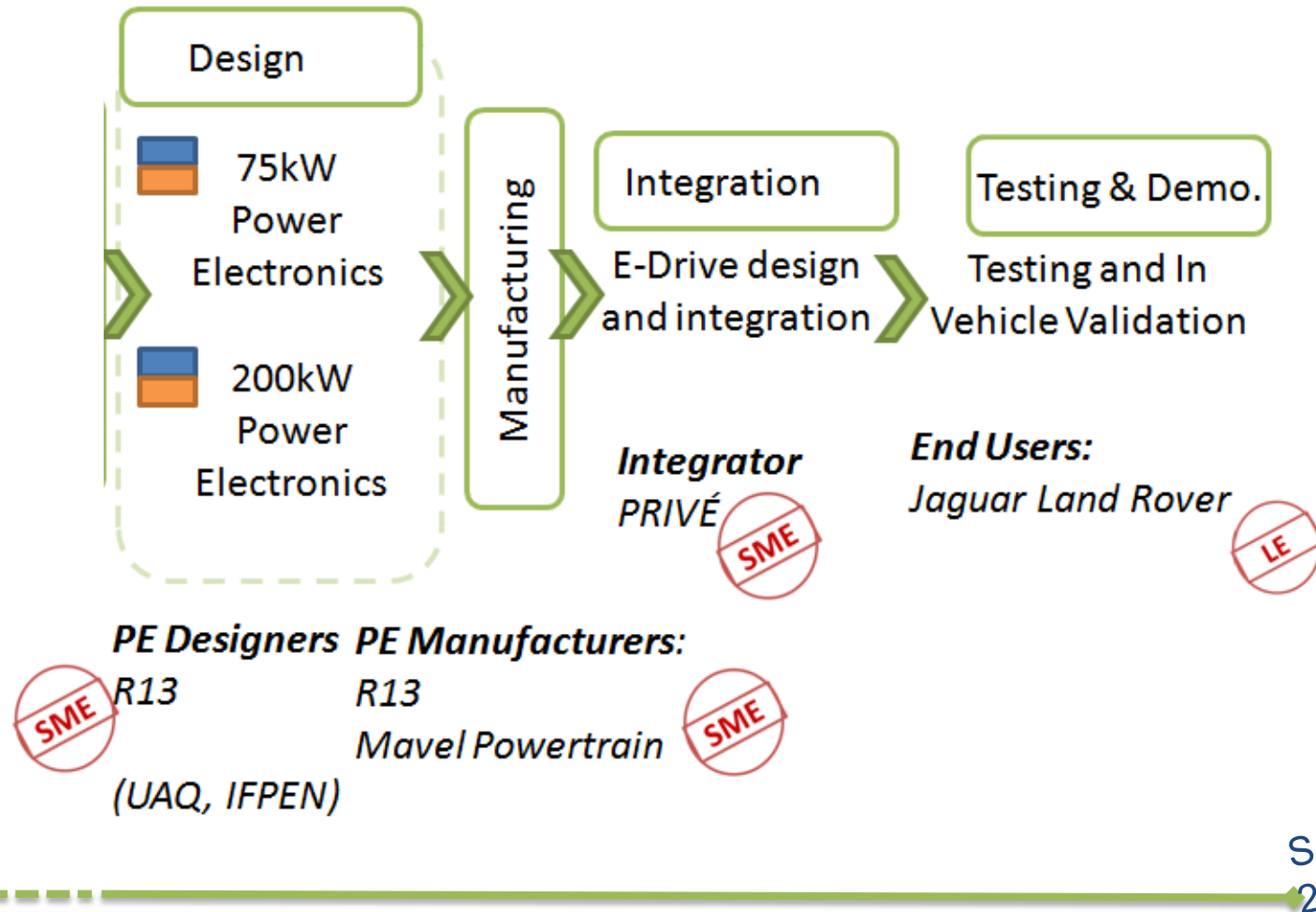
# Project Overview

## Project Outline 1



# Project Overview

## Project Outline 2





- The ReFreeDrive EU project is one of many worldwide actions to reduce or avoid the adoption of Rare Earth.
- Electric motor manufacturers are waiting for suitable alternative solutions from R&D.
- The project aims to provide the evidence that Rare Earth Free e-drives are not only possible but also effective for mass production.
- The project started six months AGO
- We are finalizing the definition of the requirements and we are starting the design stage.

# Project Overview

## Discussion and proposed joint actions

- Automotive industries and related Policy Makers are considering the adoption of RE free e-drives and promote actions in this direction
- What about other industries? High performance Brushless drives for industrial application have been always based on RE magnets, the same happens in other industries.
- EU initiatives seems to be oriented to Industry 4.0 with no attention to motors for industrial automations (apart Efficiency ratings)
- Initiatives promoting R&D in RE free technologies could arise to new opportunities for the motor industry



Thank you for the attention  
additional information on [www.refreedrive.eu](http://www.refreedrive.eu)

