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First Period Publishable Report

WP1: Project Management and Coordination

NIWE

New induction wireless manufacturing efficient process for energy intensive industries

Grant agreement: 296024

From January 2013 to December 2016

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Project Overview & Deliverable information

Project Information

Grant Agreement Number	296024	
Project Acronym	NIWE	
Project Full Title	New Induction Wireless Manufacturing Efficient Process for Energy Intensive Industries	
Project partners	**Roles**	**EU Country**
TECNALIA	Coordinator	Spain
CIRCE **TECNALIA**	R & D Centres	Spain
GIS **ABP**	Equipment manufacturers	Spain
SEEIF	Refractory developer	Spain
F2A **FURESA** **BILBOBUL**	Industrial partners (end users)	Italy Spain Bulgaria
SEMATEC	Environmental issues	Spain
AFV	Sector Association	Spain
Project Coordinator	Alberto Abuin (TECNALIA)	
Project Website	http://www.niweproject.eu	
Period reported	01/01/2013 – 31/12/2013 (First period)	

Dissemination Level

PU	Public	✓
PP	Restricted to other programme participants (incl. Commission Services)	
RE	Restricted to a group specified by the consortium (incl. Commission Services)	
CO	Confidential, only for the members of the consortium (incl. Commission Services)	

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1 General objectives and project context

NIWE project will demonstrate a new production process able to decrease the embodied energy of the foundry products by over 25%, reducing drastically its carbon footprint. The demonstration will be performed in the aluminium, iron and steel sectors.

The expected energy efficiency gains are due to a new furnace that, by means of a power transmission system based on induction, will allow a highly flexible production. This increase on the production flexibility attends to the current variability of the foundry products demand.

The current crisis has introduced a high variability in the demand, which can be measured in terms of quantity and diversity of the demanded products. The manufacturers are now forced to start and stop many times their production chains, change the moulds and, the most important in energy penalty terms, to reheat many times big quantities of raw materials. Consequently, the cost efficiency of the process has suffered a high reduction.

NIWE tackles these actual and current problems by providing a new furnace that will take the power by an inductive coupling. This will provide a very quick power transmission from the grid to the furnace. This power will be supplied to the heating system, which, depending on the foundry material could consist on resistances or induction heating.

The rapidity of the power transmission system, as well as the wireless operation, will allow the use of smaller furnaces. This way, the reserve of melted material for feeding the moulds will be smaller, and therefore the required energy to maintain it melted. In addition, the wireless furnace will provide a flexible operation, allowing a quick modification of the factory layout, which will be based on easy interchangeable furnaces of different types and sizes, depending on the demand.

2 Summary of project

The NIWE project deals with new production process able to decrease the embodied energy of foundry products by over 25%, reducing drastically its carbon footprint. The demonstration of the solution will be performed in energy intensive industries specifically: aluminium, cast iron and steel sectors.

NIWE is proposing an integrated approach to achieve an overall optimisation of the furnace operating conditions and process management along with highly innovative breakthrough in power transfer, heating technologies and insulation designs, significantly contributing to a reduction in the energy waste, the environmental footprint and products rejection while increasing the competitiveness of such designed systems.

The expected energy efficiency gains are due to a new furnace design that, by means of a power transmission system based on inductively coupled transfer (wireless system), will allow a highly flexible production on the involved sectors. This increase on the production flexibility attends to the current variability of the foundry products demand. This demand can be measured in terms of quantity and diversity of products. The manufacturers are now forced to start and stop many times their production chains, changing moulds and, the most important in energy penalty terms, to remelt several times high quantities of raw materials. Consequently, the cost efficiency of the process suffers an important decrease.

NIWE deals with these actual and current problems by providing a new furnace that will get the electrical power by an inductive coupling system. This will provide a very quick power transmission from the grid to the furnace; it will avoid the need of overheating the melt material in order to have enough temperature to follow the steps on the foundry process, so the temperature reduction will have a beneficial effect on the consumed energy to keep the material on liquid state. This power will be supplied to the heating system, which, depending on the foundry material could consist of resistances or induction heating.

The speed of the power transmission system, as well as the wireless operation, will allow the use of smaller furnaces. This way, the quantity of melted material needed for feeding the moulds will be smaller, and therefore the required energy to retain this material melted will also be reduced.

In addition, the wireless furnace will provide a flexible operation, allowing a quick change of the factory layout; this will be based on easy exchangeable furnaces of different types and sizes, depending on the production demand.

During this first period, the definitions of the work lines have been carried out. The end users taking part on the NIWE project have shown their interest on obtaining an energy reduction of their melting process: at this stage two main scenarios have arisen based mainly on the fact that the process will be more flexible, Table 1. One scenario for the aluminium and cast iron sectors deals with the wireless system to feed the power to the furnace; a second scenario for the steel sector deals with energy reduction got by better isolation and transmission efficiency of the electrical power to the heating power on the raw material.

Table 1: Selected scenarios for involved industries

SECTOR	MAIN INTEREST	APPLICATION
Aluminium die casting	Wireless technology	Moving furnace to pour liquid metal on maintenance furnace
Cast iron	Wireless technology	Pouring ladle
Steel	Energy efficiency	Energy saving on melting furnace

The furnace manufacturers have shown their interest and have proposed their best solutions to the needs brought up by the end users. These solutions have been discussed in different meetings to adapt the different systems in order to obtain the estimated solution for the problems. At this point, it was very interesting to evaluate together the different propositions of the different partners in order to know the implications of the different issues on other aspects: inductive power transfer on health and safety; inductive power transfer on induction heating; induction heating on refractory and both of them on energy losses…

The first tasks developed in the project were related to the definition of the initial needs and measurement of the melting process of each involved sector. The validation of the final demonstrators will be done at the end user facilities adapting the demonstrators to their process. So, a first step is to define the current consumptions and descriptions of needs to start the life cycle analysis to agree with the end users and manufacturers.

The health and safety issues are important to discuss at this first stage of the project in order to identify the potential problems. The legal rules to be fulfilled by the proposed solutions should be identified. These aspects will consider the equipment and staff safety.

The health and safety issues analysis have been focused on the electromagnetic field (EMF) issue in the induction furnace environment. Obviously we must consider other aspects and directives / regulations related to health and safety. A first identification of electrical and magnetic effects has been carried out:

- Biological effects
- Thermal and non-thermal effects
- Other hazard identification: other risks related to the furnace and functional risks from the equipment's near to the furnace

A search of applicable references has been performed to measure and compare the emissions generated by the power systems used to feed different furnaces. A number of national and international organizations have developed guidelines or recommendations setting limits on exposure to electromagnetic fields in the residential or commercial environment.

The limits on exposure to electromagnetic fields set by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) - a non-governmental organization officially recognized by the World Health Organization (WHO), have been developed on the basis of analysis of all articles published in scientific journals with peer review, including those devoted to thermal and non-thermal effects. The standards are based on an assessment of biological effects including the health effects. This standard deals mainly with the values for occupational exposure and public exposure; Table 2 shows general public exposure

Our case: B maximum
50 Hz : 20 mT
3 kHz: 27 μT

Table 4. Reference levels for general public exposure to time-varying electric and magnetic fields (unperturbed rms values).

Frequency range	E-field strength E ($kV\ m^{-1}$)	Magnetic field strength H ($A\ m^{-1}$)	Magnetic flux density B (T)
1 Hz–8 Hz	5	$3.2 \times 10^4/f^2$	$4 \times 10^{-2}/f^2$
8 Hz–25 Hz	5	$4 \times 10^3/f$	$5 \times 10^{-3}/f$
25 Hz–50 Hz	5	1.6×10^2	2×10^{-4}
50 Hz–400 Hz	$2.5 \times 10^2/f$	1.6×10^2	2×10^{-4}
400 Hz–3 kHz	$2.5 \times 10^2/f$	$6.4 \times 10^4/f$	$8 \times 10^{-2}/f$
3 kHz–10 MHz	8.3×10^{-2}	21	2.7×10^{-5}

Notes:
- f in Hz.

Table 2: Public exposure limits recommended by ICNIRP.

Several simulations have been carried out to define the intensity values of the electromagnetic fields according to the power supplied to the furnace system; these values have shown that a shielding will be required to reduce the intensity of these fields. Then some preliminary designs have already been shown to select the better shielding of the EMF produced by the Inductively Power Transfer (IPT) system, Figure 1.

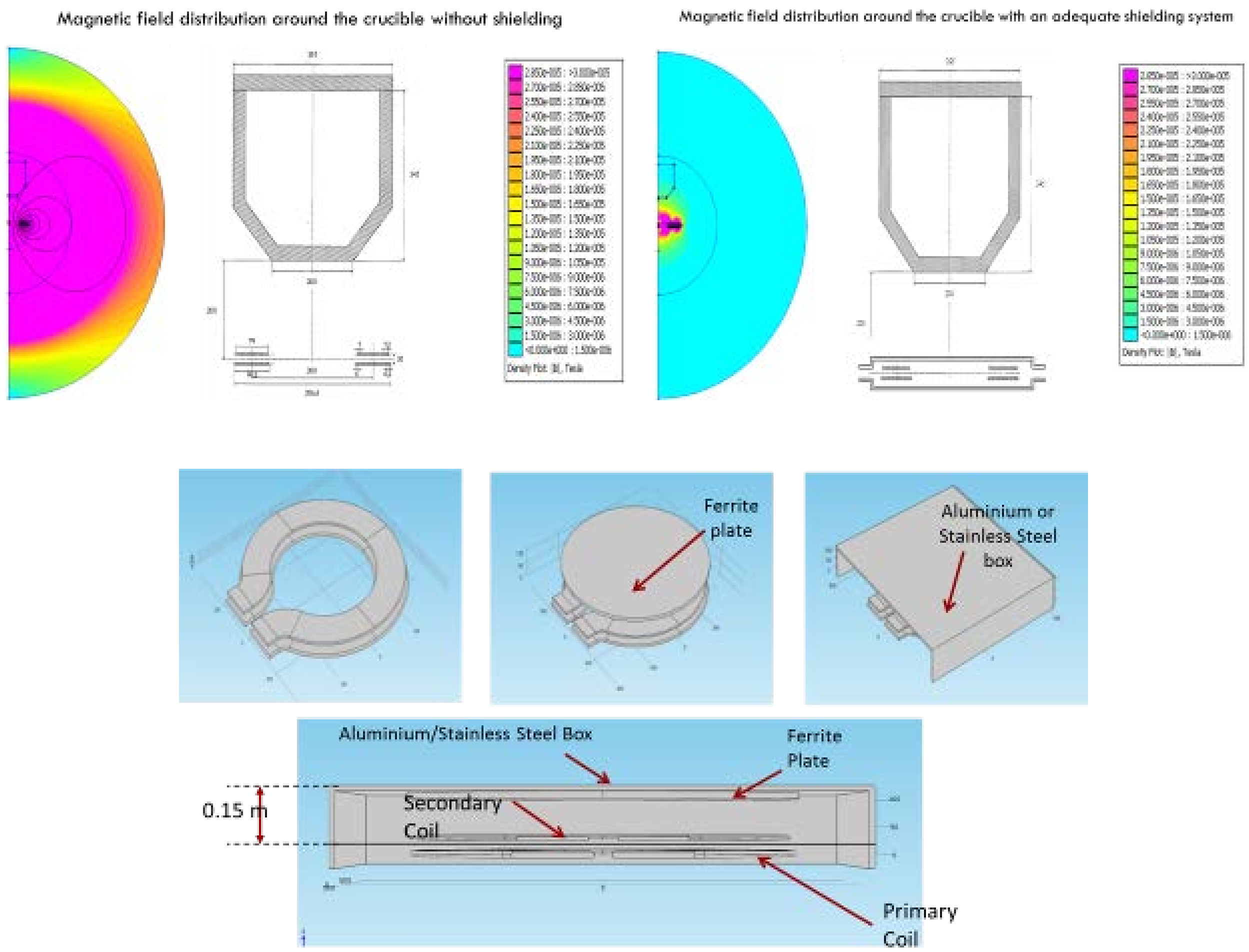

Figure 1: Simulation of EMF intensity in the surroundings of an IPT system and preliminary shielding designed

The different aspects on the frequency range of both circuits (electrical power supply to the heating circuit and power supply for the inductively power transfer system) and possible solutions to adapt the mismatch between frequencies. Medium frequencies are in use for heating purposes and higher frequencies for power transfer were also discussed. First designs in order to adapt the electrical circuits for both sections have been analysed; Figure 2

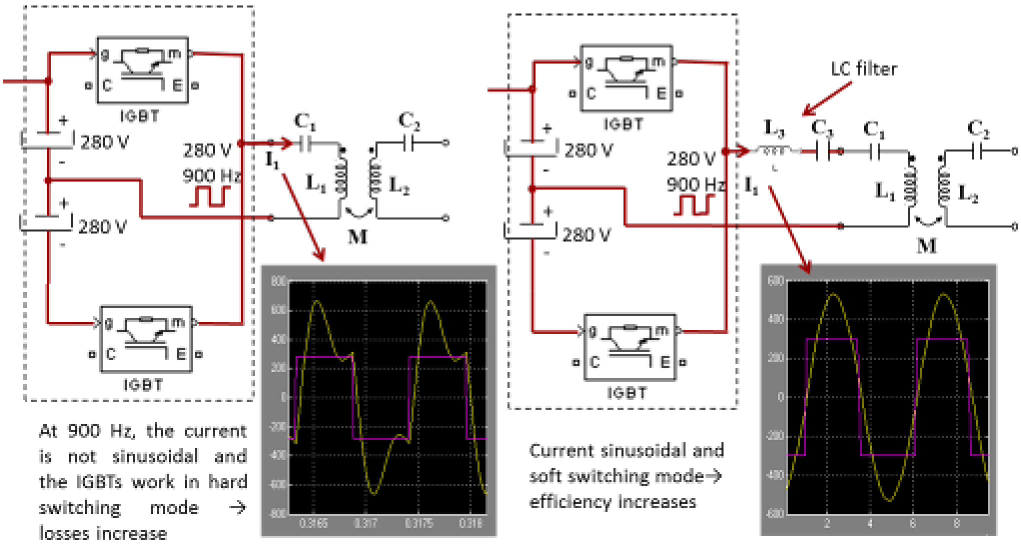

Figure 2: Electrical designs to adapt the wave form induced in the IPT system and wave used for the heating coils.

As a matter of fact, an important definition of the main losses on induction heating system were identified in Figure 3.

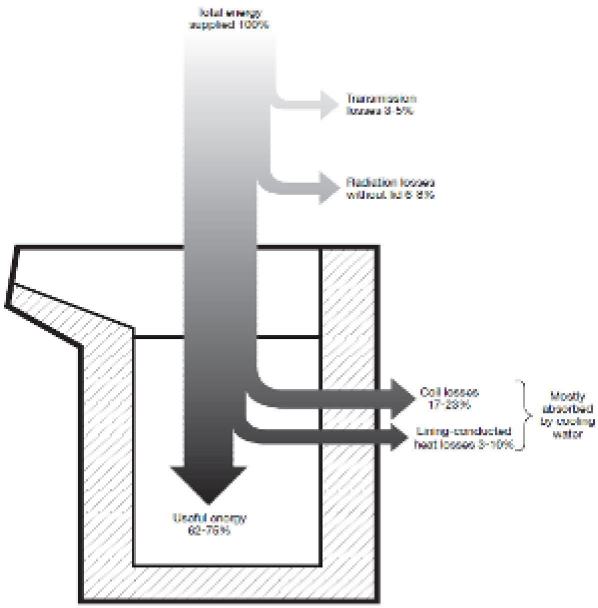

Figure 3: Main energy losses on an induction heating system

As shown on the graphic, the energy supplied for melting process on an induction furnace is around 62% to 75% of the energy supplied to the system. The main losses are:

- Transmission: 3-5%
- Radiation: 6-8%
- Coil: 17-23%
- Lining (refractory): 3-10%

These figures have been checked to know the starting point in order to define the actions to reduce the losses on the induction system.

A web page has been created to spread related documents, deliverables, and interesting news:

www.projectniwe.eu

The web page consists of a public domain area with related information about the project itself: objectives, expected results, funding; information about the partners; Figure 4. This area is accesible to anybody.

This area is also intended to show information about publications, dissemination material, information about the demonstrator, news and events, obviously material not to be kept as confidential.

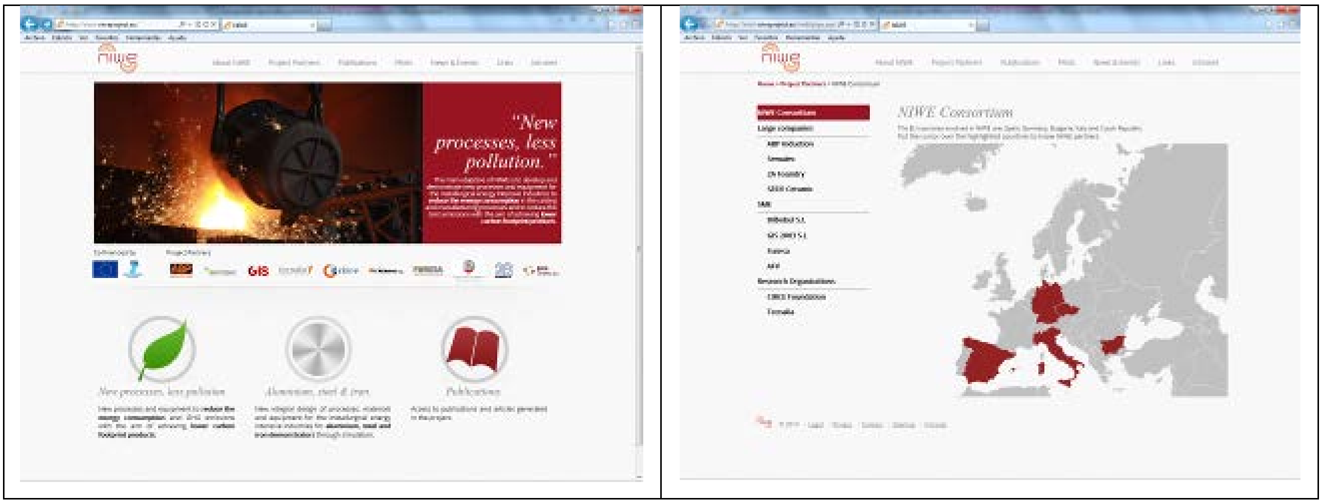

Figure 4: Welcome page of the NIWE website (left) and NIWE consortium information (right)

The web page has a private area which is only accessible for partners. This area is where the exchange of private information or confidential deliverables can take place; Figure 5.

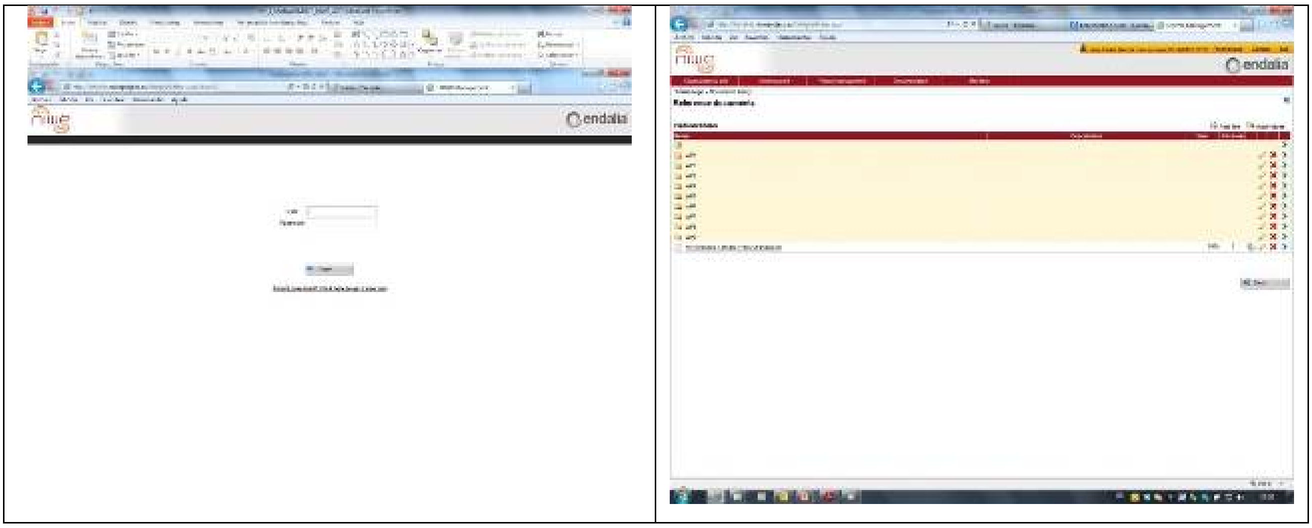

Figure 5: Access to the website private area (left) and WP structure to gather information (right)

Important issues on the management aspects of the NIWE project. We shall regret the departure of two partners. One of them EBCC left the project at the same beginning of the project life. He was assumed to be the end user of the aluminium sector. A second partner, VESUVIUS, left the project also during the first semester and was the refractory provider for the different furnaces.

These withdrawals have affected the goals of the project. Aluminium sector is an important energy intensive industry on metallic material process with a melting temperature of around 700 ºC, quite different with the other involved sectors iron-based (cast iron and steel) on which the melting temperature is around 1500 ºC. Also, it is important to keep a different sector such as iron based materials, they work mainly with induction systems to melt the raw material. With the contribution of aluminium sector we will be able to check the implemented solutions on other type of furnaces mainly based on resistance heating.

The departure of VESUVIUS also affected the project; a furnace is, in its simplest concept, a heating system thermally isolated from the surrounding. Without the contribution of a refractory manufacturer, all the effort will be devoted toward the heating systems, losing information about the influence of furnace lining and interaction with the proposed solutions.

Fortunately these leaving partners could be replaced with two other partners working on same fields.

Fonderie 2A from Italy; 2A is the first aluminium die-casting foundry in Torino region and owns the biggest existing die-casting press worldwide. 2A is a young and innovative die-casting foundry oriented and specialized in the development and production of components for the automotive and domestic industries, especially in the field of compressors.

2A is a complete die-casting partner: they can produce pieces from few grams up to 40 Kg, machine, paint, test and assemble them and usually develop and industrialize the products together with the customer on a partnership relation.

SEEIF Ceramic from Czech Republic; SEEIF, was established in year 2009 by the mergence of three traditional refractories manufacturers in Czech Republic. As a result of this merge, it became an important, rising manufacturer and producer of shaped and monolithic refractories, focused mainly to foundries and ironworks.

SEEIF also produces and sells fireclay based and thermo-insulating shaped products. These products are mainly used for foundries, stove-building, building industry and also for manufacturers of industrial furnaces. Fireclay products include three production branches: fireclay bricks for building industry, stove fireclays and casting fireclays. Fireclay products for foundries (casting fireclays) are preferently used in gating systems for metal casting. Fireclay bricks and lightened thermo-insulating bricks are designed to stand up to 1730 °C.

With the incorporation of these new partners, the project will continue with the same objectives and same planning as initially conceived.

Table 3 summarizes the involved companies with their corresponding contact people:

Table 3: Involved companies and contact people

End-users	2A (Aluminium)	Dennis Delanoy
	Furesa (Cast iron)	Beatriz González
	Bilbobul (Steel)	Malvina Vega
Furnace manufacturer	ABP	Christoph Aundrup
	G.I.S.	Igotz Arocena
Refractory manufacturer	SEEIF	Katerina Kadlikova
IPT manufacturer & dissemination	CIRCE	José Luis Vadillo
Health and safety expert	SEMATEC	Oihana Arizcuren
Foundry association	AFV	Oroitz Unzain
Project management & expertise in casting processes and research	TECNALIA	José Carlos García (Steel) Antton Meléndez (Cast iron) Iban Vicario (Aluminium) Alberto Abuin (Head of department)