

**UNIVERSITA' DEGLI STUDI DI PERUGIA**  
**DIPARTIMENTO DI INGEGNERIA**  
Allegati al Verbale n. 4 del 10/06/2020

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TITOLO ASSEGNO:

Allegato N. *A* al punto  
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**Tecniche di analisi aerodinamica mediante prove in Galleria del Vento**

AREA 09 - INGIND/08



UNIVERSITY OF PERUGIA  
DEPARTMENT OF ENGINEER

Annual Report 2019-2020

**Techniques of aerodynamic analysis through wind  
tunnel tests**

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## Abstract

### Techniques of aerodynamic analysis through wind tunnel tests

The widespread availability of wind turbine operation data has considerably boosted the research and the applications for wind turbine monitoring. It is well established that a systematic misalignment of the wind turbine nacelle with respect to the wind direction has a remarkable impact in terms of down-performance, because the extracted power is in first approximation proportional to the cosine cube of the yaw angle. Nevertheless, due to the fact that in the wind farm practice the wind field facing the rotor is estimated through anemometers placed behind the rotor, it is challenging to robustly detect systematic yaw errors without the use of additional upwind sensory systems. The importance of the yaw control of the wind machines The first part of the work aim to compare the wake generated from a wind turbine in different yaw condition and in particular between the classic yaw control, which is achieved thank to a mechanical actuator located between the base of the nacelle and the top of the tower, and the innovative Individual Pitch Control. This latter aim to yaw the wind turbine changing cyclically and independently the pitch angle of each blade. As a wind turbine extract energy from the wind, it leaves behind it a wake characterized by a reduced wind speed and an increased level of turbulence. Another turbine operating in this region will therefore produce less energy and suffer greater structural loading than wind turbine operating in the free stream. The second part was focused on a new method for systematic yaw error detection through operation data analysis is presented and is applied for individuating a misaligned multi-MWwind turbine.

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# Chapter 1

## Introduction

In this year of research the main activities were focused on wind energy, the aim of the research was to test a scaled wind turbine model device used to simulate the behaviour of real scale machine. This give the opportunity to simulate the real control of the machine and the possibility to test it in a wind tunnel for example using several models to create a scale farm.

### 1.1 Wind Turbines

Wind turbines are mechanical devices which convert the kinetic energy of the wind energy into electricity or mechanical energy. The power is extracted from the wind by allowing itself to blow through moving blades and thank to the lift generated by these latter, a torque is exerted on a shaft which is connected to an electric power generator. There are many ways to classify wind turbines, as dimensions and therefore for the amount of power that can extract from the wind, from the shape of the blade, for the position of the rotational axis. This field of the research is focused on horizontal three blades wind machine that have the possibility to extract 2 MW of power.

### 1.2 Performance and reliability

The optimization of this kind of machine is very important, so the interesting of the research is based on the optimisation of the power produce from a several machines of a farm. A minimal increase of the power output can produce lot of money so the scientific community try to find strategies for the optimization of them based on experimental tests using scale model and also using real data acquired from scada data system that each real machine has on board.

### 1.3 Pitch system

An important part of the control system of a pitch-controlled turbine is the pitch actuation system. Both hydraulic and electric actuators are commonly used, each type having its own particular advantages and disadvantages which should be considered

at the design stage. Smaller machines often have a single pitch actuator to control all the blades simultaneously, although there is an increasing trend to use individual pitch actuators for each blade on larger turbines. This has the advantage that it is then possible to dispense with the large and expensive shaft brake which would otherwise be needed. This is because of the requirement for a turbine to have at least two independent braking systems capable of bringing the turbine from full load to a safe state in the event of a failure. Provided the individual pitch actuators can be made independently fail-safe, and as long as the aerodynamic braking torque is always sufficient to slow the rotor down to a safe speed even if one pitch actuator has failed at the working pitch angle, then multiple actuators may be considered to be independent braking systems for this purpose. A collective pitch actuation system commonly consists of an electric or hydraulic actuator in the nacelle, driving a push-rod which passes through the centre of the gearbox and hollow main shaft. The push-rod is attached to the pitchable blade roots through mechanical linkages in the hub. The actuator in the nacelle is often a simple hydraulic cylinder and piston. An alternative arrangement is to use an electric servo motor to drive a ballnut which engages with a ball screw on the push-rod. The individual pitch control requires separate actuators in the hub for each blade. Therefore there must be some means of transmitting power to the rotating hub to drive the actuators. This can be achieved by means of slip rings in the case of electric actuators, or a rotary hydraulic joint for hydraulic actuators.

## **1.4 Rotation speed control**

The majority of wind turbines generate electricity and are grid connected, so they need to produce electricity supply which is constant in frequency. Consequently the most favoured development is operating at constant rotational speed. The two modes to do it is the stall control or the pitch control. In the ideal stall regulation the power should rise with wind speed to the maximum value and then remain constant regardless of the increase in wind speed. In order for the stall to occur when the wind speed tends to exceed the rated speed, the blades need to have specific aerodynamic features. Another disadvantage is that they have low vibration damping, which can give rise to large vibration displacement amplitudes that will inevitably be accompanied by large bending moments and stresses, causing fatigue damage. Despite the simplicity of the control system, their blades introduce a great cost penalty.



Figure 1.1: Individual pitch control (IPC).

The active pitch control can overcome many of the passive stall control limits. The blades are equipped with appropriate mechanisms to allow themselves to rotate around their own axis, adjusting the angle of attack to vary the wind incidence to cause the stall. Through the pitch control it is possible to operate at a constant rotational speed in a large speed range, even though the logic and technology of the control is way more complicated and consequently more expensive. Thus it is used on medium and large size turbines, where the improvement in performance justifies the higher costs.

## 1.5 Objectives of the research

The objective of this research is to perform test using a scale model of a real wind machine to measure the wakes behaviour downstream the rotor, controlling yaw rotation of the model using IPC control of the machine, that is able to rotate the nacelle instead using the yaw motor. A new method to find a non-alignment of the yaw angle of the machine and a calculation of the power loss due to this fact is analysed in the second part of the report. The impact of yaw angle on the energy yield is remarkable: a theoretical estimation is that the extracted power is proportional to the cosine cube of the yaw angle.

## Chapter 2

# Model scale wind turbine

### 2.1 Wind turbine model

The wind turbine G1 was developed to represent a scaled aerolastic model of a modern multi-MW three bladed machine. The two main dimensions are the rotor radius of 0.55 m and the tower height of 0.756 m. The operational data about the wind are the cut-in speed which is 4 m/s and the cut-out speed equal to 25 m/s. G1 has a rated rotor speed of 850 rpm, is equipped with three blades, which are composed by a layer of carbon fiber covering a machined Rohacell core, mounted on the hub with two bearings in order to enable pitch actuation while limiting free-play. The individual pitch angle of each blade can be varied by means of a small brushed motor equipped with a gear and built-in relative encoder, used to measure the blade pitch. The three motors are housed within the blades hollow root, and their position is monitored and adjusted by dedicated electronic control boards housed in the hub spinner (IPC). The shaft is held by two bearings, in turn housed in the rectangular carrying box that constitutes the mainframe of the nacelle.

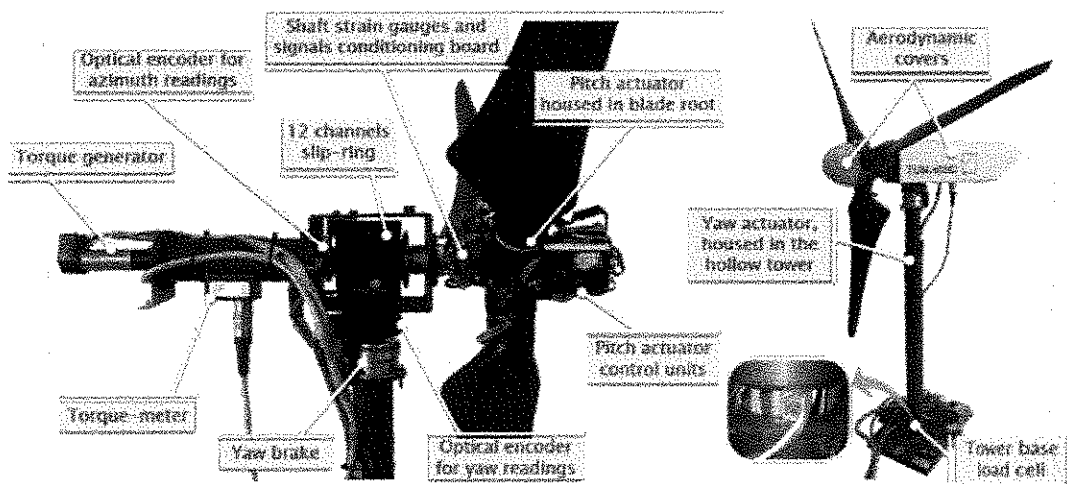


Figure 2.1: G1 wind turbine scale model.

The shaft also exhibits four small bridges on which strain gauges are glued, to provide measurements of the torsional and bending loads. Three miniaturized electronic boards, to the hub, provide for the power supply and conditioning of the shaft strain gauges. In the following tables are shown all the wind turbine characteristics.

## 2.2 CTA anemometry

Anemometry based on thermal properties is extensively used as a tool in research. In hot wire anemometer a tiny electrically heated element is placed in a air flow for measuring the velocity and other properties like turbulence, flow spatial pattern. The principle of hot-wire anemometer is based on heat transfer by convection method from a heated element exposed to the fluid flow and if there is any change in the fluid medium it will cause a change in heat loss in sensor. It is an ideal tool for measuring velocity fluctuation in time domain in turbulent flows. There are two types of probe: hot wire and hot film, but since in our experiment we used the first type, we will just talk about this category

## 2.3 Traversing System

To measure different points with the probe, the probe has to be mount on a traverse system that is an xy motorized table that move the probe in the space so it is possible to create a measurement plane with different points. The hardware and the mechanical part of the system was developed in the university and consist in a driver able to move the stepper motor and a structure where the probe is fixed. A proper software for the PC control of the traversing was developed in Labview and a firmware on traversing board was written in C code.

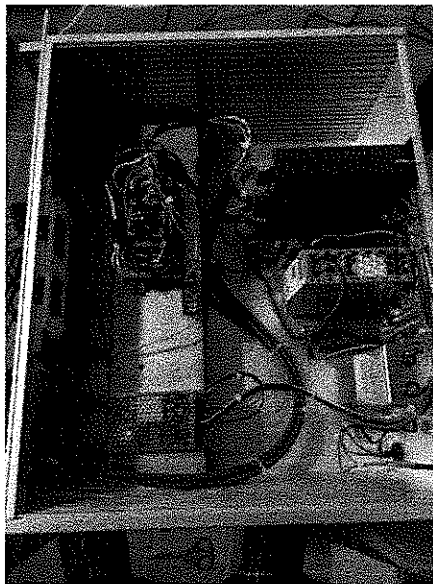


Figure 2.2: Traversing driver electronics.

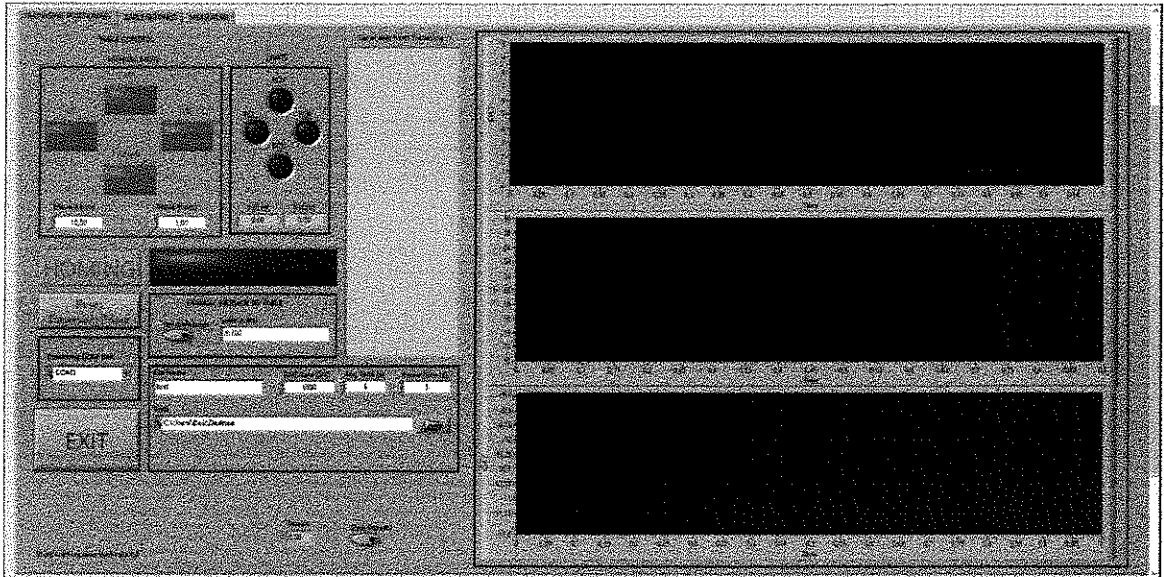


Figure 2.3: Control software.

## 2.4 Layout of the experiments in the wind tunnel

The G1 model was fixed in the test chamber of the wind tunnel facility of the University, next to the convergent section and the traversing was mounted behind at a distance 2.5 times the rotor diameter.

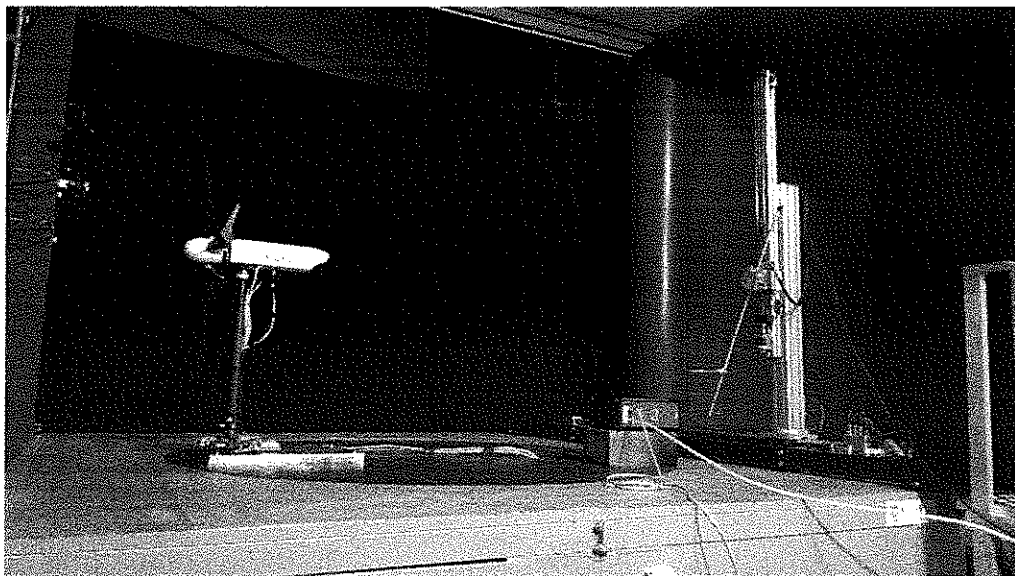


Figure 2.4: G1 and traversing mounted in the wind tunnel facility.

The measurements plane was parallel to the rotor with a certain number (around 160) of points each of which was acquired for 20 seconds. An example of points measured for the case in which we had Yaw 0 is shown in Fig. 2.6. A series of test were

performed to measure wake. For the CTA hot wire Dantec Streamline was used, and ad probe was a 1D probe, 55P11 type as shown in Fig. 2.5. The analog signal of the anemometer was acquired with CDAQ NI9185, using 9211 module.

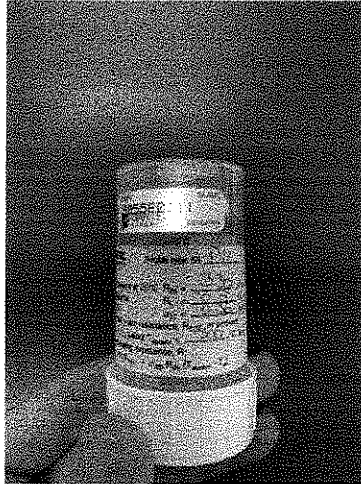


Figure 2.5: Probe used for the measurements.

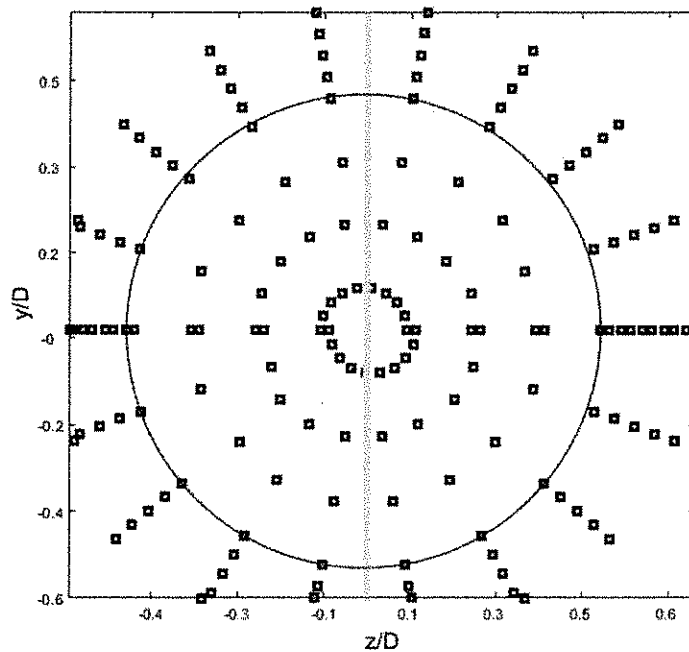


Figure 2.6: Mesh points measured during experiments.

Several measurements were performed changing the rotor yaw angle from 0 to 30 degree and -30 degree using the IPC control of the turbine to rotate the nacelle.

## 2.5 Results

In order to have a general overview on the behaviour of the wake behind the turbine the data point collected were interpolated to create a map of the wind speed normalized by velocity of the undisturbed flow in front of the turbine. From this point of view there are not evident differences between the case with IPC on and off, but we can see how effective the yaw control is in steering the wake of the turbine itself.

### 2.5.1 Normalized wind speed map

As expected the wake goes in the same direction of the yaw angle the turbine is turned clockwise ( $30^\circ$ ), the wake is steered to the left, when the turbine is turned counterclockwise ( $-30^\circ$ ), the wake is steered to the right as can be seen in the followed images:



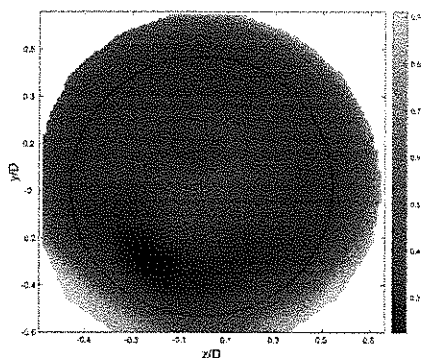


Figure 2.7: Yaw 0 IPC off.

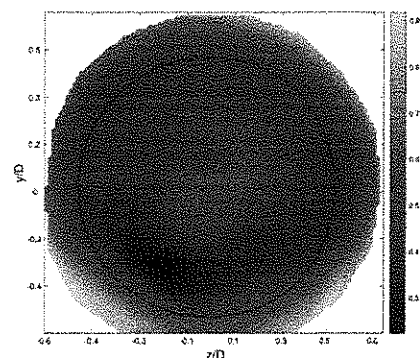


Figure 2.8: Yaw 0 IPC on.

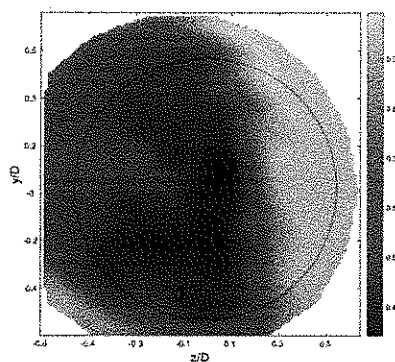


Figure 2.9: Yaw 30 IPC off.

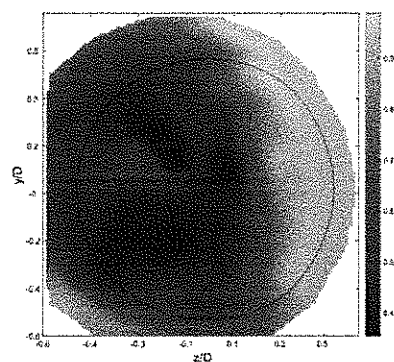


Figure 2.10: Yaw 30 IPC on.

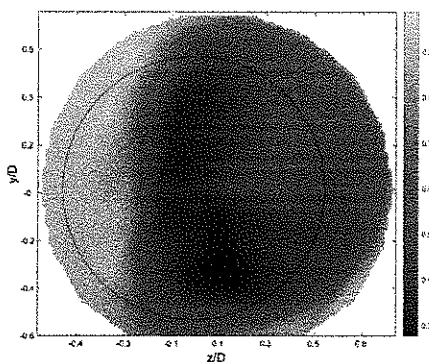


Figure 2.11: Yaw minus30 IPC off.

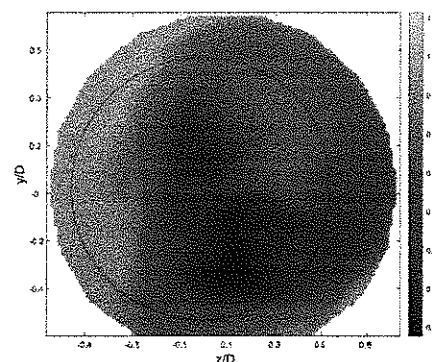


Figure 2.12: Yaw minus30 IPC on.

## 2.5.2 Turbulence intensity map

The same procedure of the previous chapter has been done for the Turbulence intensity. As before, looking at the following figures the differences are hardly noticeable.

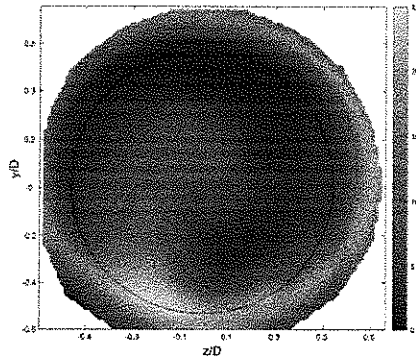


Figure 2.13: Yaw 0 IPC off.

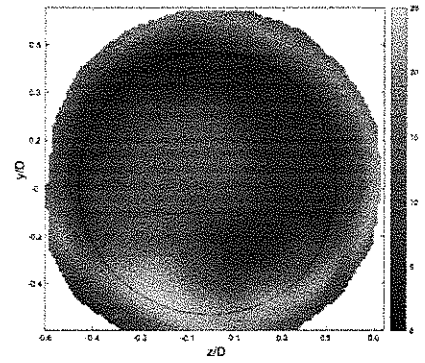


Figure 2.14: Yaw 0 IPC on.

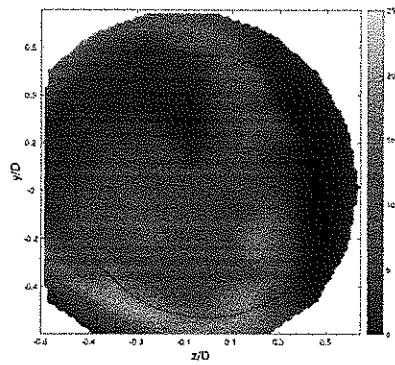


Figure 2.15: Yaw 30 IPC off.

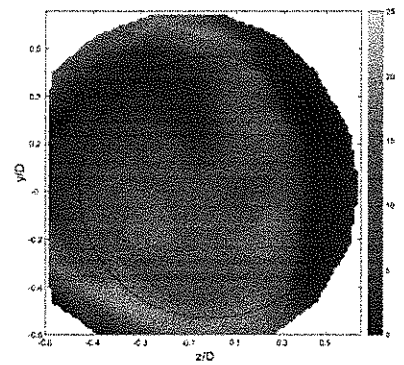


Figure 2.16: Yaw 30 IPC on.

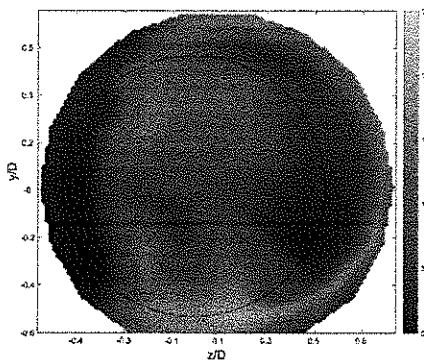


Figure 2.17: Yaw minus30 IPC off.

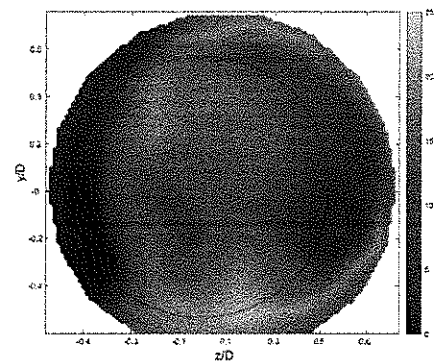


Figure 2.18: Yaw minus30 IPC on.

# Chapter 3

## Research on full scale machine

### 3.1 Yaw correction for real wind machine

Having Scadas data from a wind farm, the idea proposed for the diagnosis of systematic yaw error is analysing the yaw error - rotor speed curve. The rationale for the selection of this target is that the rotor speed of a wind turbine does not depend on the wind flow measurements from the nacelle anemometer placed behind the rotor span. The wind turbine regulates the rotor speed basing on the torque exerted on the rotor and the wind turbine control follows consequently. Therefore, if a wind turbine is losing torque because there is a systematic yaw error, it is losing rotor speed.

### 3.2 Test case

The wind farm features six multi-MWwind turbines, it is sited in southern Italy and the owner company is Renvico. The lowest inter-turbine distance is of the order of more than 6 rotor diameters. The target wind turbine for the diagnosis of systematic yaw error is WTG05 and it is indicated in red in the layout reported in Fig. 3.2.

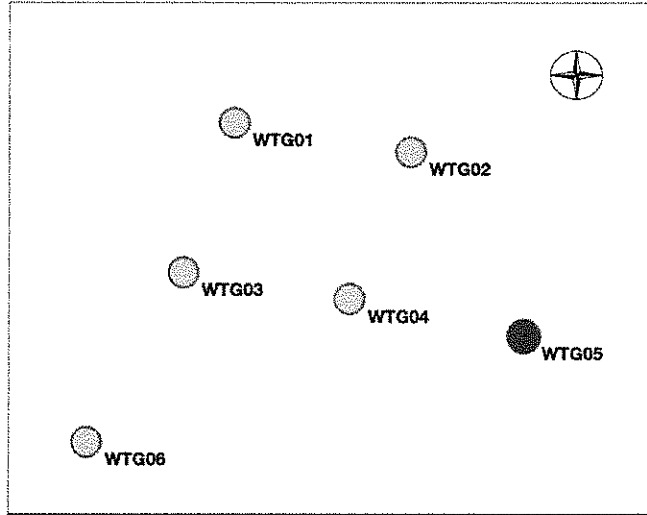


Figure 3.1: The layout of the wind farm.

### 3.3 Methods

The wind turbine regulates the rotor speed basing on the torque exerted on the rotor and the wind turbine control follows consequently. Therefore, if a wind turbine is losing torque because there is a systematic yaw error, it is losing rotor speed. The yaw error is defined in Equ. 3.1:

$$\gamma = \theta_{nac} - \theta_{wd} \quad (3.1)$$

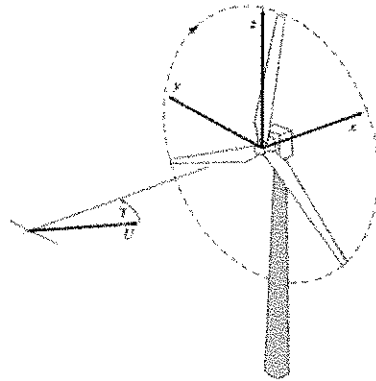


Figure 3.2: Representation of the yaw error  $\gamma$ .

The collected data from wind turbine operation time using the appropriate time counter were filtered on a narrow wind speed interval in Region II then the average yaw error - rotor speed curve was calculated. Data can be averaged on yaw error

intervals, for example, 1 or 2. It is appropriate to filter data on a wind speed interval that is not too close to rated power because, approaching rated, the pitch control is more important than the yaw control and because the rotor speed saturates. For a multi-MW wind turbine, an appropriate choice can be for example [7, 8] m/s. For the present test case, WTG02, WTG04 and WTG06 have been selected as reference wind turbines because, on the grounds of the knowledge of interventions on the wind farm, it has been evaluated that they are the most appropriate. The input variables have been selected on the grounds of their Pearson correlation coefficient with the target Y (power of WTG05). Given in general a pair of variables x and y, the Pearson correlation coefficient is defined in as:

$$r_{xy} = \frac{\sum_{i=1}^N x_i y_i - \sum_{i=1}^N x_i \sum_{i=1}^N y_i / N}{\sqrt{N \sum_{i=1}^N x_i^2 - \left(\sum_{i=1}^N x_i\right)^2 / N} \sqrt{N \sum_{i=1}^N y_i^2 - \left(\sum_{i=1}^N y_i\right)^2 / N}} \quad (3.2)$$

where N is the number of x and y observations. Basing on this criterion, the following input variables have been selected for the model whose target Y is the power of WTG05. The matrix X is based on:

- power of WTG02
- power of WTG04
- power of WTG06
- rotor speed of WTG02
- rotor speed of WTG04
- rotor speed of WTG06
- generator speed of WTG02
- generator speed of WTG04
- generator speed of WTG06

In order to understand the principles of Support Vector Regression, consider at first a linear model:

$$f(X) = X\beta + b \quad (3.3)$$

## Performance analysis

The data sets chosen are employed as follows for estimating the energy yield improvement subsequent to the yaw error correction:  $D_{bef}$  is randomly divided in two subsets: D0 (a random selection of 23 of the data set) and D1 (the remainder 13 of the data set). D0 is used for training the regression, D1 is used for testing the regression. The convergence of model training is verified through the MATLAB routine  $D_{aft}$  (also

named D2 for notation consistency) is used to quantify the performance deviation with respect to D1 (and therefore  $D_{bed}$ ). Once the Support Vector Machine model has been trained with the D0 data set, the output is simulated using this equation:

$$f(X) = \sum_{i=1}^N (\alpha_n - \alpha_n^*) G(X_n, X) + b \quad (3.4)$$

(basing on the input variables observations) for the data sets D1 and D2. If the performance of the wind turbine has improved in D2 with respect to D1, the behaviour of the difference between measured and simulated target should have changed. Therefore, consider Equ. 3.4 with  $i = 1, 2$ .

$$R(X_i) = Y(X_i) - f(X_i) \quad (3.5)$$

and

$$\Delta_i = 100 \frac{\sum_{X \in Data_i} (Y(X) - f(X))}{\sum_{X \in Data_i} Y(X)} \quad (3.6)$$

and the quantity  $\Delta = \Delta_2 - \Delta_1$  provides an estimate of the performance deviation from data set D1 to D2. If, instead the performance improves during D2, the residuals Equ. 3.4 are averagely higher than in D1, because  $f(X)$  is estimated through a model trained on a data set characterized by a lower performance. Therefore, one would reasonably obtain  $\Delta$  non-negligibly higher than 0.

### 3.4 Results

The method described before has been applied to the data sets collected from scada data. Results are reported for the [7, 8] m/s wind speed interval selection, but it has been cross checked that the method does not depend on this peculiar selection, as long as rated power (and therefore rotor speed saturation) is not reached.

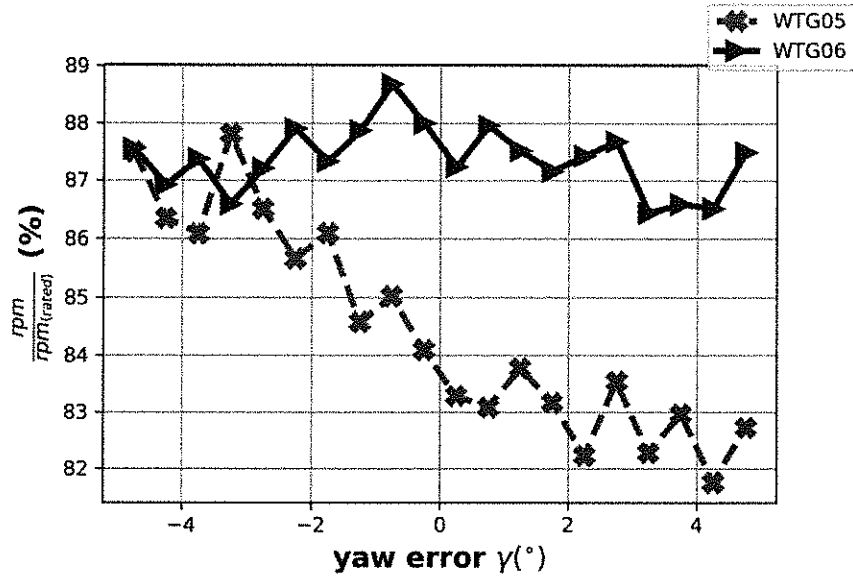


Figure 3.3: The yaw error - rotor speed curve for WTG05 and a sample reference wind turbine (WTG06): [7, 8] m/s wind speed interval.

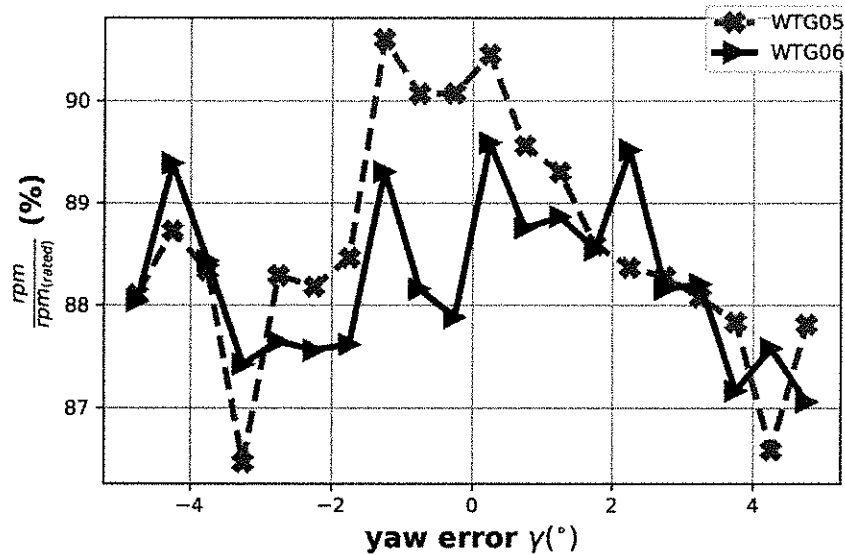


Figure 3.4: The yaw error - rotor speed curve for WTG05 and a sample reference wind turbine (WTG06): [7, 8] m/s wind speed interval.

Comparing Fig. 3.3 and Fig. 3.4, it is possible to observe that Fig. 3.3 describes the wind turbine WTG05 affected by a systematic yaw error. This can be argued because in Fig. 3.3, the highest rotor speed is achieved when the yaw error is of the order of 5 and the curve is clearly asymmetric. Furthermore, the highest torque should be exerted on the wind turbine when the yaw error is around 0 and it is therefore expected that the curves of WTG05 and WTG06 should be comparable, especially at

0 yaw error when there is the highest data population: instead, it happens that around 0, the rotor speed deficit for WTG05 with respect to WTG06 is of the order of the 10% of the rotor speed working range for that model of wind turbine.

### 3.5 Performance assessment

Following Equation 13, for  $i = 1, 2$ , one can write the average residual between measurements and model estimates as:

$$R = \frac{1}{N_i} \sum_{X \in D_i} Y(x) - F(X) \quad (3.7)$$

where  $N_i$  is the sample size in D1 and D2. The WTG05 performance improvement after the yaw error correction should resemble in different statistical properties of the residuals  $R(X2)$  with respect to  $R(X1)$ . If the model  $f(X)$  is trained with pre-correction data, when the output is simulated on the post-correction data set D2, the model estimate  $f(X)$  should be systematically lower than the measurements in a manner which should be distinguishable with respect to D1. This is indeed the case, as can be seen in Tab. 3.1: the measured WTG05 power is averagely 13.4 kW higher than the model estimate after the yaw correction with respect than before the correction.

Data Set	R[kW]
D1	-0.9
D2	12.5

Table 3.1: Statistical behavior of the residuals between measurement and estimation, for the D1 and D2 data sets.

Finally, it is interesting to analyze the dependence of the energy yield improvement for the different operation regions of the wind turbines. This can be appreciated in Fig. 3.5:  $R(X1)$  and  $R(X2)$ , computed on a sample model run, are displayed. The data are averaged in power production intervals, whose amplitude is 10% of the rated. From Fig. 3.5 it arises that the correction of the yaw error improves the wind turbine performance especially between 35% and 75% of the rated power, with an increasing effect with increasing power. This corroborates the observations in [6] yaw behavior of a wind turbine must be analyzed taking into account the control and the operation regime. When rated power is approached, the pitch behavior becomes important and the yaw error becomes less relevant. Basing on the results in Fig. 3.5, it is supported also that the yaw error is less relevant near the cut-in, because also in this regime the control involves also the pitch. The yaw error is therefore particularly relevant in Region II, when the rotor speed increases and the blade pitch is practically constant.



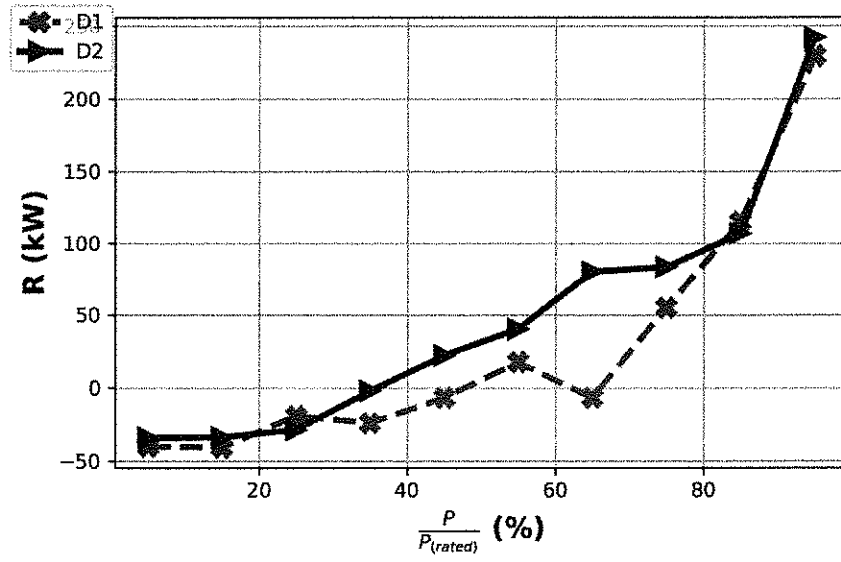


Figure 3.5: The average difference  $R$  between power measurement  $Y$  and estimation  $f(X)$  (Equation 13). Data sets: D1 and D2. Sample run of the model.

# Chapter 4

## Publications

1. Davide Astolfi, Francesco Castellani, Matteo Becchetti, Andrea Lombardi, and Ludovico Terzi. Wind turbine systematic yaw error: Operation data analysis techniques for detecting it and assessing its performance impact. *Energies*, 13:2351, 05 2020

### 4.1 Other works

Work accepted at ISMA2020. The 29th edition of the Biennial ISMA conference on Noise and Vibration Engineering. ISMA2020 will be organised on 7-9 September 2020, in Leuven (Belgium), in conjunction with USD2020:

1. Natili, Francesco, Campagnolo, Filippo, Castellani, Francesco, Bottasso, Carlo, Astolfi, Davide, and Becchetti, Matteo, 'Experimental analysis of the wind turbine yaw by individual pitch control strategy'

Relazione finale assegno di  
ricerca dal titolo  
**Sensoristica Digitale per  
applicazioni Smart  
Livestock Farming**

Assegnista  
Vanni Mecarelli

Docente  
Fabrizio Frescura

## Introduzione

Lo studio ha riguardato l'analisi e la prototipazione di un sistema per il monitoraggio di animali in stalla, in particolar modo bovini da latte. Si è lavorato alla progettazione e allo sviluppo dell'infrastruttura completa a partire dalla realizzazione e programmazione dei microcontrollori da installare nei collari degli animali, ai gateway da installare all'interno della stalla per raccogliere i dati dai collari e parametri ambientali, alla realizzazione di una interfaccia PHP attraverso la quale i gateway inviano i dati raccolti che vengono convogliati all'interno di un unico database.

Sono stati realizzati 4 prototipi di nodo animale, 2 gateway da interno e 1 gateway da esterno.

## Nodo Animale

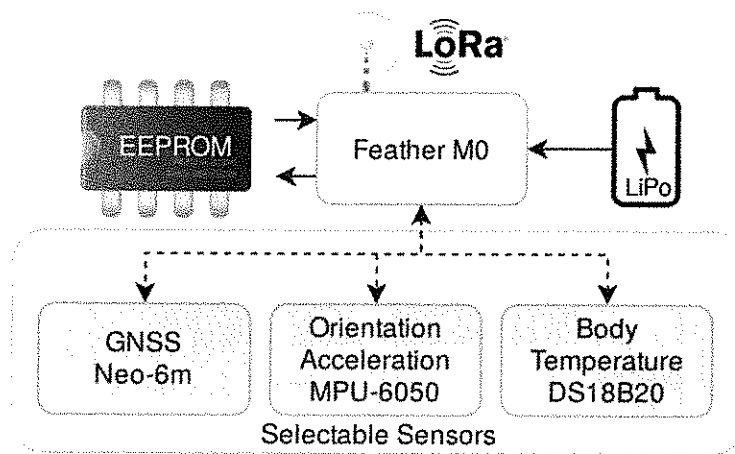
Lo scopo del nodo animale è quello di raccogliere più informazioni possibile attraverso diversi sensori posizionati nel collare indossato dall'animale come mostrato nella figura seguente.



Ci sono diversi parametri legati alla salute dell'animale che possono essere monitorati; in questo progetto sono stati scelti: il posizionamento GNSS, l'accelerazione, la rotazione e la temperatura corporea.

Visto che il collare viene posizionato su di un animale è importante ridurre al minimo lo stress ed il fastidio provocato, far sì l'elettronica sia protetta dagli urti provocati dall'animale e ridurre al minimo il consumo di potenza per estendere il più possibile la durata della batteria.

L'hardware del nodo animale può essere personalizzato per adattarsi a diversi scenari: ad esempio, se l'animale è sempre all'interno della stalla, il posizionamento GNSS diventa meno informativo e può essere rimosso o disattivato per aumentare la durata della batteria; d'altronde in uno scenario con pascolo, il tracciamento della posizione risulta molto importante.



Nella figura qui sopra viene mostrata lo schema a blocchi dell'architettura del nodo animale.

La modularità del nodo animale è stata quindi resa possibile sia a livello software introducendo quanta più astrazione possibile per quanto riguarda sia i modelli specifici dei sensori, sia per l'acquisizione o meno di una data grandezza. Ci sono comunque tre blocchi funzionali comuni a tutti i nodi: un microcontrollore Adafruit Feather M0 RFM95 con un modem LoRa integrato, una batteria LiPo ricaricabile e una memoria EEPROM per conservare le configurazioni del nodo.

Il microcontrollore è stato programmato per raccogliere i dati dai sensori, perseguire il più possibile una politica di risparmio energetico (ad esempio spegnendo i sensori quando non necessari), bufferizzare i pacchetti, accedere al canale LoRa con un protocollo Carrier Sense Multiple Access Collision Avoidance (CSMA/CA) e inviare i dati al gateway dopo averli compressi e criptati.

I sensori utilizzati nei primi quattro prototipi realizzati sono:

- u-blox Neo-6m, un ricevitore GNSS interfacciato tramite UART;
- InvenSense MPU-6050, un accelerometro e giroscopio interfacciato tramite bus I<sup>2</sup>C;
- WINOMO DS18B20, un sensore di temperatura impermeabile da esterno, interfacciato tramite il protocollo One Wire.

## Gateway

Il gateway è composto da diversi componenti e sensori controllati da un Raspberry Pi 3B, il cui scopo è coordinare e gestire la raccolta dei dati dai sensori e dai collari e stabilire la comunicazione con il server. La connessione ad internet può essere garantita utilizzando la porta ethernet o la WiFi integrate nel Raspberry oppure utilizzando un modem USB 3G/4G.

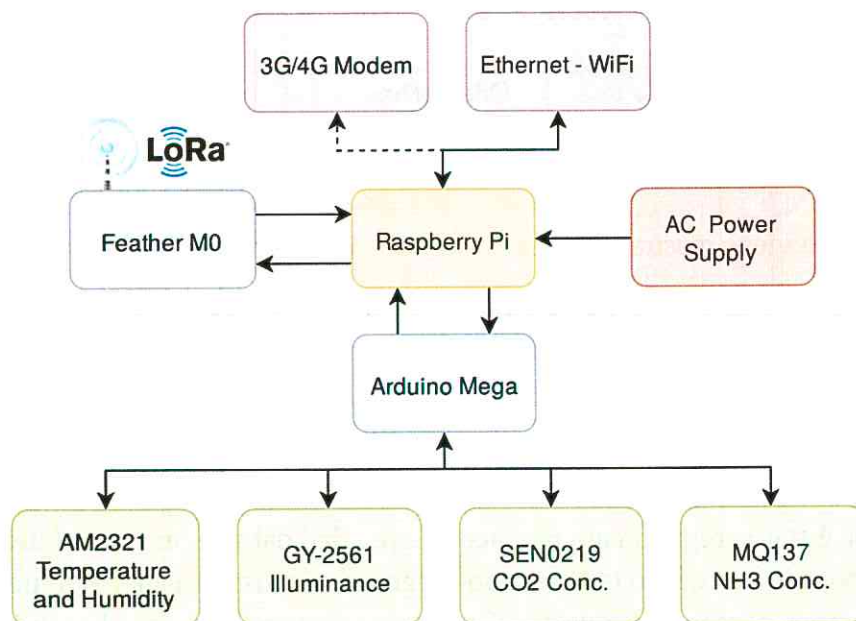
Sono stati realizzati diversi demoni in C++ e Python3 che, partendo all'avvio del Raspberry, si occupano della gestione dei vari compiti come ad esempio raccogliere i dati dai sensori presenti all'interno del gateway, raccogliere i dati dai collari e stabilire la comunicazione con il server andando a bufferizzare i dati qualora vi siano problemi nella connessione internet.

In particolare, vista la diversa natura degli scenari, sono state progettate due tipologie diverse di gateway, una versione da installare all'interno della stalla e una da installare al pascolo.



## Gateway da Interno

Il gateway da interno è stato concepito, oltre che per la raccolta dei dati dei collari, anche per il monitoraggio di alcuni parametri importati all'interno di una stalla, come ad esempio la temperatura, l'umidità relativa, l'illuminanza, la concentrazione di anidride carbonica e la concentrazione di ammoniaca.



Nella figura qui sopra viene mostrata lo schema a blocchi dell'architettura del gateway da interno.

La raccolta dei dati dai sensori è gestita da un Arduino Mega 2560 che si occupa di leggere dai sensori i dati grezzi, riformattarli ed inviarli tramite UART al Raspberry utilizzando una struttura di messaggio predisposta. Lo scopo dell'Arduino è anche quello di disaccoppiare la fragile elettronica del Raspberry dai sensori.

Nei due prototipi di gateway da interno realizzati sono stati utilizzati i seguenti sensori:

- Aosong AM2321, un sensore di temperatura e umidità relativa interfacciato tramite bus I<sup>2</sup>C;
- Adafruit TLS2561 (GY-2561), un sensore di illuminanza interfacciato tramite bus I<sup>2</sup>C;
- DFRobot SEN0219, un sensore di concentrazione di anidride carbonica con una uscita analogica;
- Winsen MQ137, un sensore di concentrazione di ammoniaca con una uscita analogica.

L'accesso alla rete LoRa è gestito da un Adafruit Feather M0 RFM95 che ascolta i messaggi provenienti dai nodi contenuti nei collari, decomprime e decodifica i dati e li invia al Raspberry tramite UART usando la stessa struttura di messaggio utilizzata dall'Arduino Mega.

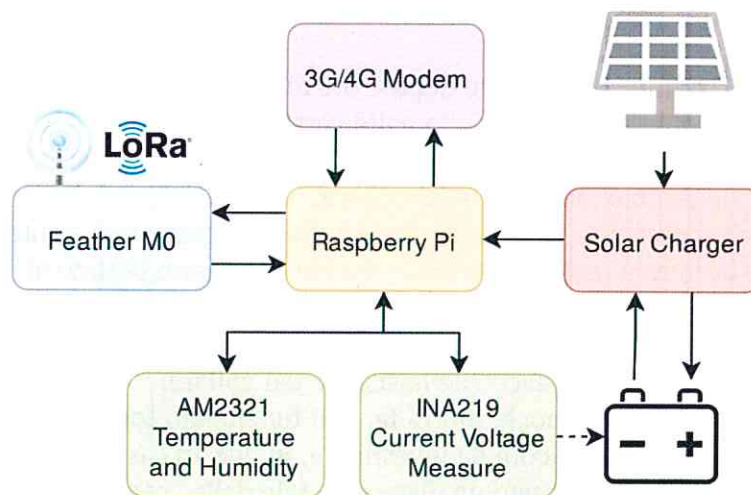
Il Raspberry tratta le comunicazioni UART provenienti dall'Arduino Mega e dall'Adafruit Feather allo stesso modo, ascoltando sulla porta seriale in attesa della struttura di messaggio definita. Dopo la ricezione, decodifica i dati in ingresso e prepara un nuovo messaggio da inviare al server tramite una richiesta POST alle API.

Tutta l'elettronica è contenuta all'interno di un armadietto elettrico impermeabile con un sistema di ventilazione forzata allo scopo di raffreddare i componenti e garantire un ricambio d'aria adeguato per la lettura dei parametri di interesse da parte dei sensori, anch'essi contenuti all'interno.

Il sistema viene alimentato con un trasformatore da 25W, da 220V AC a 5V DC.

## Gateway da Esterno

Lo scopo principale della versione da esterno è quello di gestire i nodi presenti in aree lontane dalla stalla, direttamente nel pascolo. Vista la tipologia di scenario è stato scelto di raccogliere solamente dati meteo (temperatura e umidità relativa).



Nella figura qui sopra viene mostrata lo schema a blocchi dell'architettura del gateway da esterno.

L'energia viene prodotta da un pannello solare da 20W e accumulata in una batteria al piombo da 12V 7Ah; i cicli di carica e la protezione del carico elettrico sono gestiti da un controllore di carica apposito. La tensione e la corrente della batteria sono monitorate tramite un sensore basato su INA219.

Per minimizzare il consumo di potenza, visto anche il basso numero di sensori impiegati in questo scenario, è stato rimosso l'Arduino Mega demandando la gestione dei sensori direttamente dal Raspberry Pi tramite GPIO.

Nel prototipo di gateway da esterno realizzati sono stati utilizzati i seguenti sensori:

- Aosong AM2321, montato all'interno di una protezione semipermeabile per riparare dalla pioggia, un sensore di temperatura e umidità relativa interfacciato tramite I<sup>2</sup>C;
- HiLetgo INA219, un sensore di tensione e corrente interfacciato tramite I<sup>2</sup>C.

Tutta l'elettronica è contenuta all'interno di un armadietto elettrico impermeabile con delle fessure per permettere la circolazione passiva di aria allo scopo di raffreddare i componenti senza pregiudicare eccessivamente l'impermeabilità.

## Test sul campo

Dopo una fase di test in laboratorio conclusa con successo si è proceduto ad eseguire test sul campo.

Sono stati installati i due gateway da interno, tutt'ora funzionanti, presso due aziende: Azienda1 dal 08/07/2019 e Azienda2 dal 31/07/2019. Entrambi i prototipi hanno presentato un comportamento normale, sopportando anche alle criticità degli ambienti come accumulo di sporcizia e connessione internet altalenante.



Un gateway da esterno è stato installato presso il Dipartimento di Ingegneria dell'Università degli Studi di Perugia dove ha funzionato senza problemi dal 10/07/2019 al 10/09/2019 dimostrando una ottima resistenza sia al caldo estivo che ai temporali e un buon dimensionamento del circuito di ricarica. Col passare del tempo è emerso un problema di deterioramento della capacità della batteria al piombo, forse legato al caldo, che però non ha pregiudicato eccessivamente la funzionalità del sistema.

I collari sono stati testati diverse volte su animali, di seguito sono elencati i test di ogni singolo collare:

- presso Azienda1, fallimento elettrico dopo 6 ore di attività dovuto ad una scarsa protezione della batteria; il problema è stato risolto nelle versioni successive.
- presso Azienda2, fallimento meccanico dopo 3 giorni legato alla rottura delle flange della scatola che hanno portato al distacco dal collare.
- presso Azienda2, fallimento meccanico dopo 4 giorni legato, nonostante il rinforzo con nastro telato, alla rottura delle flange della scatola che hanno portato al distacco dal collare.
- presso Azienda2, recuperato pochi giorni fa, ha smesso di funzionare dopo 7 ore per cause ancora da investigare; in questo caso, in seguito all'applicazione di ulteriori rinforzi, si è presentato solo un parziale distacco della scatola dal collare.
- presso Azienda2, recuperato pochi giorni fa, mai funzionato forse causa collegamenti elettrici o saldature saltate, ancora da investigare; in questo caso, nonostante l'applicazione di ulteriori rinforzi, si è presentato un distacco totale della scatola (questa volta sprovvista di flange) dal collare.
- presso Azienda2, recuperato pochi giorni fa, ha smesso di funzionare dopo 3 giorni per cause ancora da investigare; in questo caso, in seguito all'applicazione di ulteriori rinforzi, si è presentato solo un parziale distacco della scatola dal collare.

## Articoli scientifici prodotti

### Publicati

- Baruffa, G.; Rugini, L.; Mecarelli, V.; Germani, L.; Frescura, F. Coded LoRa Performance in Wireless Channels. 2019 IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (IEEE PIMRC 2019); , 2019; pp. 1-6.

### Completati, da sottomettere

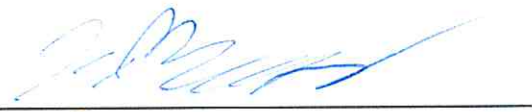
- Germani, L.; Mecarelli, V.; Baruffa, G.; Rugini, L.; Frescura, F.; An IoT Architecture for Continuous Livestock Monitoring using LoRa LPWAN presso la rivista MDPI Electronics.

## Finanziamenti

L'attività di ricerca è stata finanziata dal progetto Livestock Smart Farming (PSR 2014-2020 16.1 Regione Umbria)

Perugia, 10/10/2019

L'Assegnista, Vanni Mecarelli



Il Docente, Fabrizio Frescura





Relazione finale assegno di  
ricerca dal titolo  
**Algoritmi di Machine  
Learning per applicazioni  
Smart Livestock Farming**

Assegnista  
Lorenzo Germani

Docente  
Fabrizio Frescura

# Introduzione

L'attività di ricerca si inquadra nell'ambito dello sviluppo e prototipazione di algoritmi di Machine Learning ed intelligenza artificiale applicati alla filiera dell'allevamento di animali in stalla e al pascolo.

Lo scopo dell'attività è quello di progettare e sviluppare una classe di algoritmi dedicati alla individuazione automatica delle anomalie di comportamento, di parametri vitali dei capi monitorati e di parametri ambientali della stalla, con l'obiettivo di individuare tempestivamente situazioni non ideali di benessere o addirittura di possibili patologie individuali o di gruppo.

## Attività svolta

I primi mesi del progetto sono stati utilizzati per la progettazione e lo sviluppo dell'infrastruttura completa:

1. realizzazione e programmazione dei microcontrollori utilizzati nei collari degli animali,
2. realizzazione dei gateway da installare all'interno delle stalle per raccogliere i dati dai collari e i parametri ambientali,
3. tecniche di comunicazioni con protocollo LoRa, e accesso al canale con meccanismo Listen Before Talk
4. realizzazione di una interfaccia PHP attraverso la quale i gateway inviano i dati raccolti e salvataggio all'interno di un unico database.
5. Graphical User Interface per visualizzare e correlare i dati raccolti

Sono stati realizzati 4 prototipi di nodo animale, 2 gateway da interno e 2 gateway da esterno.

Nella seconda fase del progetto si è sviluppato un modello 3D di un alloggiamento per il montaggio dell'apparecchiatura elettronica da utilizzare sui collari delle mucche da latte. Le scatole precedentemente utilizzate e testate non hanno resistito alle condizioni estreme dell'ambiente stalla. Infatti nei vari test effettuati la scatola si è sempre staccata dal collare e in un caso si è riscontrata la presenza di acqua all'interno. Per i precedenti motivi è sorta l'esigenza di progettare una scatola che soddisfa le seguenti proprietà:

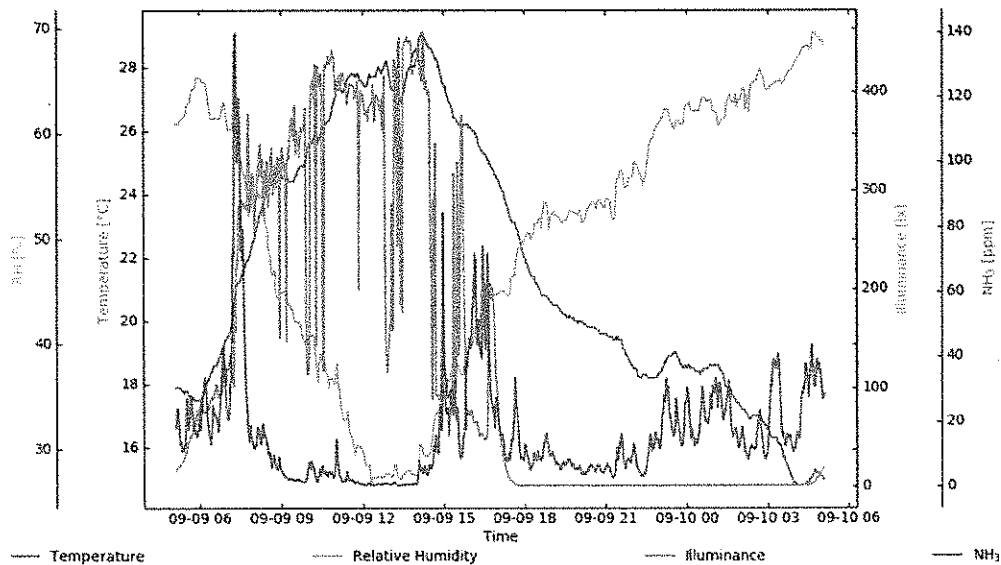
- IP 64, completamente ermetico a polveri e fumi e protetto contro spruzzi d'acqua da qualsiasi direzione
- la resistenza, materiali come ABS in grado di resistere agli urti dell'animale
- il corretto ancoraggio al collare, scatola con montanti per far passare la cintura e avere un perfetto fissaggio della scatola sia dal punto di vista della stabilità che del posizionamento del sensore sulla mucca
- la trasmissione radio, materiale plastico che non schermi le radiazioni dell'antenna LoRa
- la comodità dell'animale, scatola leggera e non ingombrante o fastidiosa

Per soddisfare le esigenze di stalle diverse da quelle dei bovini da latte, come ad esempio le stalle suine, sono stati progettati dei nuovi Gateway Distribuiti. Vengono chiamati con questa nomenclatura perché hanno accesso ad internet e sono dotati di sensori, inoltre essendo piccoli e molto meno cari dei classici Gateway (esterno o interno) possono essere replicati e distribuiti in vari punti della stalla. Il microcontrollore utilizzato è il NODE MCU ESP8266 che ha incorporato un modulo WiFi e tramite il protocollo MQTT scambia i dati raccolti dai sensori con il Database del progetto. Sono stati realizzati 4 Gateway Distribuiti in grado di misurare temperatura esterna, umidità relativa, ppm di Ammonio NH<sub>3</sub> e ppm di acido solfidrico H<sub>2</sub>S.

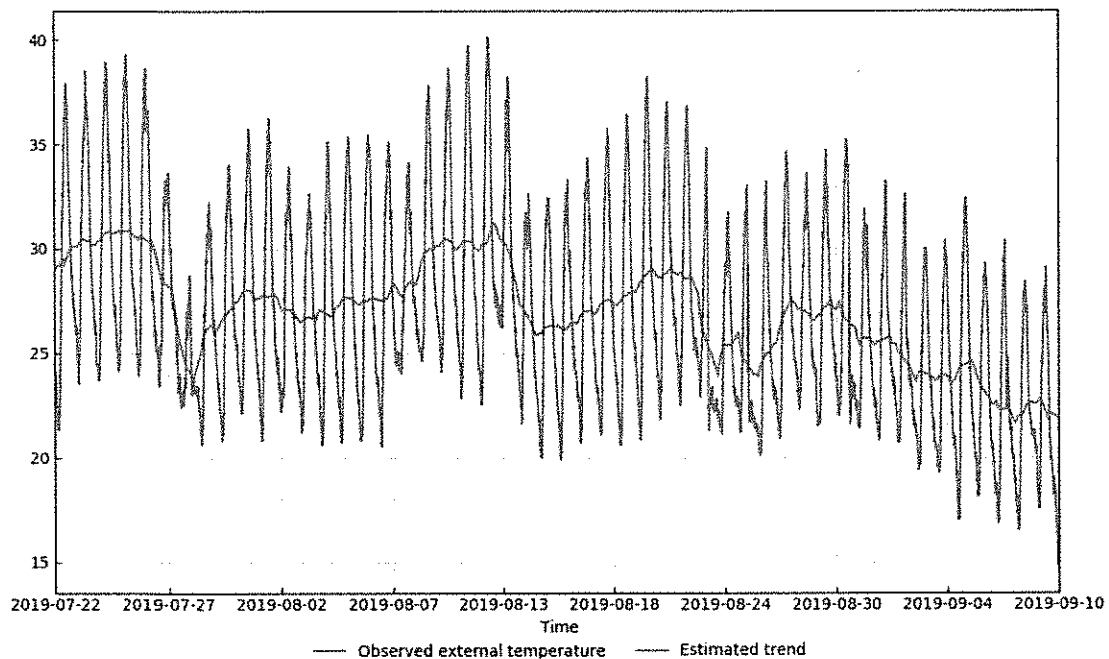
Una volta raccolti i primi dati consistenti è iniziata la fase di analisi.

I primi algoritmi utilizzati sono quelli tipicamente utilizzati nella Exploratory Data Analysis.

Come primo esempio vengono mostrati i valori di temperatura , umidità relativa, illuminamento e concentrazione di NH<sub>3</sub> misurati da un Gateway Interno installato presso una stalla di mucche da latte nella giornata del 6 settembre 2019

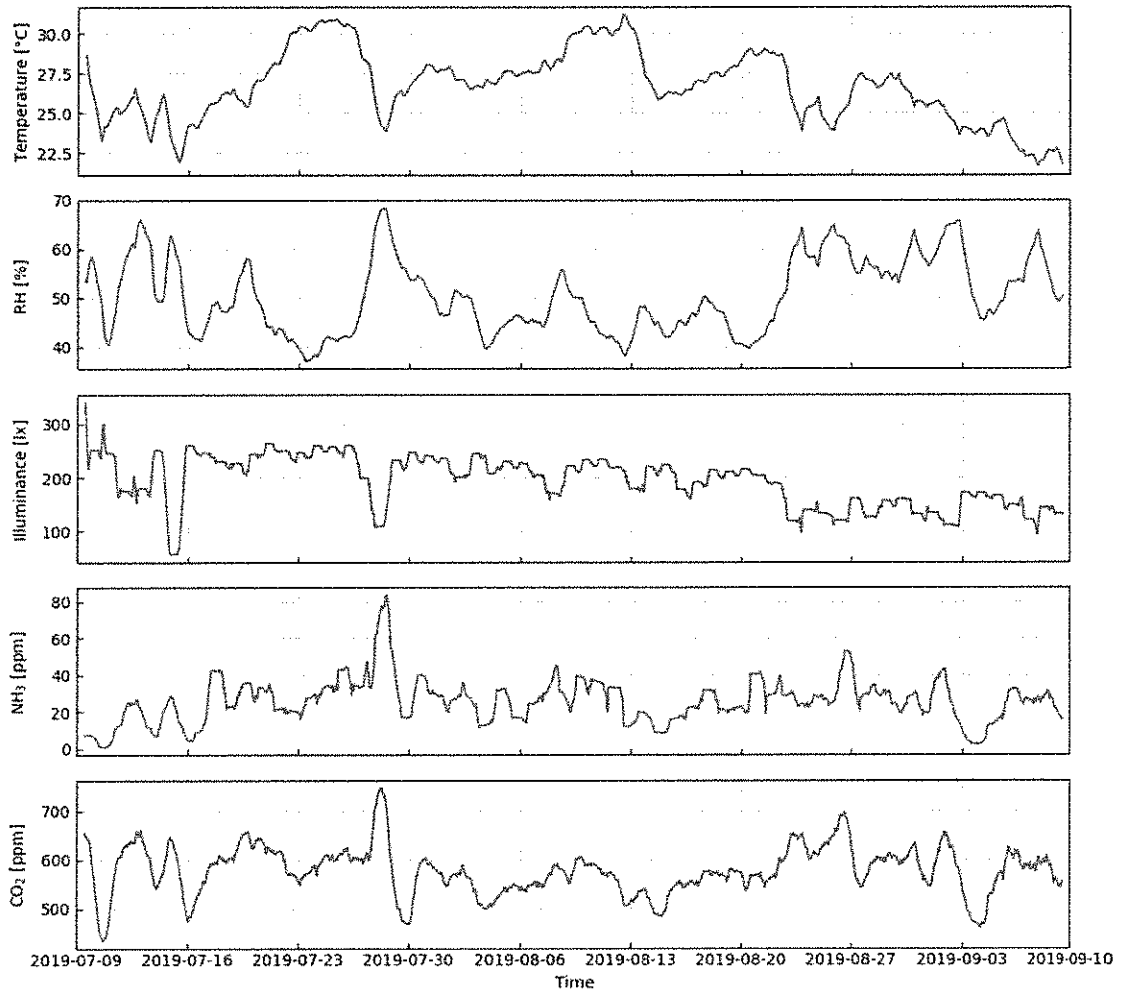


Una seconda analisi svolta è stata quella di analizzare la stagionalità e la presenza di trend usando il metodo della decomposizione stagionale con media mobile.



Viene mostrata la variazione della temperatura della stalla e in rosso il trend estrapolato usando la decomposizione stagionale realizzata inferendo un trend dalle serie temporali rimuovendo le variazioni veloci e altri disturbi dai dati osservati.

Una altra importante analisi svolta è quella della correlazione fra i dati per confermare relazione presunte fra grandezze e anche per trovarne di nuove non ipotizzate.



Ad esempio nella giornata del 29 luglio 2019 si nota una decrescita della temperatura e illuminamento insieme ad un incremento dell'umidità relativa. Un'altra relazione interessante è dovuta al fatto che CO2 e NH3 sono linearmente dipendenti.

La sola analisi visiva non è chiaramente sufficiente e quindi sono stati utilizzati:

Istogrammi,

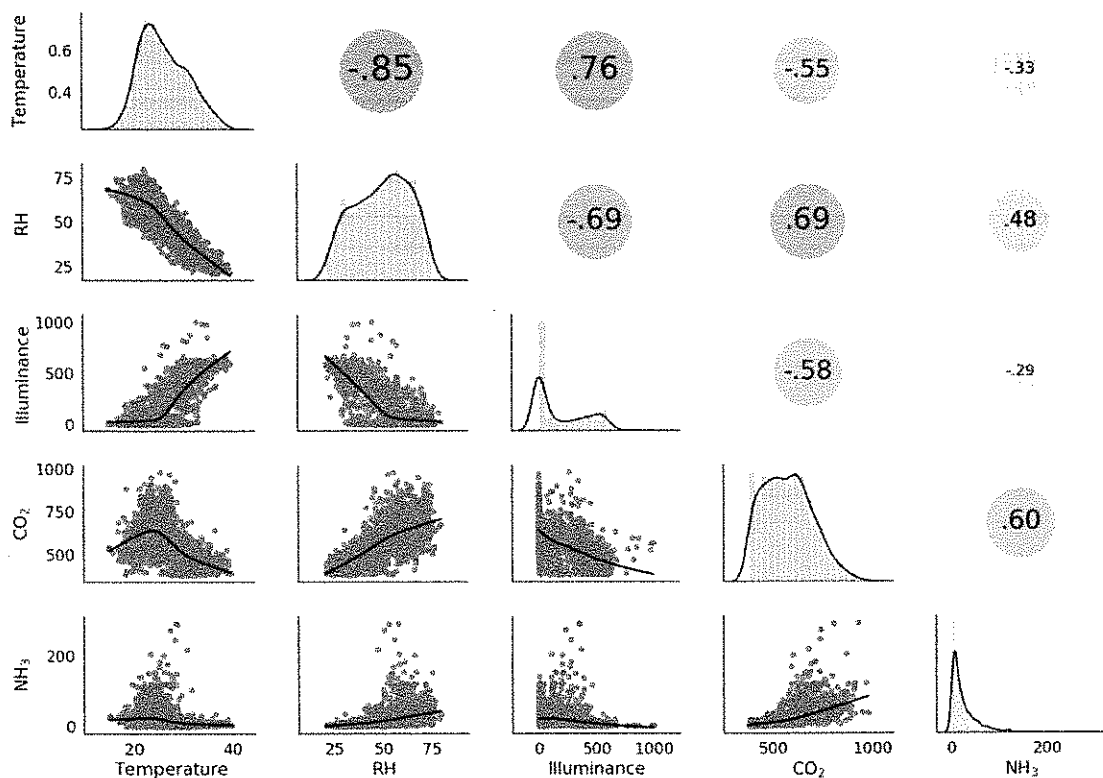
Stime di PDF con Kernel Density Estimation,

Coefficienti di correlazione e di cross correlazione,

Scattering plots fra le varie grandezze

Modelli locali di regressioni lineari pesate.

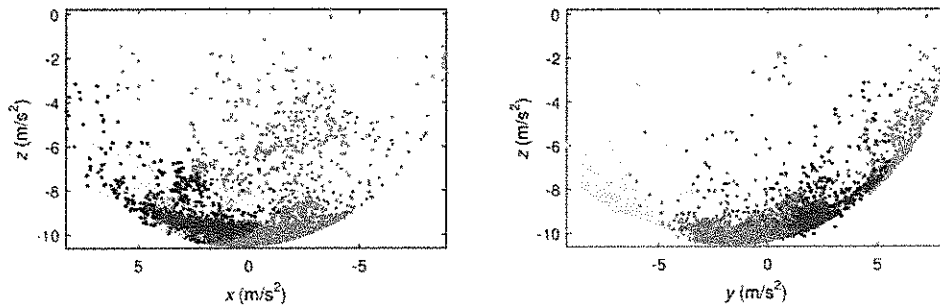
Tutte queste analisi possono essere ad esempio visualizzate insieme nella seguente immagine.



Sulla diagonale sono visibili gli istogrammi e le PDF stimate con l'algoritmo KDE delle rispettive grandezze. I 10 grafici situati nel triangolo inferiore sono gli scatter plot per ogni coppia di parametri insieme ad una curva ottenuta tramite l'utilizzo di una regressione lineare pesata. Con questi grafici si può analizzare visualmente la presenza di correlazione fra coppie di parametri.

Infine nella parte triangolare superiore sono presenti i coefficienti di cross correlazione, in blu e rosso per distinguere da correlazioni positive e negative.

Un'ulteriore analisi svolta è quella effettuata con i valori di accelerazione catturati dal collare delle mucche. Ogni 5 secondi viene misurata e calcolata l'accelerazione media rispetto alle componenti x, y e z. Su i dati raccolti per 3 giorni è stata effettuata un'analisi dei gruppi, clustering, utilizzando l'algoritmo K-Means.



Dalla precedente immagine emerge che è stato possibile classificare i valori di accelerazioni medie registrate in 4 classi separate, raffigurate con colori diverse. Questo significa che tramite questa tipologia di dati è possibile discriminare 4 momenti o comportamenti diversi dell'animale, ad esempio cammino, masticazione, riposo e corsa.

La precedente analisi risulta però onerosa in merito al consumo della batteria e anche dal punto di vista dei dati trasmessi. Infatti l'Inertial Measurement Unit che campiona le accelerazioni rimane sempre accesa e la dimensione del pacchetto dati IMU pari a circa= 160 bit ogni 5 secondi.

Per ovviare a queste problematiche è stato proposto un altro tipo di pacchetto chiamato Attivometro che effettua un pre-processamento dei dati provenienti dal IMU direttamente a bordo del sensore nodo, e tramite una soglia trasmette solamente un 1 se è stato rilevato un movimento e uno 0 nel caso contrario. Inoltre in questo modo il sensore non è sempre acceso e non consuma energia. In conclusione viene così inviato un vettore di 0 e 1 che successivamente può essere analizzato per la ricerca di pattern ricorrenti utilizzabili per la classificazione dei comportamenti animali.

## Test sul campo

Dopo una fase di test in laboratorio conclusa con successo si è proceduto ad eseguire test sul campo.

Sono stati installati i due gateway da interno, tutt'ora funzionanti, presso due aziende: Azienda1 dal 08/07/2019 e Azienda2 dal 31/07/2019. Entrambi i prototipi hanno presentato un comportamento normale, sopperendo anche alle criticità degli ambienti come accumulo di sporcizia e connessione internet non stabile.

Due gateway da esterno sono stati installati presso il Dipartimento di Ingegneria dell'Università degli Studi di Perugia dove hanno funzionato senza problemi dal 10/07/2019 al 10/09/2019 e dal 14/10/2019 al 30/1/2020 dimostrando una ottima resistenza sia al caldo estivo, sia ai temporali e anche al freddo intenso e gelate tipiche della stagione invernale.

I collari sono stati testati diverse volte su animali, di seguito sono elencati i test di ogni singolo collare:

- presso Azienda1, fallimento elettrico dopo 6 ore di attività dovuto ad una scarsa protezione della batteria; il problema è stato risolto nelle versioni successive.
- presso Azienda2, fallimento meccanico dopo 3 giorni legato alla rottura delle flange della scatola che hanno portato al distacco dal collare.
- presso Azienda2, fallimento meccanico dopo 4 giorni, nonostante il rinforzo con nastro telato, alla rottura delle flange della scatola che hanno portato al distacco dal collare.
- presso Azienda2, ha smesso di funzionare dopo 7 ore per cause ignote; in questo caso, in seguito all'applicazione di ulteriori rinforzi, si è presentato solo un parziale distacco della scatola dal collare.
- presso Azienda2, ha smesso di funzionare dopo poche ore forse causa di collegamenti elettrici o saldature saltate dovute a urti della scatola; in questo caso, nonostante l'applicazione di ulteriori rinforzi, si è presentato un distacco totale della scatola (questa volta sprovvista di flange) dal collare.
- presso Azienda2, ha smesso di funzionare dopo 3 giorni esaurimento batteria; in questo caso, in seguito all'applicazione di ulteriori rinforzi, si è presentato solo un parziale distacco della scatola dal collare.

Sperimentazione volta a determinare il miglior compromesso tra quantità e frequenza di parametri vitali trasmessi dai sensori LoRa e consumo energetico.

LiPo voltaggio 3.7V

LiPo capacità 2800 mAh

Potenza trasmissione 20 dBm

Payload Size 256 byte

periodo dati della board(tensione batteria, temperatura CPU) 3600 secondi

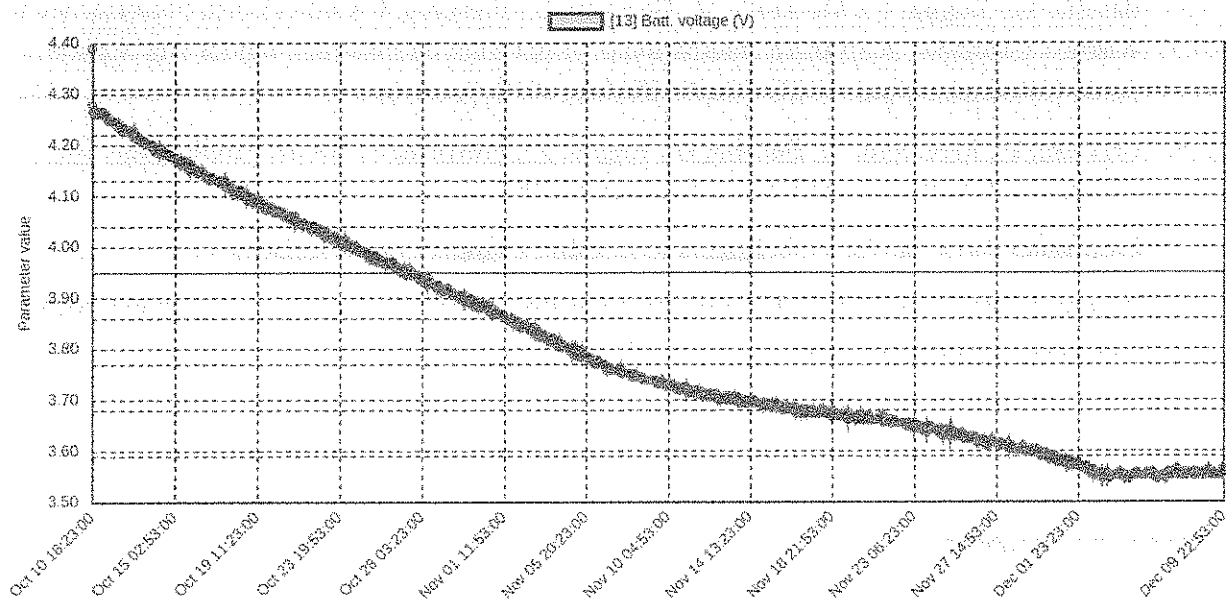
periodo dati temperatura corporea 900 secondi

periodo dati accelerometro 5 secondi

periodo trasmissione 4200 secondi, circa 70 minuti



Con questi parametri è stata testata la durata della batteria che è stata di circa 60 giorni, dal 10/10/19 al 9/12/19



Nel mese di dicembre 2 Gateway distribuiti sono stati installati presso un Azienda3 di suini.

Installati su 2 stanza separate per poter fare un confronto e correlare i dati raccolti. Infatti nelle 2 stanze verranno effettuate prove e cure diversi da parte dei veterinari o personale ARA e i dati raccolti verranno divisi in grandezze di riferimento e di test per correlare e visualizzare i risultati dei trattamenti.

Dal mese di gennaio i dati dell'azienda3 di suini vengono inviati correttamente e continuamente senza problemi.

## Articoli scientifici prodotti

### Pubblicati

- Baruffa, G.; Rugini, L.; Mecarelli, V.; Germani, L.; Frescura, F. Coded LoRa Performance in Wireless Channels. 2019 IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (IEEE PIMRC 2019); , 2019; pp. 1–6.
- Germani, L.; Mecarelli, V.; Baruffa, G.; Rugini, L.; Frescura, F.; An IoT Architecture for Continuous Livestock Monitoring using LoRa LPWAN.

*Electronics* 2019, 8(12), 1435. <https://doi.org/10.3390/electronics8121435>

Received: 30 October 2019 / Revised: 19 November 2019 / Accepted: 22 November 2019 /

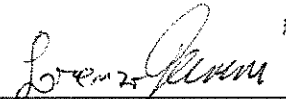
Published: 1 December 2019

### Finanziamenti

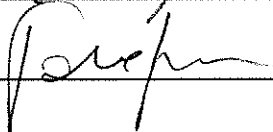
L'attività di ricerca è stata finanziata dal progetto Livestock Smart Farming (PSR 2014-2020 16.1 Regione Umbria)

Perugia, 31/1/2020

L'Assegnista, Lorenzo Germani



Il Docente, Fabrizio Frescura





UNIVERSITÀ DEGLI STUDI  
DI PERUGIA

Allegato N. ....4..... al punto  
dell'ordine del giorno N. ....9.....

## Dipartimento di Ingegneria Università degli Studi di Perugia

Decreto n. 68/2020

### Oggetto:

Approvazione  
"Piano operativo di  
rotazione del  
personale e di  
utilizzo degli spazi  
del Dipartimento",  
attuativo della rev.  
1 dell'Addendum  
sicurezza - fase 2  
al Protocollo di  
gestione delle fasi  
2 e 3  
dell'emergenza  
sanitaria Covid-19;  
nomina addetti  
rilevamento  
temperature

### IL DIRETTORE

**Visti** i DD.PP.CC.MM. relativi all'emergenza epidemiologica da Covid-19 e da ultimo quello del 26 aprile 2020 volto a disciplinare le misure urgenti di contenimento del contagio nella fase 2 a partire dal 4 maggio 2020;

**Visto** il "Protocollo condiviso di regolamentazione delle misure per il contrasto e il contenimento della diffusione del virus Covid-19 negli ambienti di lavoro" del 14 marzo 2020, integrato in data 24 aprile 2020;

**Visto** altresì il documento INAIL del 23 aprile 2020 avente ad oggetto "Documento tecnico sulla possibile rimodulazione delle misure di contenimento del contagio da SARS-CoV-2 nei luoghi di lavoro e strategie di prevenzione";

**Vista** la Direttiva n. 3/2020 del Ministro della Pubblica Amministrazione avente ad oggetto "Modalità di svolgimento della prestazione lavorativa nell'evolversi della situazione epidemiologica da parte delle pubblicazione amministrazioni";

**Visti** da ultimo il DPCM 17 maggio 2020 e il D.L. n. 34 del 19 maggio 2020 avente ad oggetto "Misure urgenti in materia di salute, sostegno al lavoro e all'economia, nonché di politiche sociali connesse all'emergenza epidemiologica da Covid-19";

**Visto** il D.R. n. 756 del 8.5.2020, ratificato dal Senato Accademico e dal Consiglio di Amministrazione nelle sedute del 28 e 29 aprile 2020, con i quali sono stati approvati il "Protocollo di gestione delle fasi 2 e 3 dell'emergenza sanitaria Covid-19 (versione n. 2 del 30.04.2020)" e l'Addendum "Sicurezza", pubblicati nel portale di Ateneo alla sezione Coronavirus;

**Visto** il D.R. n. 909 del 27.05.2020 con il quale è stata approvata la rev. 1 del 25 maggio 2020 dell'addendum sicurezza, pubblicata nel portale di Ateneo;

**Viste** le note rettorali prot. 42709 del 8.5.2020 e prot. 47031 del 26.05.2020 con le quali sono stati invitati i Direttori dei Dipartimenti e dei Centri a presentare i propri piani operativi di rotazione del personale e di accesso e utilizzo degli spazi, funzionali all'avvio della fase 2, in attuazione all'Addendum sicurezza sopra richiamato;

**Visto** il D.R. n. 909 del 27.05.2020 con il quale è stata approvata la rev. 1 del 25 maggio 2020 dell'addendum sicurezza, pubblicata nel portale di Ateneo;

**Viste** le note rettorali prot. 42709 del 8.5.2020 e prot. 47031 del 26.05.2020 con le quali sono stati invitati i Direttori dei Dipartimenti e dei Centri a presentare i propri piani operativi di rotazione del

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Direttore  
Segretario Amministrativo  
Segreteria Amministrativa  
Segreteria Didattica

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Tel: +3975 585 3605-3603-3604



personale e di accesso e utilizzo degli spazi, funzionali all'avvio della fase 2, in attuazione all'Addendum sicurezza sopra richiamato;

**Considerato** che, a seguito di accordi tra i Direttori delle strutture aventi sede nel Polo di Ingegneria di Perugia (Centro Interuniversitario di Ricerca sull'Inquinamento da Agenti Fisici, Dipartimento di Ingegneria e Dipartimento di Ingegneria Civile ed Ambientale), è stato redatto un documento unico, allegato al presente decreto per farne parte integrante e sostanziale;

**Ravvisata** la necessità di incaricare espressamente gli addetti alle operazioni di rilievo della temperatura con termoscanner, indicati nella tabella in calce al documento sopra citato;

**Dato atto** che il personale indicato ha espressamente accettato l'incarico in questione;

**Ravvisata** l'urgenza di approvare il piano operativo e la designazione degli addetti con decreto, in quanto non stata prevista a breve la convocazione di un Consiglio di Dipartimento;

#### DECRETA

1. Di approvare il Piano operativo esecutivo dell'Addendum sicurezza - fase 2 al Protocollo di gestione delle fasi 2 e 3 dell'emergenza sanitaria Covid-19, nel testo allegato al presente decreto;
2. Di incaricare alle operazioni di rilievo della temperatura con termoscanner per il Dipartimento di Ingegneria Civile e Ambientale i dipendenti Colazza Cinzia, Gigli Ivo, Meattelli Fabio, Ricci Vitiani Marco (con funzioni di responsabile), Trancanelli Fosco;
3. Di trasmettere il presente decreto all'amministrazione di Ateneo per i provvedimenti di competenza.

Il presente decreto sarà portato a ratifica nel prossimo Consiglio di Dipartimento.

Perugia, 28/05/2020

Il Direttore  
F.to Prof. Ermanno Cardelli





UNIVERSITÀ DEGLI STUDI  
DI PERUGIA

Allegato N. ....2..... al punto  
dell'ordine del giorno N. ....9.....

**UNIVERSITÀ DEGLI STUDI DI PERUGIA**  
**Dipartimento di Ingegneria**

**Decreto n. 69 del 29/05/2020**

**IL DIRETTORE**

**VISTI** gli artt. 41 dello Statuto e 94 del Regolamento Generale di Ateneo;  
**CONSIDERATO** l'art. 10 del Regolamento di funzionamento del Dipartimento di Ingegneria;

**VISTO** La convenzione proposta dalla Soc. SEAC SRL- avente per oggetto **Digital Value Chain (DVC)**: "*Ricerca e applicazione di soluzioni di machine learning per la digitalizzazione degli spazi retail*";

**CONSIDERATO** che l'azienda SEAC SRL ha necessità di procedere alla formalizzazione dei contratti tra l'Università e l'RTI, costituita da Confcommercio Holding e Nexus & Soci, procedura essenziale per la conferma delle graduatorie entro il 3 giugno del 2020.

**VISTA** pertanto l'urgenza di approvare la sottoscrizione della convenzione proposta dalla Soc. SEAC SRL;

**DECRETA**

- Di approvare la sottoscrizione della Convenzione con la Società SEAC SRL dal tema: : **Digital Value Chain (DVC)**: "*Ricerca e applicazione di soluzioni di machine learning per la digitalizzazione degli spazi retail*", il cui responsabile scientifico è il prof. Paolo Valigi;

- Di accettare, per lo sviluppo delle attività di ricerca, il corrispettivo proposto pari ad € 15.000,00 + IVA, come specificato nell'art.5 della Convenzione;

Il presente decreto sarà sottoposto a ratifica del prossimo Consiglio di Dipartimento.

Perugia, 29/05/2020

Il Direttore

F.to Prof. Ermanno Cardelli

**Oggetto:**  
**Approvazione**  
**Convenzione** di  
**ricerca**  
DING/UNIPG e  
Soc. SEAC SRL-  
progetto: **Digital**  
**Value Chain**  
**(DVC)**: "*Ricerca*  
*e applicazione di*  
*soluzioni di*  
*machine learning*  
*per la*  
*digitalizzazione*  
*degli spazi retail* "

**DIPARTIMENTO DI INGEGNERIA**

Via G. Duranti, 93  
06125 Perugia

Direttore  
Segretario Amministrativo  
Segreteria Amministrativa  
Segreteria Didattica

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UNIVERSITÀ DEGLI STUDI  
DI PERUGIA

DIPARTIMENTO DI INGEGNERIA

Allegato N. 3 al punto  
dell'ordine del giorno N. 9

8 giugno 2020

Prot n. 50390

Decreto n.70

Determinazione del contingente riservato agli studenti cinesi partecipanti al Progetto  
"Marco Polo"- a.a. 2021/2022

IL DIRETTORE

Vista la nota della Ripartizione Didattica del 03.06.2020 prot.n.48412;  
Sentiti i presidenti dei corsi di studio;  
Ritenuta la propria competenza;

DECRETA

di stabilire per l'a.a. 2021/2022, il seguente contingente riservato agli studenti  
cinesi - Progetto "Marco Polo", come riportato in allegato (scheda B):

**corsi di laurea**

L-8 Ingegneria Informatica ed Elettronica	5
L-9 Ingegneria Meccanica	5
L-9 Ingegneria Industriale	5

**corsi di laurea magistrale**

LM-32 Ingegneria Informatica e Robotica	5
LM-29 Ingegneria Elettronica per l'Internet of Things	5
LM-33 Ingegneria Meccanica	5
LM-33 Ingegneria Industriale	5
LM-26 Ingegneria della Sicurezza per il Territorio e il Costruito	5

Il presente decreto sarà portato a ratifica del prossimo consiglio di dipartimento.



IL DIRETTORE  
F.to Prof. Ing. Ermanno Cardelli

Via G. Duranti, 93  
06125 Perugia

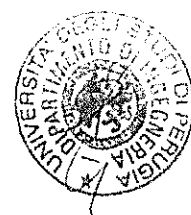
Direttore  
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Scheda B

Dipartimento di Ingegneria AA 2021/2022

	Contingente stranieri (A)	Contingente "Marco Polo" (B)	Contingente Riserve Paese (C)	Posti Totali (A+B+C)	Eventuale Soprannumero Borsisti Governo Italiano
<b>Corsi di laurea</b>					
L-8 INGEGNERIA INFORMATICA ED ELETTRONICA		5			
L-9 INGEGNERIA MECCANICA		5			
L-9 INGEGNERIA INDUSTRIALE (Terni)		5			
<b>Corsi di laurea magistrale</b>					
LM-33 INGEGNERIA MECCANICA		5			
LM-32 INGEGNERIA INFORMATICA E ROBOTICA		5			
LM-29 INGEGNERIA ELETTRONICA PER L'INTERNET-OF-THINGS		5			
LM-33 INGEGNERIA INDUSTRIALE (Terni)		5			
LM-26 INGEGNERIA DELLA SICUREZZA PER IL TERRITORIO E IL COSTRUITO		5			







Allegato N. .... al punto  
dell'ordine del giorno N. ....

## UNIVERSITA DEGLI STUDI DI PERUGIA

### Dipartimento di Ingegneria

D.S.A. n. 5/2020

### Il Segretario Amministrativo

**Oggetto:** Disposizioni per movimentazioni interne  
**Prelievo quota funzionamento dipartimento anni 2017-2018**  
**Conguagli telefonici SIM mobili anni 2017-2018**

**VISTA** la Legge n. 240/2010;  
**VISTO** il vigente Regolamento per l'amministrazione, la finanza e la contabilità dell'Università degli Studi di Perugia;  
**VISTO** il nuovo Regolamento per l'attività conto terzi, emanato con D.R. n.201 del 18/02/2015, approvato dal Senato Accademico e dal Consiglio di Amministrazione nelle sedute del 04/02/2015;  
**VISTA** la delibera n. 8/1 del Consiglio di Dipartimento del 28/06/2018 dove si definisce la quota fissa pro capite annua per la copertura delle spese di funzionamento del dipartimento, quali: carta, telefoni fissi, copie e fotocopie, manutenzioni straordinarie per le segreterie e fondo di riserva, individuata per € 250,00;  
**VISTI** i piani finanziari relativi agli anni 2017 e 2018, redatti, ai sensi degli art.9 e 10 del sopracitato regolamento per l'attività conto terzi, dai singoli responsabili scientifici dei progetti conto terzi nonché le indicazioni per il prelievo su progetti di ricerca di natura istituzionale e dai quali risulta una quota forfettaria per complessivi € **35.994,54** (trentacinquemilanovecentonovantaquattro/54) da destinare ad attività di supporto alle ricerche in atto nonché a programmi di ricerca di interesse generale del Dipartimento;  
**CONSIDERATO** che alla data del 31/12/2018 sono stati conteggiati conguagli telefonici per gli anni 2017 -2018 sulle proprie SIM mobili di tutti gli afferenti al Dipartimento di Ingegneria per un importo di € **29.218,67** (ventinovemiladuecentodiciotto/51)  
**CONSIDERATO** che, la predisposizione di una procedura contabile mediante trasferimento interno per l'assegnazione delle citate risorse, utilizzabili per costi a sostegno delle spese generali ed in ogni caso per attività di interesse comune della Struttura, garantisce una più agevole e opportuna corretta imputazione del singolo costo imputato a carico di ciascun PJ indicato dal rispettivo responsabile, assicurando il corretto funzionamento del metodo "cost to cost";  
**CONSIDERATO** che l'ammontare complessivo pari ad € 65.213,21 dei trasferimenti sopradescritti comporta una variazione contestuale di ricavo e di costo correlata ad entrate finalizzate in forza di legge, di atti contrattuali o convenzionali o di delibere degli Organi, non prevista nel Bilancio Unico di Previsione 2020;  
**RITENUTO** di dover procedere quindi alle necessarie e relative variazioni di bilancio;

### DECRETA

*di autorizzare, a seguito del trasferimento interno, in premessa indicato, per complessivi € 65.213,21 suddiviso per le quote di seguito riportate a gravare sui PJ a fianco di ciascuna indicati :*





BIDINI GIANNI	41EAEA09UD	€ 605,39
	SOLID17GB	€ 73,55
	ISER15GBID	€ 2,12
	PONFCL14GB	€ 206,33
	41CONVI4GB	€ 4,50
	41RIVA14GB	€ 0,55
	ISE16GB	€ 699,41
	41ELMA12UD	€ 4,54
BORRI ANTONIO	RELUIS18AB	€ 500,00
BRACCESI CLAUDIO	PREST16CBR -	€ 62,04
	41CONVI4CB	€ 204,00
	41ZAMP10CB	€ 218,12
	41ZAMP12CB	€ 15,84
	41SISA11CB	€ 444,92
BURRASCANO PIETRO	CEM15PB	€ 770,55
CARBONE PAOLO	RICVARPC	€ 814,06
	SVILU15PC	€ 27,01
	SIOPG16PC	€ 25,25
CARDELLI ERMANN CONTI PAOLO	41PRES14EC	€ 746,93
	41RIVA14PC	€ 1,82
	41CONVI4PC	€ 649,92
COTANA FRANCO	POLIMA16FC	€ 278,30
	PCOTANA	€ 1.413,75
FRANCESCHINI GIORDANO	41RIVA14GF	€ 397,82
	41OFFII4GF	€ 102,18
GRIMALDI CARLO NAZARENO	FEDMOG15CG	€ 30,59
	41NARD13CG	€ 6,00
	41MARE08CG	€ 3,31
	41SOLF12CG	€ 46,60
	41SOST13CG	€ 1.210,26
LIOTTA GIUSEPPE	40PRIN12GL	€ 212,50
	RICVARGL	€ 587,44
	40VARDIR	€ 22,88
MONGIARDO MAURO	PREST16RS	€ 21,74
	40THFILERS	€ 543,98
PANE VINCENZO	RELUIS16VP	€ 500,00
PUCCI EDVIGE	41FLOR14EP	€ 1.322,44
RADICIONI FABIO	SIII4FRAD	€ 39,50
	PREST18FR	€ 455,87



ROSSI GIANLUCA	41CONV14GR	€ 9,36
	41RICV14GR	€ 5,06
	RECRICVAR17GR	€ 819,19
	41SIGI12GR	€ 281,81
	ROSATI16RM	€ 8,13
	PRIN2015_ROSSI	€ 1.379,22
SACCOMANDI GIUSEPPE	SVUM15SATI	€ 660,31
SORRENTINO ROBERTO 2017	40THFILERS	€ 882,84
VALIGI PAOLO	ART17PV -	€ 860,95
BANELLI PAOLO	ENIACFEA	€ 1.253,30
BARELLI LINDA	TVBMISE16LB	€ 1.100,09
BIANCONI FRANCESCO	PREST17FB -	€ 7,19
	41PRES14FB -	€ 4,68
	PREST18FB	€ 488,13
BURATTI CINZIA	PRESTVA15CBU	€ 254,01
	TAKECO17CB	€ 1.070,26
CASTELLANI FRANCESCO	DELVIC15FC	€ 500,00
	FAIS14FCAS	€ 848,26
CIANETTI FILIPPO	CONV15FC	€ 10,43
	41SCIE13FC	€ 946,25
DIDIMO WALTER	CONV14WD	€ 7,52
	ETI316WD	€ 1,83
	GDOC15WD	€ 3,96
	RICVARWD	€ 12,28
	COLLEGALI18EDG	€ 773,79
DI GIACOMO EMILIO	COLLEGALI18EDG	€ 778,97
DI MARIA FRANCESCO	41MIPA09FD	€ 42,59
	41PSR13FD	€ 360,30
	41RICV14FD	€ 207,09
	41RIVA14FD	€ 125,76
	CONV15FD -	€ 72,39
	POLOE14FDM	€ 104,15
	ATBASRICFDM	€ 90,64
	AISA19FDM	€ 213,73
DI SCHINO ANDREA	PREST19AD	€ 27,52
	SEAM16ASSC	€ 642,26
FANTOZZI FRANCESCO	IREXFO17FF	€ 1.481,00
FRAVOLINI MARIO LUCA	XIBO14AF	€ 834,22



MARIANI FRANCESCO	NARD14FMA	€ 69,82
	UMBRIN14FM	€ 429,18
	41ANGE09FM	€ 581,61
MEZZANOTTE PAOLO	40ATCOPM	€ 179,72
	40SAIPEMPM	€ 116,39
	40RIVAPM	€ 350,16
NICOLINI ANDREA	ATBASERIAN	€ 72,42
PASSERI DANIELE	40MICRO08DP	€ 768,37
POSTRIOTI LUCIO	MAMARE14LP	€ 951,83
REALI GIANLUCA	PUCCUFF18GR	€ 77,00
	40RIVAGR	€ 756,28
ROSELLI LUCA	40RIVALR	€ 777,94
	RICVARLR	€ 349,45
ROSSI FEDERICO	41PRIN08FR	€ 91,45
	PRIN_2017ROSSI	€ 475,05
SAETTA STEFANO	41RIVA14SS	€ 887,07
ANTONIO SCORZONI	40RFMT12AS	€ 275,25
ANDREA SENIN NICOLA	CONV15NS	€ 751,36
SPERANZINI EMANUELA	RELUIS18AB	€ 500,00
STOPPINI AURELIO	TOPCON15FR	€ 500,00
TIACCI LORENZO	CONV15LT	€ 829,27
VALIGI MARIA CRISTINA	41OMGA14CV	€ 500,00
ALIMENTI FEDERICO	ENIACFEA	€ 915,74
BALDINELLI GIORGIO	MONE16GB	€ 212,26
	3M16GB	€ 583,91
BARUFFA GIUSEPPE	ENIACFEA	€ 701,78
BATTISTONI MICHELE	41RIVA14MB	€ 34,54
	41ENFO10MB	€ 97,28
	41MAGM12MB	€ 1.110,64



BINUCCI CARLA	ATBASRICCB	€ 652,83
	BASENG16CB	€ 83,44
BONAFONI	RICVARSB	€ 675,97
STEFANIA		
CASTORI GIULIO	RELUIS18AB	€ 250,00
2017		
CECCONI	ATBASERICMC	€ 500,00
MANUELA		
CINTI GIOVANNI	ENVIU19GC	€ 500,00
CORRADI MARCO	RELUIS18AB	€ 500,00
DE ANGELIS	GIORI15ADA	€ 500,00
ALESSIO		
DIONIGI MARCO	RFMC18MD	€ 510,10
	RFMC15MD	€ 193,15
DISCEPOLI	41SOST13CG	€ 500,00
GABRIELE		
FABA ANTONIO	PREST15ANF	€ 1.023,60
FEMMINELLA	40RADL12MF	€ 878,63
MAURO		
FICOLA ANTONIO	XIBO14AF	€ 500,00
FILIPPONI MIRKO	TRRETI18MF	€ 500,00
	MECUM17MF	€ 159,14
	VUETE16FF	€ 1.086,45
FRESCURA		
FABRIZIO		
GRILLI LUCA	COLLEGALI18EDG	€ 83,84
	PRIN_2017ROSSI	€ 416,16
	PREST15LL	€ 6,69
LANDI LUCA	41COME11LL	€ 225,71
	PEAR15LL	€ 267,60
MARSILI ROBERTO	41RIVA14RM	€ 263,82
	41CONV14RM	€ 785,12
MORETTI ELISA	ENEAI7EM	€ 500,00
MORETTI MICHELE	41PRESI4EC	€ 500,00
MOSCHITTA	ATBASERICAM	€ 943,00
ANTONIO		
PLACIDI PISANA	ATBASERICPP	€ 752,47
RICCI MARCO	NDTONAIR16MR -	€ 484,66
2017		
RUGINI LUCA	ENIACFEA -	€ 724,25
SENNI LUCA	AST17LS	€ 250,00
TOMASSONI	RFMICH17CT	€ 322,37
CRISTIANO		
	RFMI19CT	€ 448,66
VENANZONI	40THFILERS	€ 500,00
GIUSEPPE		
VERDUCCI PAOLO	ATBASERICPV	€ 90,98
	DIGA18MC	€ 1.731,57
VERGORI LUIGI	ATBASERICLV	€ 500,00
VINCENTI GATTI	PRESTI6VGA	€ 500,00
ROBERTO		
ZANETTI	PRESVA15EZ	€ 1.516,29
ELISABETTA		



Pag. n. 6 del D.S.A. n. 5/2020

BIDINI GIANNI	4IENEA09UD	€ 605,39
	SOLID17GB	€ 73,55
	ISER15GBID	€ 2,12
	PONFCL14GB	€ 206,33
	4ICONV14GB	€ 4,50

e del *reincameramento della suddetta somma nei trasferimenti interni di ricavo (voce COAN CA.03.05.01.12.01 "Trasferimenti Interni Vari")*, la conseguente variazione:

*Voce COAN*

CA.03.05.01.12.01 "Trasferimenti Interni Vari"

UA.PG.RICVARDING	+ € 12.753,77
UA.PG.DINGUTENZE	+ € 52.459,44

*Totale*

+ € 65.213,21

*Voce COAN*

CA.04.09.09.01.03 "Cancelleria e altro materiale di consumo"

UA.PG.RICVARDING	+ € 12.753,77
UA.PG.DINGUTENZE	+ € 52.459,44

*Totale*

+ € 65.213,21

Di trasmettere scansione dell'originale del presente decreto al Collegio dei Revisori dei Conti, come previsto dall'art.32 del vigente Regolamento per l'amministrazione, la finanza e la contabilità, richiamato in premessa.

Il presente decreto sarà portato a ratifica del Consiglio di Dipartimento nella prima seduta utile.

Perugia, 17/03/2020

Il Segretario Amministrativo  
Dipartimento di Ingegneria

F.to Sig. Giovanni Magara



Allegato N. 2 al punto  
dell'ordine del giorno N. 11

**UNIVERSITA DEGLI STUDI DI PERUGIA**  
**Dipartimento di Ingegneria**

**D.S.A. n. 6/2020**

**Il Segretario Amministrativo**

**VISTA** la Legge n. 240/2010;

**VISTO** il vigente Regolamento per l'amministrazione, la finanza e la contabilità dell'Università degli Studi di Perugia;

**Oggetto:**

Disposizioni per  
Nuovo assegno di  
ricerca proponente:  
Prof. F. Cianetti  
**Autorizzazione**  
**Ufficio Compensi**  
**pagamento stipendi**

**VISTA** la nota del Dirigente della Ripartizione Gestione Risorse Finanziarie prot. N. 3449 del 03.02.2015 recante "*Note operative U.GOV – modalità di attivazione/proroga/rinnovi assegni di ricerca ...*"

**VISTA** la direttoriale prot. n. 92123 del 15/12/2016 e la successiva prot. n. 116080 del 21/10/2019 relative alle nuove modalità per l'attivazione di Assegni di ricerca su nuovi finanziamenti acquisiti a partire dall'esercizio 2017, dalla quale si evince chiaramente che per tutte le richieste inoltre dai sotto elencati docenti rientrano nella nuova modalità;

**VISTA** la richiesta inoltrata dal **Prof. Filippo Cianetti- SSD- ING-IND/04** per un nuovo assegno di ricerca annuale, dal titolo: "*Progettazione/verifica sia funzionale che strutturale del nano satellite oggetto del progetto di ricerca e Sviluppo delle tecniche di qualifica strutturale vibrazionale per la sua validazione numerica e sperimentale*" per un importo di pari ad € 23.800 (EURO ventitremilaottocento/00);

**CONSIDERATO** che il costo del suddetto nuovo assegno sarà garantito con fondi appostati sul progetto: UA.PG.DING.CONVENZIONE\_ASI\_DING assegnati alla voce di costo: CA.04.08.01.02.01 sotto la macro voce "Finanziamento Assegni di Ricerca" di cui è responsabile IL Prof. Marco Dionigi;

**VISTA** la delibera n. 3/1 del Consiglio di Dipartimento del 26/02/2020 con cui è stato autorizzato il sopradescritto nuovo assegno proposto dal Prof. Filippo Cianetti;

Per quanto sopra esposto;

**DECRETA**

1) di autorizzare l'Ufficio Compensi ai successivi pagamenti delle mensilità spettanti al vincitore del nuovo assegno di ricerca richiesto dal

- Prof. F. Cianetti a gravare su fondi appostati sulla voce di costo: CA.04.08.01.02.01 sotto la macro voce "Finanziamento Assegni di Ricerca" PJ: UA.PG.DING.CONVENZIONE\_ASI\_DING per un totale di € 23.800,00;

Perugia, 17/03/2020

Il Segretario Amministrativo  
Dipartimento di Ingegneria  
F.to Sig. Giovanni Magara



Allegato n. 3 al punto  
dell'ordine del giorno n. 1

## UNIVERSITA' DEGLI STUDI DI PERUGIA

Dipartimento di Ingegneria

D.S.A. n.7/2020

**Oggetto:**

Variazione al Bilancio  
Unico di Previsione  
Autorizzatorio - Esercizio  
2020

### Il Segretario Amministrativo

**VISTO** l'art. 32 comma 1 - lett. e) del Regolamento per l'Amministrazione la Finanza e la Contabilità dell'Università degli Studi di Perugia attualmente vigente;  
**CONSIDERATO** che tutte le somme disponibili al 31.12.2019, assegnate ai Progetti di pertinenza, derivanti da rapporti convenzionali e/o contratti per lo sviluppo di ricerca di natura, sia istituzionale che commerciale, con enti pubblici e privati sono state considerate grandezze vincolate ed in quanto tali, riportate nel Budget Economico e nel Budget investimenti dell'esercizio finanziario 2020 mantenendo l'assegnazione ai Progetti di origine;

**PRESO ATTO** delle richieste per lo spostamento delle risorse finanziarie dal Budget Investimenti al Budget Economico, pervenute all'Amministrazione del Dipartimento, presentate da vari responsabili di progetto, per un ammontare complessivo di € 30.459,88 per le voci COAN indicate:

CA.04.09.09.01.03 - Cancelleria e altro materiale di consumo - € 26.549,92;

CA 04.08.01.05.01 - Costo per competenze fisse per altro personale dedicato alla ricerca ed alla didattica - € 3.152,21;

CA.04.08.01.01.05- Indennità di missione, rimborsi spese viaggi e iscrizione a convegni del personale docente e ricercatori - € 757,75.

**CONSIDERATO** che al fine di consentire una corretta imputazione dei costi aventi natura economica e/o di investimento nei singoli progetti di ricerca si ritiene opportuno appostare le disponibilità finanziarie nelle corrispondenti voci COAN come di seguito indicato:

CA 01.10.02.07.01 – Apparecchiature di natura informatica - € 14.952,51;

CA 01.10.02.05.01 – Mobili e arredi - € 5.000,00;

CA 01.10.02.03.01 – Attrezzature per la ricerca scientifica € 10.507,37;

**RITENUTO** necessario ed urgente procedere alle relative variazioni al Bilancio Unico di Ateneo di previsione annuale autorizzatorio dell'esercizio finanziario 2020;

### DECRETA

di proporre all'Ufficio Budgeting e Bilancio Unico di Ateneo la seguente variazione al Bilancio Unico di Previsione Autorizzatorio dell'esercizio finanziario 2020:

**costi - UA.PG.DING**

CA.04.09.09.01.03 - Cancelleria e altro materiale di consumo	- € 26.549,92
CA 04.08.01.05.01 - Costo per competenze fisse per altro personale dedicato alla ricerca ed alla didattica	- € 3.152,21
CA.04.08.01.01.05- Indennità di missione, rimborsi spese viaggi e iscrizione a convegni del personale docente e ricercatori	- € 757,75

**costi - UA.PG.DING**

CA 01.10.02.07.01 – Apparecchiature di natura informatica	+ € 14.952,51
CA 01.10.02.05.01 – Mobili e arredi	+ € 5.000,00
CA 01.10.02.03.01 – Attrezzature per la ricerca scientifica	+ € 10.507,37

Il presente decreto viene trasmesso all'Ufficio Bilancio Consolidato, Coordinamento e controllo Centri Istituzionali e Centri di Servizio per quanto di competenza e sarà portato a ratifica del Consiglio di Dipartimento nella prima seduta utile.

Perugia,02/04/2020

Il Segretario Amministrativo

F.to Sig. Giovanni Magara





Allegato N. 4 al punto  
dell'ordine del giorno N. 11

**UNIVERSITA DEGLI STUDI DI PERUGIA**  
**Dipartimento di Ingegneria**

**D.S.A. n.08/2020**

**Il Segretario Amministrativo**

**VISTA** la Legge n. 240/2010;

**VISTO** il vigente Regolamento per l'amministrazione, la finanza e la contabilità dell'Università degli Studi di Perugia;

**Oggetto:**

Disposizioni per  
finanziamento n.1  
posto di ricercatore a  
T.D., ex art.24, c.3,  
lettera a) L.  
n.240/2010

proponente Prof.  
Federico Rossi

**Autorizzazione**

Ufficio Stipendi  
pagamento mensilità

**VISTA** la richiesta inoltrata dal Prof. Federico Rossi, per l'attivazione delle procedure necessarie all'emanazione di un bando per l'assunzione **di un ricercatore universitario, con rapporto di lavoro subordinato a tempo determinato, con regime di impegno a tempo definito, ai sensi e per gli effetti dell'art.24, comma3, lettera a) della Legge 240/2010– SC 09/C2 S.S.D. ING-IND/10 per un periodo di tre anni, eventualmente prorogabile per ulteriori due** al fine di poter realizzare il progetto di ricerca dal titolo "Sistemi innovativi per il recupero del gas naturale ed il sequestro dell'anidride carbonica" per un importo pari di € 118.209,78 (EURO centodiciottomiladuecentonove/78);

**VISTA** la nota del Dirigente della Ripartizione Gestione Risorse Finanziarie prot. N. 3449 del 03.02.2015 recante "Note operative U.GOV – modalità di attivazione/proroga/rinnovi assegni di ricerca ..."

**VISTA** la direttoriale prot. n. 92123 del 15/12/2016 relativa alle nuove modalità per l'attivazione di "Assegni di ricerca....." su nuovi finanziamenti acquisiti a partire dall'esercizio 2017, dalla quale si evince chiaramente che per la richiesta inoltra dal Prof. F.Rossi rientra nella nuova modalità;

**CONSIDERATO** che il costo del suddetto nuovo contratto per un ricercatore universitario T.D. sarà garantito con fondi appostati alla macrovoce "Finanziamento Ricercatori T.D." del PJ: UA.PG.DING.PRIN\_2017ROSSI di cui il richiedente è responsabile;

**DECRETA**

di autorizzare l'Ufficio Stipendi ai successivi pagamenti delle mensilità spettante al vincitore della selezione di riferimento a gravare su fondi appostati sulla macrovoce "Finanziamento Ricercatori T.D.": UA.PG. DING. PRIN\_2017ROSSI per un totale di € 118.209,78 (EURO centodiciottomiladuecentonove/78) di cui è responsabile il Prof.Federico Rossi.

Il presente decreto sarà portato a ratifica del prossimo Consiglio di Dipartimento.  
Perugia, 02/04/2020

Il Segretario Amministrativo  
Dipartimento di Ingegneria  
F.to Sig. Giovanni Magara



Allegato N. 5 al punto  
dell'ordine di giorno N. 11

**UNIVERSITA DEGLI STUDI DI PERUGIA**  
**Dipartimento di Ingegneria**

**D.S.A. n. 9/2020**

**Il Segretario Amministrativo**

**VISTA** la Legge n. 240/2010;

**VISTO** il vigente Regolamento per l'amministrazione, la finanza e la contabilità dell'Università degli Studi di Perugia;

**VISTA** la richiesta inoltrata dalla **Dott.ssa A. L. Pisello** - SSD- ING-IND/11 per il rinnovo dell'assegno di ricerca già titolare la Dott.ssa Claudia Fabiani, dal titolo: "*G-A. 764025 Development and validation of an innovative solar compact selective – water sorbent based heating system*" per un importo pari di € 28.000,00 (EURO ventottomila);

**VISTA** la nota del Dirigente della Ripartizione Gestione Risorse Finanziarie prot. N. 3449 del 03.02.2015 recante "*Note operative U.GOV – modalità di attivazione/proroga/rinnovi assegni di ricerca ...*"

**VISTA** la direttoriale prot. n. 92123 del 15/12/2016 relativa alle nuove modalità per l'attivazione di Assegni di ricerca su nuovi finanziamenti acquisiti a partire dall'esercizio 2017, dalla quale si evince chiaramente che per la richiesta inoltra dalla Dott.ssa A.L. Pisello rientra nella nuova modalità;

**CONSIDERATO** che il costo del suddetto nuovo assegno sarà garantito con fondi appostati sulla voce COAN CA. 04.08.01.02.01 - Assegni di ricerca alla macrovoce "Finanziamento Assegni di Ricerca" del PJ: UA.PG.DING.SWEHEATING17ALP di cui la richiedente è responsabile;

**DECRETA**

di autorizzare l'Ufficio Compensi ai successivi pagamenti delle mensilità spettante alla Dott.ssa Claudia Fabiani a gravare su fondi appostati sulla macrovoce "Finanziamento per Assegni di Ricerca": UA.PG. DING.SWEHEATING17ALP per un totale di € 28.000,00 di cui è responsabile la Dott.ssa A.L. Pisello.

Il presente decreto sarà portato a ratifica del prossimo Consiglio di Dipartimento.  
Perugia, 15/04/2020

Il Segretario Amministrativo  
Dipartimento di Ingegneria  
F.to Sig. Giovanni Magara

**Oggetto:**

Disposizioni per  
Rinnovo assegno di  
ricerca già Titolare la  
Dott.ssa Claudia  
Fabiani proponente  
Dott.ssa A. L. Pisello  
**Autorizzazione**  
**Ufficio Compensi**  
**pagamento stipendi**





Allegato N. 6 al punto  
dell'ordine del giorno N. 14

**UNIVERSITÀ DEGLI STUDI DI PERUGIA**  
**Dipartimento di Ingegneria**

**D.S.A. n. 10/2020**

**Il Segretario Amministrativo**

**Oggetto:**

**VISTI** gli art. 60 e 61 del vigente Regolamento per l'Amministrazione, la Finanza e la Contabilità dell'Università degli Studi di Perugia ;

**Autorizzazione**

all'acquisto di beni e servizi informatici all'esterno del Mercato Elettronico della P.A. in deroga all'obbligo di cui all'art. 1 - commi 512 e 514 - della legge 208/2015 (Disposizioni per la formazione del bilancio annuale e pluriennale dello Stato)

**VISTO** l'art. 1 comma 450 del L. 296/2006, come modificato dall'art. 22 comma 8 L. 114/2014, dall'art. 1 commi 495 e 502 L. 208/2015 e dall'art. 1 comma 1 L. 10/2016, circa gli obblighi per le amministrazioni pubbliche di far ricorso al mercato elettronico della pubblica amministrazione (Me.PA.) per gli acquisti di beni e servizi di importo pari o superiore a 1.000,00 euro e al di sotto della soglia di rilievo comunitario, ovvero di fare ricorso ad altri mercati elettronici istituiti ai sensi dell'art. 328 del DPR 207/2010;

**VISTI** i commi 512 e 514 dell'art. 1 della legge della legge 208/2015 (Disposizioni per la formazione del bilancio annuale e pluriennale dello Stato);

**VISTA** la Legge n. 208/2015 - Disposizioni per la formazione del bilancio annuale e pluriennale dello Stato (legge di stabilità 2016), che in particolare all'art. 1, comma 516 recita "Le amministrazioni e le società di cui al comma 512 possono procedere ad approvvigionamenti al di fuori delle modalità di cui ai commi 512 e 514 esclusivamente a seguito di apposita autorizzazione motivata dell'organo di vertice amministrativo, qualora il bene o il servizio non sia disponibile o idoneo al soddisfacimento dello specifico fabbisogno dell'amministrazione ovvero in casi di necessità ed urgenza comunque funzionali ad assicurare la continuità della gestione amministrativa. Gli approvvigionamenti effettuati ai sensi del presente comma sono comunicati all'Autorità nazionale anti-corruzione e all'Agid;

**VISTA** la delibera della Corte dei Conti - Sezione Regionale Di Controllo Per L'Umbria n. 52/2016/PAR - in particolare laddove recita "Più in dettaglio si contempla la possibilità di approvvigionamento al di fuori delle modalità previste dal citato comma 512 solamente in alcuni casi (autorizzazione motivata dell'organo di vertice amministrativo, solo per beni non disponibili o idonei o nei casi di necessità ed urgenza, con comunicazione all'Anac e all'Agid- comma 516). Inoltre la mancata osservanza delle disposizioni dettate in materia rileva ai fini della responsabilità disciplinare e per danno erariale (comma 517)";

**VISTA** la richiesta inoltrata dal prof. Federico CIANETTI in data 05/03/2019, per l'acquisto di "Licenza MSC (150 users) + Manutenzione software da 1/12/2020 a 31/11/2023";

**Preso atto** che, come da dichiarazione del richiedente, e relativa dichiarazione dell'operatore economico, tale software è prodotto e distribuito in via esclusiva da "MSC software GmbH - Monaco di Baviera - Germania";

**VERIFICATO** che il sopracitato operatore economico non è presente sul MePA;

**CONSIDERATO** altresì che le spese del suddetto acquisto graveranno sul PJ:UA.PG.DING.RICBA17FCI, responsabile prof. Filippo CIANETTI, i cui fondi sono



appostati sulla pertinente voce COAN - del Budget economico del Bilancio autorizzatorio dell'esercizio in corso.

### **DECRETA**

di autorizzare la deroga all'obbligo di acquisto di beni e servizi informatici attraverso il Me.PA. per **“Licenza MSC (150 users) + Manutenzione software da 1/12/2020 a 31/11/2022”** per un importo complessivo di EURO 1.770,66 + IVA.

Perugia, 24/04/2020

Il Segretario Amministrativo  
Dipartimento di Ingegneria  
F.to Sig. Giovanni Magara





Allegato N. 7 al punto  
dell'ordine di giorno N. 11/2020

**UNIVERSITÀ DEGLI STUDI DI PERUGIA**  
**Dipartimento di Ingegneria**

**D.S.A. n.11/2020**

**Il Segretario Amministrativo**

**Oggetto:**

**VISTI** gli art. 60 e 61 del vigente Regolamento per l'Amministrazione, la Finanza e la Contabilità dell'Università degli Studi di Perugia - emanato con D.R. n. 389 del 18.03.2013; in vigore dal 1° gennaio 2015 - modificato con D.R. n. 469 del 24.03.2016;

**VISTO** l'art. 1 comma 450 del L. 296/2006, come modificato dall'art. 22 comma 8 L. 114/2014, dall'art. 1 commi 495 e 502 L. 208/2015 e dall'art. 1 comma 1 L. 10/2016, circa gli obblighi per le amministrazioni pubbliche di far ricorso al mercato elettronico della pubblica amministrazione (Me.PA.) per gli acquisti di beni e servizi di importo pari o superiore a 1.000,00 euro e al di sotto della soglia di rilievo comunitario, ovvero di fare ricorso ad altri mercati elettronici istituiti ai sensi dell'art. 328 del DPR 207/2010;

**VISTI** i commi 512 e 514 dell'art. 1 della legge della legge 208/2015 (Disposizioni per la formazione del bilancio annuale e pluriennale dello Stato);

**VISTA** la Legge n. 208/2015 - Disposizioni per la formazione del bilancio annuale e pluriennale dello Stato (legge di stabilità 2016), che in particolare all'art. 1, comma 516 recita "Le amministrazioni e le società di cui al comma 512 possono procedere ad approvvigionamenti al di fuori delle modalità di cui ai commi 512 e 514 esclusivamente a seguito di apposita autorizzazione motivata dell'organo di vertice amministrativo, qualora il bene o il servizio non sia disponibile o idoneo al soddisfacimento dello specifico fabbisogno dell'amministrazione ovvero in casi di necessità ed urgenza comunque funzionali ad assicurare la continuità della gestione amministrativa. Gli approvvigionamenti effettuati ai sensi del presente comma sono comunicati all'Autorità nazionale anti-corruzione e all'Agid;

**VISTA** la delibera della Corte dei Conti - Sezione Regionale Di Controllo Per L'Umbria n. 52/2016/PAR - in particolare laddove recita "Più in dettaglio si contempla la possibilità di approvvigionamento al di fuori delle modalità previste dal citato comma 512 solamente in alcuni casi (autorizzazione motivata dell'organo di vertice amministrativo, solo per beni non disponibili o idonei o nei casi di necessità ed urgenza, con comunicazione all'Anac e all'Agid- comma 516). Inoltre la mancata osservanza delle disposizioni dettate in materia rileva ai fini della responsabilità disciplinare e per danno erariale (comma 517)";

**VISTA** la richiesta inoltrata dal prof. Paolo VALIGI in data 27/03/2019, per l'acquisto di "Rinnovo Licenza MATLAB anno 2020";

**Preso atto** che, come da dichiarazione del richiedente, e relativa dichiarazione dell'operatore economico, tale software è distribuito in via esclusiva per l'Italia da "The Mathworks SrL - Via Bertola 34 - 1022 TORINO - P. IVA 08333270018";

**VERIFICATO** che il sopracitato operatore economico non è presente sul MePA;

**CONSIDERATO** altresì che le spese del suddetto acquisto graveranno sul PJ:UA.PG.DING.40DIDFUNZ\_2014 responsabile prof. Paolo VALIGI, i cui fondi sono



appostati sulla pertinente voce COAN - del Budget economico del Bilancio autorizzatorio dell'esercizio in corso.

### **DECRETA**

di autorizzare la deroga all'obbligo di acquisto di beni e servizi informatici attraverso il Me.PA. per **"Rinnovo Licenza MATLAB anno 2020"** per un importo complessivo di **EURO 820,00 + IVA;**

Perugia, 27/04/2020

Il Segretario Amministrativo  
Dipartimento di Ingegneria

F.to Sig. Giovanni Magara





UNIVERSITÀ DEGLI STUDI  
DI PERUGIA

Allegato II ..... al punto  
dell'ordine del giorno II. ....

## UNIVERSITÀ DEGLI STUDI DI PERUGIA

Dipartimento di Ingegneria

D.S.A. n. 12/2020

### Il Segretario Amministrativo

**VISTO** La legge 240/2010;

**VISTO** il vigente Regolamento per l'amministrazione, la finanza e la contabilità dell'Università degli Studi di Perugia;

**VISTA** la richiesta presentata dal prof. Pietro Burrascano riferita all'attivazione di due nuovi assegni di ricerca per complessivi € 48.000,00, la cui copertura finanziaria sarà garantita con fondi derivanti dal finanziamento del progetto PJ.UA.DING.NDTONAIR16MR

**VISTA** la richiesta presentata dal prof. Antonio Borri riferita all'attivazione di un nuovo assegno di ricerca per € 24.000,00, la cui copertura finanziaria sarà garantita con fondi derivanti dal finanziamento del progetto PJ. UA.PG.DING.RELUIS19AB;

**VISTA** La nota dirigenziale prot. n.92123 del 15/12/2016, recante "note operative sistema contabile UGOV per attivazione/proroga/rinnovi di assegni di ricerca, borse di dottorato, contratti per il personale a tempo determinato, correlati a finanziamenti esterni delle Strutture – Nuove modalità da seguire per i nuovi finanziamenti acquisiti a partire dall'esercizio 2017;

**VISTA** la nota dirigenziale prot. n.116080 del 21/10/2019, recante "note operative per Assegni di ricerca, posti aggiunti Borse di dottorato di ricerca, Ricercatori ed altro personale a tempo determinato c.d. "finanziato" ai fini della gestione del fabbisogno finanziario (DM 11 marzo 2019)";

**CONSIDERATO** che, la predisposizione di una procedura contabile mediante trasferimento interno per l'assegnazione delle citate risorse, necessarie per il sostenimento di costi relativi alla sviluppo di attività di ricerca ed in ogni caso per attività di interesse comune della Struttura, garantisce una più agevole e opportuna corretta imputazione del singolo costo a carico del PJ di riferimento, assicurando il corretto funzionamento del metodo "cost to cost";

**CONSIDERATO** che il trasferimento summenzionato comporta una variazione contestuale di entrata e di spesa correlata ad entrate finalizzate in forza di legge, di atti contrattuali o convenzionali o di delibere degli Organi, non prevista nel Bilancio Unico di Previsione 2020;

**RITENUTO** di dover procedere quindi alle necessarie e relative variazioni di bilancio;

### DECRETA

1) *di autorizzare, a seguito del trasferimento interno, in premessa indicato, per complessivi € 72.000,00 così suddivisi: € 48.000,00 da UA.PG.DING.NDTONAIR16MR e € 24.000,00 da UA.PG.DING.RELUIS19AB e del reincameramento della suddetta somma per complessivi € 72.000,00 nei trasferimenti interni di ricavo (voce COAN CA.03.05.01.12.01 "Trasferimenti Interni Vari"), la conseguente variazione:*

Via G. Duranti, 93  
06125 Perugia

Direttore  
Segretario Amministrativo  
Segreteria Amministrativa  
Segreteria Didattica

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UNIVERSITÀ DEGLI STUDI  
DI PERUGIA

Pag. n. 2 DSA 12/2020

*Voce COAN*

CA.03.05.01.12.01 "Trasferimenti Interni Vari":

PJ:UA.PG.DING. NDTONAIR\_ASSRIC

+ € 48.000,00

PJ:UA.PG.DING. RELUIS\_ASSRIC

+ € 24.000,00

**TOTALE**

+ € **72.000,00**

*Voce COAN*

CA.04.08.01.02.01 "Assegni di Ricerca":

PJ:UA.PG.DING. NDTONAIR\_ASSRIC

+ € 48.000,00

PJ:UA.PG.DING. RELUIS\_ASSRIC

+ € 24.000,00

**TOTALE**

+ € **72.000,00**

2) Di trasmettere scansione dell'originale del presente decreto al Collegio dei Revisori dei Conti, come previsto dall'art.32 del vigente Regolamento per l'amministrazione, la finanza e la contabilità, richiamato in premessa.

Il presente decreto sarà portato a conoscenza del Consiglio di Dipartimento nella prima seduta utile.

Perugia, 30/04/2020

Il Segretario Amministrativo  
Dipartimento di Ingegneria

F.to Sig. Giovanni Magara

Via G. Duranti, 93  
06125 Perugia

Direttore  
Segretario Amministrativo  
Segreteria Amministrativa  
Segreteria Didattica

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UNIVERSITÀ DEGLI STUDI  
DI PERUGIA

**Oggetto:**

autorizzazione al pagamento delle mensilità vincitori delle selezioni per assegni di ricerca autorizzati con D.D. n.62/2020 –DING – a gravare su PJ UA.PG.DING.NDTONAIR\_A SSRIC

Allegato N. .... al punto  
dell'ordine del giorno N. ....

D.S.A. n. 13/2020

IL SEGRETARIO AMMINISTRATIVO

- VISTA la legge n. 240/2010;
- VISTO il vigente Regolamento per l'Amministrazione, la Finanza e la Contabilità;
- VISTA La nota dirigenziale prot. n.92123 del 15/12/2016, recante "note operative sistema contabile UGOV per attivazione/proroga/rinnovi di assegni di ricerca, borse di dottorato, contratti per il personale a tempo determinato, correlati a finanziamenti esterni delle Strutture – Nuove modalità da seguire per i nuovi finanziamenti acquisiti a partire dall'esercizio 2017;
- VISTA la nota dirigenziale prot. n.116080 del 21/10/2019, recante "note operative per Assegni di ricerca, posti aggiunti Borse di dottorato di ricerca, Ricercatori ed altro personale a tempo determinato c.d. "finanziato" ai fini della gestione del fabbisogno finanziario (DM 11 marzo 2019)";
- DATO ATTO che per la valorizzazione originaria del progetto "PJ.UA.PG.DING.NDTONAIR16MR" è stata utilizzata la voce COAN di Ricavo CA.03.01.03.04.01 "Finanziamenti competitivi erogati da Organismi Internazionali;
- RICHIAMATO il D.D. N.62/2020 del 30/04/2020 di autorizzazione per l'attivazione di 2 nuovi assegni di ricerca annuali dal titolo:  
"Sviluppo di procedure di imaging per applicazioni di diagnostica non distruttiva ultrasonora",  
"Sviluppo di algoritmi di post-processing per imaging termografico e a correnti indotte" dell'importo di € 24.000,00 (euro ventiquattromila/00) ciascuno;
- RITENUTO di dover dar seguito a quanto autorizzato dal Direttore nel Decreto in epigrafe;
- per tutto quanto sopra esposto

**DECRETA**

1) che la copertura finanziaria dei due nuovi assegni dal titolo:  
"Sviluppo di procedure di imaging per applicazioni di diagnostica non distruttiva ultrasonora";  
"Sviluppo di algoritmi di post-processing per imaging termografico e a correnti indotte";  
pari a complessivi € 48.0000,00(quarantottomila/00, è assicurata dalle risorse derivanti dal finanziamento del Progetto di Ricerca H2020-MSCA-ITN-2016 "NDTonAIR" Grant Agreement n. 722134, di cui è Responsabile scientifico il prof. Pietro Burrascano, allocate nella macrovoce di costo "Finanziamento Assegni di Ricerca" del PJ UA.PG.DING.NDTONAIR\_ASSRIC;

2) di autorizzare l'Ufficio Compensi dell'Amministrazione Centrale di Ateneo ad effettuare il pagamento delle mensilità, spettanti ai rispettivi vincitori delle selezioni dei suddetti assegni di ricerca, a gravare sul PJ UA.PG.DING.NDTONAIR\_ASSRIC per un ammontare complessivo di € 48.0000,00(quarantottomila/00).

Perugia, 30/04/2020

Il Segretario Amministrativo  
F.to Sig. Giovanni Magara

Via G. Duranti, 93  
06125 Perugia

Direttore  
Segretario Amministrativo  
Segreteria Amministrativa  
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UNIVERSITÀ DEGLI STUDI  
DI PERUGIA

Allegato N. *10* al punto  
dell'ordine di giorno N. *11*

D.S.A. n. 14/2020

### Il Segretario Amministrativo

**VISTO** La legge 240/2010;

**VISTO** il vigente Regolamento per l'amministrazione, la finanza e la contabilità dell'Università degli Studi di Perugia;

**VISTA** la richiesta presentata dal prof. Gianni Bidini riferita all'attivazione di un nuovo assegno di ricerca per complessivi € 25.000,00, la cui copertura finanziaria sarà garantita, previo parere favorevole espresso dai singoli responsabili di progetto, con fondi derivanti dalle disponibilità assegnate rispettivamente ai PJ.UA.DING.NETOOLS17GC per € 16.547,76 e UA.DING.TVBMISE16LB per € 8.452,24;

**VISTA** La nota dirigenziale prot. n.92123 del 15/12/2016, recante "note operative sistema contabile UGOV per attivazione/proroga/rinnovi di assegni di ricerca, borse di dottorato, contratti per il personale a tempo determinato, correlati a finanziamenti esterni delle Strutture – Nuove modalità da seguire per i nuovi finanziamenti acquisiti a partire dall'esercizio 2017;

**VISTA** la nota dirigenziale prot. n.116080 del 21/10/2019, recante "note operative per Assegni di ricerca, posti aggiunti Borse di dottorato di ricerca, Ricercatori ed altro personale a tempo determinato c.d. "finanziato" ai fini della gestione del fabbisogno finanziario (DM 11 marzo 2019)";

**CONSIDERATO** che, la predisposizione di una procedura contabile mediante trasferimento interno per l'assegnazione delle citate risorse, necessarie per il sostenimento di costi relativi alla sviluppo di attività di ricerca ed in ogni caso per attività di interesse comune della Struttura, garantisce una più agevole e opportuna corretta imputazione del singolo costo a carico del PJ di riferimento, assicurando il corretto funzionamento del metodo "cost to cost";

**CONSIDERATO** che il trasferimento summenzionato comporta una variazione contestuale di entrata e di spesa correlata ad entrate finalizzate in forza di legge, di atti contrattuali o convenzionali o di delibere degli Organi, non prevista nel Bilancio Unico di Previsione 2020;

**RITENUTO** di dover procedere quindi alle necessarie e relative variazioni di bilancio;

### DECRETA

1) di autorizzare, a seguito del trasferimento interno, in premessa indicato, per complessivi € **25.000,00** così suddivisi: € 16.547,76 da UA.PG.DING. NETOOLS17GC e € 8.452,24 da UA.PG.DING.TVBMISE16LB e del reincameramento della suddetta somma per complessivi € **25.000,00** nei trasferimenti interni di ricavo (voce COAN CA.03.05.01.12.01 "Trasferimenti Interni Vari"), la conseguente variazione:

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Segreteria Amministrativa  
Segreteria Didattica

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Tel: +3975 585 3657-3652-3949-3686-3688 FAX 3654  
Tel: +3975 585 3605-3603-3604

### Oggetto:

Disposizioni per  
Movimentazioni  
Interne  
proponenti Prof.  
G.Bidini-G.Cinti-  
L.Barelli





UNIVERSITÀ DEGLI STUDI  
DI PERUGIA

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*Voce COAN*

CA.03.05.01.12.01 "Trasferimenti Interni Vari":

PJ:UA.PG.DING.ASS\_RIC\_BIDINI

+ € 25.000,00

**TOTALE**

+ € **25.000,00**

*Voce COAN*

CA.04.08.01.02.01 "Assegni di Ricerca":

PJ:UA.PG.DING.ASS\_RIC\_BIDINI

+ € 25.000,00

**TOTALE**

+ € **25.000,00**

2) Di trasmettere scansione dell'originale del presente decreto al Collegio dei Revisori dei Conti, come previsto dall'art.32 del vigente Regolamento per l'amministrazione, la finanza e la contabilità, richiamato in premessa.

Il presente decreto sarà portato a conoscenza del Consiglio di Dipartimento nella prima seduta utile.

Perugia, 30/04/2020

Il Segretario Amministrativo

F.to Sig. Giovanni Magara

Via G. Duranti, 93  
06125 Perugia

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UNIVERSITÀ DEGLI STUDI  
DI PERUGIA

Allegato N. 11 al punto  
dell'ordine del giorno N. 11

## UNIVERSITA' DEGLI STUDI DI PERUGIA

Dipartimento di Ingegneria

D.S.A. n.17/2020

### Il Segretario Amministrativo

#### Oggetto:

Variazione al Bilancio  
Unico di Previsione  
Autorizzatorio - Esercizio  
2020

**VISTO** l'art. 32 comma 1 - lett. e) del Regolamento per l'Amministrazione la Finanza e la Contabilità dell'Università degli Studi di Perugia attualmente vigente;

**CONSIDERATO** che tutte le somme disponibili al 31.12.2019, assegnate ai Progetti di pertinenza, derivanti da rapporti convenzionali e/o contratti per lo sviluppo di ricerca di natura, sia istituzionale che commerciale, con enti pubblici e privati sono state considerate grandezze vincolate ed in quanto tali, riportate nel Budget Economico e nel Budget investimenti dell'esercizio finanziario 2020 mantenendo l'assegnazione ai Progetti di origine;

**PRESO ATTO** delle richieste per lo spostamento delle risorse finanziarie dal Budget Investimenti al Budget Economico, pervenute all'Amministrazione del Dipartimento, presentate da vari responsabili di progetto, per un ammontare complessivo di € 9.822,18 per le voci COAN indicate:

CA.04.09.09.01.03 - Cancelleria e altro materiale di consumo - € 7.923,90;

CA.04.08.01.01.05- Indennità di missione, rimborsi spese viaggi e iscrizione a convegni del personale docente e ricercatori - €1.898,28;

**CONSIDERATO** che al fine di consentire una corretta imputazione dei costi aventi natura economica e/o di investimento nei singoli progetti di ricerca si ritiene opportuno appostare le disponibilità finanziarie nelle corrispondenti voci COAN come di seguito indicato:

CA 01.10.02.07.01 – Apparecchiature di natura informatica - € 1.598,70;

CA 01.10.02.03.01 – Attrezzature per la ricerca scientifica € 8.223,48;

**RITENUTO** necessario ed urgente procedere alle relative variazioni al Bilancio Unico di Ateneo di previsione annuale autorizzatorio dell'esercizio finanziario 2020;



UNIVERSITÀ DEGLI STUDI  
DI PERUGIA

## DECRETA

di proporre all'Ufficio Budgeting e Bilancio Unico di Ateneo la seguente variazione al Bilancio Unico di Previsione Autorizzatorio dell'esercizio finanziario 2020:

### costi - UA.PG.DING

CA.04.09.09.01.03 - Cancelleria e altro materiale di consumo	- € 7.923,90
CA.04.08.01.01.05- Indennità di missione, rimborsi spese viaggi e iscrizione a convegni del personale docente e ricercatori	- € 1.898,28

### costi - UA.PG.DING

CA 01.10.02.07.01 – Apparecchiature di natura informatica	+ € 1.598,70
CA 01.10.02.03.01 – Attrezzature per la ricerca scientifica	+ € 8.223,48

Il presente decreto viene trasmesso all'Ufficio Bilancio Consolidato, Coordinamento e controllo Centri Istituzionali e Centri di Servizio per quanto di competenza e sarà portato a ratifica del Consiglio di Dipartimento nella prima seduta utile.

Perugia, 28/05/2020

Il Segretario Amministrativo

(Sig. Giovanni Magara)  
F.to Giovanni Magara

## **Al Consiglio del Dipartimento di Ingegneria**

### **Oggetto: Richiesta di un posto di Ricercatore tempo determinato ex art. 24, comma 3, lettera a) – SC 09/C2, SSD ING-IND/11**

Il sottoscritto ANNA LAURA PISELLO, in qualità di Ricercatore a Tempo Determinato di tipo B e responsabile scientifico dei progetti PRIN 2017 Next.Come ed Horizon 2020 dal titolo GEOFIT, per le seguenti esigenze di:

- ricerca sui temi dell'efficienza energetica in edilizia, del benessere ambientale, dei materiali innovativi per l'involucro ed integrazione nello stesso di sistemi alimentati da fonti energetiche rinnovabili
- didattica sugli stessi temi di cui sopra, nell'ambito dei nuovi corsi nel corso di laurea in Ingegneria Edile-Architettura

pone all'attenzione del Consiglio del Dipartimento la necessità di chiedere al Consiglio di Amministrazione l'autorizzazione alla copertura di un posto di ricercatore tempo determinato **tempo definito** ex art. 24, comma 3, lettera a) – SC 09/C2, SSD ING-IND/11 per un periodo di tre anni, **eventualmente prorogabile per ulteriori due**, al fine di poter realizzare il progetto di ricerca Efficienza energetica e benessere ambientale in edilizia.

Il costo complessivo del ricercatore a tempo determinato pari ad € 118.209,78. e verrà coperto con fondi relativi al progetto PRIN 2017 Next.Com per il 50% (cioè pari a 59.104,89 euro), e con i fondi relativi al progetto Horizon 2020 dal titolo GEOFIT per il restante 50% (cioè pari a 59.104,89 euro).

Nel rispetto del Regolamento per l'assunzione di ricercatori a tempo determinato ai sensi della Legge 30.12.2010 n. 240 si forniscono di seguito le seguenti informazioni:

**A) SETTORE CONCORSUALE: 09/C2**

**B) Profilo: SETTORE/I SCIENTIFICO DISCIPLINARE/I: ING-IND/11**

**C) ATTIVITA' DI RICERCA:**

- Titolo del progetto in italiano: Efficienza energetica e benessere ambientale in edilizia.

- Titolo del progetto in inglese: Energy efficiency and environmental comfort in the built environment.

- Descrizione dell'attività di ricerca in italiano:

L'attività di ricerca riguarda lo sviluppo di modelli numerici ed analitici, anche convalidati mediante attività sperimentale, riguardanti l'efficienza energetica in edilizia ed il benessere ambientale. Questo aspetto in particolare verrà analizzato nell'ambito delle infrastrutture di monitoraggio ambientale del progetto PRIN Next.Com e del progetto Europeo GEOFIT. Verranno testati poi materiali innovativi da integrare nei sistemi impiantistici, anche alimentati da fonte energetica rinnovabile con particolare attenzione agli impianti geotermici, e nei sistemi di involucro. A tale proposito, verranno elaborati modelli di analisi energetica ed ambientale, nell'ambito del ciclo di



vita di materiali e processi energetici nel campo dell'edilizia civile e delle applicazioni industriali di reti energetiche.

- Descrizione dell'attività di ricerca in inglese: The research involves the development of numerical and analytical models, also validated by experimental activities, concerning energy efficiency in construction and environmental comfort. This aspect in particular will be analyzed in the context of the environmental monitoring infrastructures of the PRIN Next.Com project and the European GEOFIT project. Innovative materials will then be tested to be integrated into energy plant systems, also powered by renewable energy sources with a focus on geothermal systems, and in building envelope systems. In this regard, models of energy and environmental analysis will be developed, according to the life cycle of materials and energy processes, in the field of civil construction and industrial applications of energy networks.

Docente referente: ING. ANNA LAURA PISELLO

**D)** ATTIVITA' DIDATTICA, DIDATTICA INTEGRATIVA E SERVIZIO AGLI STUDENTI: 200 ore annue (regime a tempo definito), prevalentemente nell'ambito del SSD di cui alla lett. **B)**, di cui non più di 60 ore per attività di didattica ufficiale\*;

**E)** Sede di servizio: Dipartimento di Ingegneria

**F)** Lingua straniera: Inglese

**G)** Numero massimo di pubblicazioni (non inferiore a 12): 14

**H)** REQUISITI DI AMMISSIONE ALLA VALUTAZIONE COMPARATIVA SONO:

- titolo di dottore di ricerca in Ingegneria Energetica o Ingegneria Industriale o Energia e Sviluppo Sostenibile, o titolo equivalente;
- esperienza maturata nel campo della ricerca, comprovante il possesso di solide competenze di base nel settore scientifico-disciplinare di cui alla lettera **B)**.

ing. Anna Laura Pisello



\* per l'attività di didattica, di didattica integrativa e di servizio agli studenti che il ricercatore dovrà svolgere dovrà essere specificato il monte ore massimo di impiego del ricercatore in attività didattica ufficiale, che dovrà essere indicato nel bando e nel successivo contratto ai sensi dell'art. 2 – comma 7 – del “Regolamento sull'impegno didattico dei professori e ricercatori universitari (L. 240/2010, art. 6 c. 2 e 3), sulla verifica dell'effettivo svolgimento dell'attività didattica (L. 240/2010, art. 6 c. 7) e sulla programmazione didattica” (emanato con D.R. n.265 del 2.3.2017).

## CONSORTIUM AGREEMENT

THIS CONSORTIUM AGREEMENT is based upon REGULATION (EU) No 1290/2013 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 December 2013 laying down the rules for the participation and dissemination in “Horizon 2020 – the Framework Programme for Research and Innovation (2014-2020)” (hereinafter referred to as “Rules for Participation”), and the European Commission Multi-beneficiary General Model Grant Agreement and its Annexes, and is made on 1 MAY 2018, hereinafter referred to as the Effective Date

### **BETWEEN:**

R2M Solution Srl, established in Via Fratelli Cuzio 42, 27100, Pavia, Italy, represented by Thomas Messervey, Co-Founder & CEO, hereinafter referred to as the “Coordinator” or “R2M”,

IDP Ingeniería y Arquitectura Iberia S.L.U., established in Avenida Francesc Macia 60, Planta 3, 08208, Sabadell, SPAIN, represented by Jaime Polo Villafaina, Co-founder and New Business Management, hereinafter referred to as “IDP”,

COMSA CORPORACIÓN DE INFRAESTRUCTURAS SL, established in Calle Viriato 47, 08014, Barcelona, SPAIN, represented by Valentí Fontserè i Pujol, Technical Director, hereinafter referred to as “COMSA”,

CONSIGLIO NAZIONALE DELLE RICERCHE – Istituto di Tecnologie Avanzate per l’Energia “Nicola Giordano”, headquarter in Piazzale Aldo Moro 7, 00185, Roma, ITALY, represented by Salvatore Vincenzo Freni, Institute Director, hereinafter referred to as “ITAE”,

Ajuntament de Sant Cugat, established in Plaça de la Vila 1, 08172, Sant Cugat del Valles, SPAIN, represented by Ms. Carme Ferrer de Miguel, Head of Public Buildings Maintenance, hereinafter to as “AJSC”,

University of Perugia, established in Piazza dell’universita 1, 06123, Perugia, ITALY, represented by Giuseppe Saccomandi, Director of the Department of Engineering, hereinafter referred to as “UNIPG”,

IDS GeoRadar srl established in Via A. Righi 1, 56121, Pisa, ITALY, represented by Alberto Bicci, legal representative, hereinafter referred to as “IDSGEO”,

Ochsner Wärmepumpen GmbH, established in Krackowitzstrasse 4, 4020, Linz, AUSTRIA, represented by Marco Schäfer, CCO,, hereinafter referred to as “OCHSNER”,

NOBATEK/INEF4 established in Rue de Mirambeau 67, 64600, Anglet, FRANCE, represented by Mr. Olivier Scheffer, Director, hereinafter referred to as “NOBATEK”,



AIT Austrian Institute of Technology GmbH established in Giefinggasse 4, 1210, Wien, AUSTRIA, represented by Anton Plimon, Managing Director, and Dr. Birgitte Bach, Head of Center for Energy, hereinafter referred to as "AIT",

Catalana de Perforacions, S.A. established in Carrer Major 8, 08259, Fonollosa, SPAIN, represented by Domènech Pinto, Director General, hereinafter referred to as "CDP",

Uponor established in Ayritie 20, 01510, Vantaa, FINLAND, represented by Ilari Aho, VP, New Business Development and CSR, hereinafter referred to as "UPONOR",

National University of Ireland, Galway established in University Road, Galway, IRELAND, represented by Ian Knight, Head of Research Contracts, hereinafter referred to as "NUIG",

Fahrenheit GmbH established in Siegfriedstraße 19, 80803, München, GERMANY, represented by Walter Mittelbach, CTO, hereinafter referred to as "FAHR",

Enervalis established in Centrum Zuid 1111, 3030, Houthalen Helchteren, BELGIUM, represented by Stefan Lodeweyckx, hereinafter referred to as "ENERVALIS",

Luleå University of Technology established in Universiteitsområdet Porson, 971 87, Luleå, SWEDEN, represented by Birgitta Bergvall-Kåreborn, Vice-Chancellor, hereinafter referred to as "LTU",

Groenholland Geo-energysystems BV established in Valschermkade 26, 1059 CD, Amsterdam, NETHERLANDS, represented by Guus Van Gelder, Director, hereinafter referred to as "GROENHOL",

KTH Royal Institute of Technology established in Brinellvagen 8, 100 44, Stockholm, SWEDEN, represented by Maria Gustafsson, Head of Research Office, hereinafter referred to as "KTH",

Fundació Eurecat established in Avenida Universitat Autonomia 23, 08290, Cerdanyola del Valles, SPAIN, represented by Xavier López, Corporate & Operations Managing Director, hereinafter referred to as "EURECAT",

Comet Technologies established in Carles Tries, 8. Local 4, 08340, Vilassar de Mar, SPAIN, represented by Joan Nuñez, Director Comercial, hereinafter referred to as "COMET",

Sistemi Informativi Analisi Rischio Territoriale Srl established in Via dei Mille 73, 27100, Pavia, ITALY, represented by Franco Bobba, legal representative, hereinafter referred to as "SIART",

Comharchumann Fuinnimh Olleáin Áraan Teoranta established in Cill Ronain, H91 WOHK, Galway, IRELAND, represented by Dara Ó MAOILDHIA, hereinafter referred to as "CFO",

Carel Industries spa established in via dell'Industria 11, 35020 , Brugine, ITALY, represented by Luigi Rossi Luciani, legal representative, hereinafter referred to as "CAREL",

Asociación Española de Normalización established in Calle Genova 6, 28004, Madrid, SPAIN, represented by Mr. Javier Garcia Diaz, Director General, hereinafter referred to as "UNE",

hereinafter, jointly or individually, referred to as "Parties" or "Party"

relating to the Action entitled **Deployment of novel Geothermal systems, technologies and tools for energy efficient building retrofitting**

in short **GEOFIT**

hereinafter referred to as "Project"

**WHEREAS:**

The Parties, having considerable experience in the field concerned, have submitted a proposal for the Project to the Funding Authority as part of the Horizon 2020 – the Framework Programme for Research and Innovation (2014-2020)

The Parties wish to specify or supplement binding commitments among themselves in addition to the provisions of the specific Grant Agreement to be signed by the Parties and the Funding Authority (hereinafter "Grant Agreement").

The Parties are aware that this Consortium Agreement is based upon the DESCA model consortium agreement.

NOW, THEREFORE, IT IS HEREBY AGREED AS FOLLOWS:

**1. Section: Definitions**

**1.1. Definitions**

Words beginning with a capital letter shall have the meaning defined either herein or in the Rules for Participation or in the Grant Agreement including its Annexes.

**1.2. Additional Definitions**

**"Consortium Body":**

Consortium Body means any management body described in the Governance Structure section of this Consortium Agreement.

**“Consortium Plan”**

Consortium Plan means the description of the action and the related agreed budget as first defined in the Grant Agreement and which may be updated by the General Board.

**“Funding Authority”**

Funding Authority means the body awarding the grant for the Project.

**“Defaulting Party”**

Defaulting Party means a Party which the General Assembly has identified to be in breach of this Consortium Agreement and/or the Grant Agreement as specified in Section 4.2 of this Consortium Agreement.

**“Needed”**

means:

For the implementation of the Project:

Access Rights are Needed if, without the grant of such Access Rights, carrying out the tasks assigned to the recipient Party would be technically or legally impossible, significantly delayed, or require significant additional financial or human resources.

For Exploitation of own Results:

Access Rights are Needed if, without the grant of such Access Rights, the Exploitation of own Results would be technically or legally impossible.

**“Software”**

Software means sequences of instructions to carry out a process in, or convertible into, a form executable by a computer and fixed in any tangible medium of expression.

**2. Section: Purpose**

The purpose of this Consortium Agreement is to specify with respect to the Project the relationship among the Parties, in particular concerning the organisation of the work between the Parties, the management of the Project and the rights and obligations of the Parties concerning inter alia liability, Access Rights and dispute resolution.

**3. Section: Entry into force, duration and termination**

**3.1. Entry into force**

An entity becomes a Party to this Consortium Agreement upon signature of this Consortium Agreement by a duly authorised representative.

This Consortium Agreement shall have effect from the Effective Date identified at the beginning of this Consortium Agreement.

A new entity becomes a Party to the Consortium Agreement upon signature of the accession document (Attachment 2) by the new Party and the Coordinator. Such accession shall have effect from the date identified in the accession document.

### **3.2. Duration and termination**

This Consortium Agreement shall continue in full force and effect until complete fulfilment of all obligations undertaken by the Parties under the Grant Agreement and under this Consortium Agreement.

However, this Consortium Agreement or the participation of one or more Parties to it may be terminated in accordance with the terms of this Consortium Agreement.

If

- the Grant Agreement is not signed by the Funding Authority or a Party, or
- the Grant Agreement is terminated, or
- a Party's participation in the Grant Agreement is terminated,

this Consortium Agreement shall automatically terminate in respect of the affected Party/ies, subject to the provisions surviving the expiration or termination under Section 3.3 of this Consortium Agreement.

### **3.3. Survival of rights and obligations**

The provisions relating to Access Rights, Dissemination and confidentiality, for the time period mentioned therein, as well as for liability, applicable law and settlement of disputes shall survive the expiration or termination of this Consortium Agreement.

Termination shall not affect any rights or obligations of a Party leaving the Consortium incurred prior to the date of termination, unless otherwise agreed between the General Board and the leaving Party. This includes the obligation to provide all input, deliverables and documents for the period of its participation.

## **4. Section: Responsibilities of Parties**

### **4.1. General principles**

Each Party undertakes to take part in the efficient implementation of the Project, and to cooperate, perform and fulfil, promptly and on time, all of its obligations under the Grant Agreement and this Consortium Agreement as may be reasonably required from it and in a manner of good faith as prescribed by Belgian law.

Each Party undertakes to notify promptly, in accordance with the governance structure of the Project, any significant information, fact, problem or delay likely to affect the Project.

Each Party shall promptly provide all information reasonably required by a Consortium Body or by the Coordinator to carry out its tasks.

Each Party shall take reasonable measures to ensure the accuracy of any information or materials it supplies to the other Parties.

#### **4.2. Breach**

In the event that a responsible Consortium Body (e.g. the PMT or General Assembly) identifies a breach by a Party of its obligations under this Consortium Agreement or the Grant Agreement (e.g. improper implementation of the project), the Coordinator or, if the Coordinator is in breach of its obligations, the Party appointed by the General Assembly, will give formal notice to such Party requiring that such breach will be remedied within 30 calendar days from the date of receipt of the written notice by the Party.

If such breach is substantial and is not remedied within that period or is not capable of remedy, the General Assembly may decide to declare the Party to be a Defaulting Party and to decide on the consequences thereof which may include termination of its participation.

#### **4.3. Involvement of third parties**

A Party that enters into a subcontract or otherwise involves third parties (including but not limited to Affiliated Entities) in the Project remains responsible for carrying out its relevant part of the Project and for such third party's compliance with the provisions of this Consortium Agreement and of the Grant Agreement. In particular, the Party involving third parties will have to ensure that such third parties follow the Description of Action in the Agreement, especially related to the use of resources set out in Annex 2 of the Grant Agreement. It has to ensure that the involvement of third parties does not affect the rights and obligations of the other Parties under this Consortium Agreement and the Grant Agreement.

### **5. Section: Liability towards each other**

### **5.1. No warranties**

In respect of any information or materials (incl. Results and Background) supplied by one Party to another under the Project, no warranty or representation of any kind is made, given or implied as to the sufficiency or fitness for purpose nor as to the absence of any infringement of any proprietary rights of third parties.

Therefore,

- the recipient Party shall in all cases be entirely and solely liable for the use to which it puts such information and materials, and

no Party granting Access Rights shall be liable in case of infringement of proprietary rights of a third party resulting from any other Party (or its Affiliated Entities) exercising its Access Rights.

### **5.2. Limitations of contractual liability**

No Party shall be responsible to any other Party for any indirect or consequential loss or similar damage such as, but not limited to, loss of profit, loss of revenue or loss of contracts, provided such damage was not caused by a wilful act.

For any remaining contractual liability, a Party's aggregate liability towards the other Parties collectively shall be limited to once the Party's share of the total costs of the Project as identified in Annex 2 of the Grant Agreement provided such damage was not caused by a wilful act or gross negligence.

The terms of this Consortium Agreement shall not be construed to amend or limit any Party's statutory liability.

### **5.3. Damage caused to third parties**

Each Party shall be solely liable for any loss, damage or injury to third parties resulting from the performance of the said Party's obligations by it or on its behalf under this Consortium Agreement or from its use of Results or Background.

### **5.4. Force Majeure**

No Party shall be considered to be in breach of this Consortium Agreement if it is prevented from fulfilling its obligations under the Consortium Agreement by Force Majeure.

Each Party will notify the competent Consortium Bodies of any Force Majeure without undue delay. If the consequences of Force Majeure for the Project are not overcome within 6 weeks after such notification, the transfer of tasks - if any - shall be decided by the competent Consortium Bodies.

## **6. Section: Governance structure**

### **6.1. General structure**

The organisational structure of the Consortium shall comprise the following Consortium Bodies:

**General Assembly** as the ultimate decision-making body of the consortium

**Project Management Team** as the supervisory body for the execution of the Project which shall report to and be accountable to the General Assembly. The Project management Team is responsible for monitoring the technical progress of the project, quality assurance, and the day-to-day management of scientific and technological activities. The PMT will consist of the project coordinator, Technical Director, WP leaders, Pilot Manager, Risk Manager, Innovation Manager and Communication Manager.

The **Coordinator** is the legal entity acting as the intermediary between the Parties and the Funding Authority. The Coordinator shall, in addition to its responsibilities as a Party, perform the tasks assigned to it as described in the Grant Agreement and this Consortium Agreement.

### **6.2. General operational procedures for all Consortium Bodies**

#### **6.2.1 Representation in meetings**

Any Party which is a member of a Consortium Body (hereinafter referred to as "Member"):

- should be present or represented at any meeting;
- may appoint a substitute or a proxy to attend and vote at any meeting;
- and shall participate in a cooperative manner in the meetings.

#### **6.2.2. Preparation and organisation of meetings**

##### **6.2.2.1 Convening meetings**

The chairperson of a Consortium Body shall convene meetings of that Consortium Body.

	Ordinary meeting	Extraordinary meeting
General Assembly	At least twice per year	At any time upon written request of the Project Management Assembly or 1/3 of the Members of the General Board
Project Management Team	At least quarterly	At any time upon written request of any Member of the Project Management Assembly

#### 6.2.2.2 Notice of a meeting

The chairperson of a Consortium Body shall give notice in writing of a meeting to each Member of that Consortium Body as soon as possible and no later than the minimum number of days preceding the meeting as indicated below.

	Ordinary meeting	Extraordinary meeting
General Assembly	30 calendar days	15 calendar days
Project Management Team	14 calendar days	7 calendar days

#### 6.2.2.3 Sending the agenda

The chairperson of a Consortium Body shall prepare and send each Member of that Consortium Body a written (original) agenda no later than the minimum number of days preceding the meeting as indicated below.

General Assembly	21 calendar days, 10 calendar days for an extraordinary meeting
Project Management Team	7 calendar days

#### 6.2.2.4 Adding agenda items

Any agenda item requiring a decision by the Members of a Consortium Body must be identified as such on the agenda.

Any Member of a Consortium Body may add an item to the original agenda by written notification to all of the other Members of that Consortium Body up to the minimum number of days preceding the meeting as indicated below.

General Assembly	14 calendar days, 7 calendar days for an extraordinary meeting
Project Management Team	2 calendar days



**6.2.2.5** During a meeting the Members of a Consortium Body present or represented can unanimously agree to add a new item to the original agenda

**6.2.2.6** Meetings of each Consortium Body may also be held by teleconference or other telecommunication means.

**6.2.2.7** Decisions will only be binding once the relevant part of the Minutes has been accepted according to Section 6.2.5.

**6.2.2.8** Any decision may also be taken without a meeting if the Coordinator circulates to all Members of the Consortium Body a written document, which is then agreed by the defined majority (see Section 6.2.3) of all Members of the Consortium Body. Such document shall include the deadline for responses.

Decisions taken without a meeting shall be considered as accepted if, within the period set out in article 6.2.4.4, no Member has sent an objection in writing to the chairperson. The decisions will be binding after the chairperson sends to all Members of the Consortium Body and to the Coordinator a written notification of this acceptance.

### **6.2.3 Voting rules and quorum**

**6.2.3.1** Each Consortium Body shall not deliberate and decide validly unless two-thirds (2/3) of its Members are present or represented (quorum).

If the quorum is not reached, the chairperson of the Consortium Body shall convene another ordinary meeting within 15 calendar days. If in this meeting the quorum is not reached once more, the chairperson shall convene an extraordinary meeting which shall be entitled to decide even if less than the quorum of Members are present or represented.

**6.2.3.2** Each Member of a Consortium Body present or represented in the meeting shall have one vote.

**6.2.3.3** A Party which the General Assembly has declared according to Section 4.2 to be a Defaulting Party does not have the right to vote.

**6.2.3.4** Decisions shall be taken by a majority of two-thirds (2/3) of the votes cast.

### **6.2.4 Veto rights**

**6.2.4.1** A Member which can show that its own work, time for performance, costs, liabilities, intellectual property rights or other legitimate interests would be severely affected by a

decision of a Consortium Body may exercise a veto with respect to the corresponding decision or relevant part of the decision.

6.2.4.2 When the decision is foreseen on the original agenda, a Member may veto such a decision during the meeting only.

6.2.4.3 When a decision has been taken on a new item added to the agenda before or during the meeting, a Member may veto such decision during the meeting and within 15 calendar days after the draft minutes of the meeting are sent. A Party that is not a Member of a particular Consortium Body may veto a decision within the same number of calendar days after the draft minutes of the meeting are sent.

6.2.4.4 When a decision has been taken without a meeting a Member may veto such decision within 15 calendar days after written notification by the chairperson of the outcome of the vote.

6.2.4.5 In case of exercise of veto, the Members of the related Consortium Body shall make every effort to resolve the matter which occasioned the veto to the general satisfaction of all its Members.

6.2.4.6 A Party may neither veto decisions relating to its identification to be in breach of its obligations nor to its identification as a Defaulting Party. The Defaulting Party may not veto decisions relating to its participation and termination in the consortium or the consequences of them.

6.2.4.7 A Party requesting to leave the consortium may not veto decisions relating thereto.

### **6.2.5 Minutes of meetings**

6.2.5.1 The chairperson of a Consortium Body shall produce written minutes of each meeting which shall be the formal record of all decisions taken. He/she shall send the draft minutes to all Members within 10 calendar days of the meeting.

6.2.5.2 The minutes shall be considered as accepted if, within 15 calendar days from sending, no Member has sent an objection in writing to the chairperson with respect to the accuracy of the draft of the minutes.

6.2.5.3 The chairperson shall send the accepted minutes to all the Members of the Consortium Body and to the Coordinator, who shall safeguard them. If requested the Coordinator shall provide authenticated duplicates to Parties.

## **6.3 Specific operational procedures for the Consortium Bodies**

### **6.3.1 General Assembly**

In addition to the rules described in Section 6.2, the following rules apply:

#### **6.3.1.1 Members**

- 6.3.1.1.1 The General Assembly shall consist of one representative of each Party (hereinafter General Assembly Member).
- 6.3.1.1.2 Each General Assembly Member shall be deemed to be duly authorised to deliberate, negotiate and decide on all matters listed in Section 6.3.1.2. of this Consortium Agreement.
- 6.3.1.1.3 The Coordinator shall chair all meetings of the General Assembly, unless decided otherwise in a meeting of the General Assembly.
- 6.3.1.1.4 The Parties agree to abide by all decisions of the General Assembly. This does not prevent the Parties to submit a dispute to resolution in accordance with the provisions of Settlement of disputes in Section 11.8.

#### **6.3.1.2 Decisions**

The General Assembly shall be free to act on its own initiative to formulate proposals and take decisions in accordance with the procedures set out herein. In addition, all proposals made by the Project Management Team shall also be considered and decided upon by the General Assembly.

The following decisions shall be taken by the General Assembly:

Content, finances and intellectual property rights

- Proposals for changes to Annexes 1 and 2 of the Grant Agreement to be agreed by the Funding Authority
- Changes to the Consortium Plan
- Modifications to Attachment 1 (Background Included)
- Additions to Attachment 3 (List of Third Parties for simplified transfer according to Section 8.3.2)
- Additions to Attachment 4 (Identified Affiliated Entities)

Evolution of the consortium

- Entry of a new Party to the consortium and approval of the settlement on the conditions of the accession of such a new Party
- Withdrawal of a Party from the consortium and the approval of the settlement on the conditions of the withdrawal
- Decision of whether or not a Party is in breach of its obligations under this Consortium Agreement or the Grant Agreement

- Declaration of a Party to be a Defaulting Party
- Remedies to be performed by a Defaulting Party
- Termination of a Defaulting Party's participation in the consortium and measures relating thereto
- Proposal to the Funding Authority for a change of the Coordinator
- Proposal to the Funding Authority for suspension of all or part of the Project
- Proposal to the Funding Authority for termination of the Project and the Consortium Agreement

### Appointments

On the basis of the Grant Agreement, the appointment if necessary of:

- Project Management Team Members

### **6.3.2 Project Management Team**

In addition to the rules in Section 6.2, the following rules shall apply:

#### **6.3.2.1 Members**

The Project Management Team shall consist of the Coordinator, the WP leaders and 5 managers identified as part of the management structure (Technical, Innovation, Communication, Risk and Pilot). The General Assembly can vote to add a members to the PMT.

The Coordinator shall chair all meetings of the Project Management Team, unless decided otherwise by a majority of two-thirds.

#### **6.3.2.2 Minutes of meetings**

Minutes of Project Management Team meetings, once accepted, shall be sent by the Coordinator to the General Assembly Members for information.

#### **6.3.2.3 Tasks**

6.3.2.3.1 The Project Management Team shall prepare the meetings, propose decisions and prepare the agenda of the General Assembly according to Section 6.3.1.2.

6.3.2.3.2 The Project Management Team shall seek a consensus among the Parties.

6.3.2.3.3 The Project Management Team shall monitor the effective and efficient implementation of the Project.

6.3.2.3.4 In addition, the Project Management Team shall collect information at least every 6 months on the progress of the Project, examine that information to assess the compliance of the Project with the Consortium Plan and, if necessary, propose modifications of the Consortium Plan to the General Assembly.

6.3.2.3.6 The Project Management Team shall:

- support the Coordinator in preparing meetings with the Funding Authority and in preparing related data and deliverables
- prepare the content and timing of press releases and joint publications by the consortium or proposed by the Funding Authority in respect of the procedures of the Grant Agreement Article 29.

6.3.2.3.7 In the case of abolished tasks as a result of a decision of the General Assembly, the Project Management Team shall advise the General Assembly on ways to rearrange tasks and budgets of the Parties concerned. Such rearrangement shall take into consideration the legitimate commitments taken prior to the decisions, which cannot be cancelled.

## **6.4 Coordinator**

6.4.1 The Coordinator shall be the intermediary between the Parties and the Funding Authority and shall perform all tasks assigned to it as described in the Grant Agreement and in this Consortium Agreement.

6.4.2 In particular, the Coordinator shall be responsible for:

- monitoring compliance by the Parties with their obligations
- keeping the address list of Members and other contact persons updated and available
- collecting, reviewing to verify consistency and submitting reports, other deliverables (including financial statements and related certifications) and specific requested documents to the Funding Authority
- transmitting documents and information connected with the Project to any other Parties concerned
- administering the financial contribution of the Funding Authority and fulfilling the financial tasks described in Section 7.3
- providing, upon request, the Parties with official copies or originals of documents that are in the sole possession of the Coordinator when such copies or originals are necessary for the Parties to present claims.

If one or more of the Parties is late in submission of any project deliverable, the Coordinator may nevertheless submit the other 'Parties' project deliverables and all other documents required by the Grant Agreement to the Funding Authority in time.

- 6.4.3 If the Coordinator fails in its coordination tasks, the General Assembly may propose to the Funding Authority to change the Coordinator.
- 6.4.4 The Coordinator shall not be entitled to act or to make legally binding declarations on behalf of any other Party or of the consortium, unless explicitly stated otherwise in the Grant Agreement or this Consortium Agreement.
- 6.4.5 The Coordinator shall not enlarge its role beyond the tasks specified in this Consortium Agreement and in the Grant Agreement.

## **7. Section: Financial provisions**

### **7.1 General Principles**

#### **7.1.1 Distribution of Financial Contribution**

The financial contribution of the Funding Authority to the Project shall be distributed by the Coordinator according to:

- the Consortium Plan
- the approval of reports by the Funding Authority, and
- the provisions of payment in Section 7.3.

A Party shall be funded only for its tasks carried out in accordance with the Consortium Plan.

#### **7.1.2 Justifying Costs**

In accordance with its own usual accounting and management principles and practices, each Party shall be solely responsible for justifying its costs with respect to the Project towards the Funding Authority. Neither the Coordinator nor any of the other Parties shall be in any way liable or responsible for such justification of costs towards the Funding Authority.

#### **7.1.3 Funding Principles**

A Party that spends less than its allocated share of the budget as set out in the Consortium Plan or – in case of reimbursement via unit costs - implements less units than foreseen in the Consortium Plan will be funded in accordance with its actual duly justified eligible costs only.

A Party that spends more than its allocated share of the budget as set out in the Consortium Plan will be funded only in respect of duly justified eligible costs up to an amount not exceeding that share.

If the General Assembly agrees, the budget might be re-distributed between Parties (see section 6.3.1.2)

#### **7.1.4 Return of excess payments; receipts**

7.1.4.1 In any case of a Party having received excess payments, the Party has to return the relevant amount to the Coordinator without undue delay.

7.1.4.2 In case a Party earns any receipt that is deductible from the total funding as set out in the Consortium Plan, the deduction is only directed toward the Party earning such income. The other Parties' financial share of the budget shall not be affected by one Party's receipt. In case the relevant receipt is more than the allocated share of the Party as set out in the Consortium Plan, the Party shall reimburse the funding reduction suffered by other Parties.

#### **7.1.5 Financial Consequences of the termination of the participation of a Party**

A Party leaving the consortium shall refund all payments it has received except the amount of contribution accepted by the Funding Authority or another contributor. Furthermore, a Defaulting Party shall, within the limits specified in Section 5.2 of this Consortium Agreement, bear any reasonable and justifiable additional costs occurring to the other Parties in order to perform its and their tasks.

### **7.2 Budgeting**

The budget set out in the Consortium Plan shall be valued in accordance with the usual accounting and management principles and practices of the respective Parties.

### **7.3 Payments**

#### **7.3.1 Payments to Parties are the exclusive tasks of the Coordinator**

In particular, the Coordinator shall:

- notify the Party concerned promptly of the date and composition of the amount transferred to its bank account, giving the relevant references
- perform diligently its tasks in the proper administration of any funds and in maintaining financial accounts



- undertake to keep the Funding Authority's financial contribution to the Project separated from its normal business accounts, its own assets and property, except if the Coordinator is a Public Body or is not entitled to do so due to statutory legislation.
- Make payments without unjustified delay after receipt of the funds from the Funding Authority
- 

With reference to Articles 21.2 and 21.3.2 of the Grant Agreement, no Party shall before the end of the Project receive more than its allocated share of the maximum grant amount from which the amounts retained by the Funding Authority for the Guarantee Fund and for the final payment have been deducted.

### **7.3.2 Payment Schedule and handling**

The payment schedule, which contains the transfer of pre-financing, interim and final payments to Parties, will be handled according to the following:

#### **a. Initial pre-financing instalment**

Each party will receive a pre-financing instalment at the beginning of the Project. The amount of the first pre-financing instalment will be **50% of each partner's prefinancing share of the total amount of pre-financing received by the Project Coordinator**

#### **b. Further pre-financing instalment**

The second and last pre-financing instalment consisting of the remaining 50% of each partner's prefinancing share will be paid in M13 after the approval by the Coordinator and the Work Package Leaders of the technical and financial progress report. Specifically, it will be conditioned to the submission of all deliverables in the first project year (M1-M12) and submission to the Coordinator of the interim financial reports which will be requested for each 6-month period. Those reports are due in months 7 for the period months 1 to 6 and months 13 for the period months 7 to 12 and will consist of personnel costs in terms of PMs spent per WP and total expenditure in the whole project over the concerned period coupled to free text per WP with description of the activities conducted.

#### **c. Interim payments**

Interim payment amounts will be distributed according to the costs reported and accepted by the EC and according to the total interim payment received by the Coordinator. Interim payments received from EC will be paid in full to Parties according to the costs accepted by EC for the relevant reporting period. There is no split of interim payments.

The interim payments correspond to the Periodic Reporting identified in the Grant Agreement except the final one (covered under the following section). Interim payments correspond to reporting period which in GEOFIT are scheduled at M18 and M30.

d. Final payment

A final payment will be issued to all Parties after the successful conclusion of the Project, calculated as the difference between the amount already paid to the Party as pre-financing and interim payments and the total eligible costs of the Party as defined in the Consortium Budget. Only those eligible costs approved by the Commission, and paid to the Project Coordinator, will be reimbursed.

Funding of costs will be paid to Parties after receipt from the Funding Authority without undue delay and in conformity with the provisions of the Grant Agreement. Funding for costs accepted by the Funding Authority will be paid to the Party concerned.

The Coordinator is entitled to withhold any payments due to a Party identified by a responsible Consortium Body to be in potential breach of its obligations under this Consortium Agreement or the Grant Agreement (e.g.: a partner producing poor quality work, a partner contravening fundamental ethical principles, or where a partner is guilty of grave professional misconduct proven by any justified means) or to a Beneficiary which has not yet signed this Consortium Agreement.

The Coordinator is entitled to recover any such payments already paid to a Defaulting Party. The Coordinator is equally entitled to withhold payments to a Party when this is suggested by or agreed with the Funding Authority.

In case of new Parties entering the consortium, the Coordinator is entitled to withhold any payments due to the new Party as long as this Consortium Agreement is not signed and the Commission does not formally approve the request to add a new beneficiary to the Grant Agreement. Payments to the new Party shall be calculated on the basis of the amended Consortium Budget approved by the Commission, and taking into account all payments made to all Parties prior to the entry of a new Party.

## **8. Section: Results**

### **8.1 Ownership of Results**

Results are owned by the Party, Parties, or employees where applicable that generates them. In the case of employees, ownership is granted if and only if the Party/Parties to this Consortium Agreement undertake the necessary measures to be able to respect its obligations according to Article 26.3 of the Grant Agreement.

### **8.2 Joint ownership**

Joint ownership is governed by Grant Agreement Article 26.2 with the following additions:

Disputes according to joint ownership may be resolved in conformity with the procedure stated in Section 11.8 of this Consortium Agreement.

The joint owners shall endeavour in good faith to, within (6) months as of the generation of such Results establish a written separate joint ownership agreement regarding the terms of exercising, exploiting, protecting and cost sharing for that protection, of the jointly owned Results that will be documented in D9.4 (Partner Agreements, IPR and Replication Planning). For the avoidance of doubt, this does not mean that the negotiation of a joint ownership agreement is not possible after the expiry of 6 months. However, until the time a joint ownership agreement has concluded and as long as such rights are in force, such Result shall be jointly owned in shares according to their share of contribution (such share to be determined by taking into account in particular, but not limited to, the contribution of a joint owner to an inventive step, the person months or costs spent on the respective work etc.) to the Result by the joint owners concerned.

Where no joint ownership agreement has yet been concluded or unless otherwise agreed:

- each of the joint owners shall be entitled to use their jointly owned Results for non-commercial research activities on a royalty-free basis, and without requiring the prior consent of the other joint owner(s), and

- each of the joint owners shall be entitled to otherwise Exploit the jointly owned Results and to grant non-exclusive licenses to third parties (without any right to sub-license), if the other joint owners are given:

- (a) at least 45 calendar days advance notice; and
- (b) Fair and Reasonable compensation.

### **8.3 Transfer of Results**

8.3.1 Each Party may transfer ownership of its own Results following the procedures of the Grant Agreement Article 30.

8.3.2 It may identify specific third parties it intends to transfer the ownership of its Results to in Attachment (3) to this Consortium Agreement. The other Parties hereby waive their right to prior notice and their right to object to a transfer to listed third parties according to the Grant Agreement Article 30.1.

8.3.3 The transferring Party shall, however, at the time of the transfer, inform the other Parties of such transfer and shall ensure that the rights of the other Parties will not be affected by such transfer. Any addition to Attachment (3) after signature of this Agreement requires a decision of the General Assembly.

8.3.4 The Parties recognize that in the framework of a merger or an acquisition of an important part of its assets, it may be impossible under applicable EU and national laws on mergers and acquisitions for a Party to give the full 45 calendar days prior notice for the transfer as foreseen in the Grant Agreement.

8.3.5 The obligations above apply only for as long as other Parties still have - or still may request - Access Rights to the Results.

#### **8.4 Dissemination**

8.4.1 For the avoidance of doubt, nothing in this Section 8.4 has impact on the confidentiality obligations set out in Section 10.

8.4.2 Dissemination of own Results

8.4.2.1 During the Project and for a period of 1 year after the end of the Project, the dissemination of own Results by one or several Parties including but not restricted to publications and presentations, shall be governed by the procedure of Article 29.1 of the Grant Agreement subject to the following provisions.

Prior notice of any planned publication shall be given to the other Parties at least 45 calendar days before the publication. Any objection to the planned publication shall be made in accordance with the Grant Agreement in writing to the Coordinator and to the Party or Parties proposing the dissemination within 30 calendar days after receipt of the notice. If no objection is made within the time limit stated above, the publication is permitted.

8.4.2.2 An objection is justified if

- (a) the protection of the objecting Party's Results or Background would be adversely affected
- (b) the objecting Party's legitimate interests in relation to the Results or Background would be significantly harmed.

The objection has to include a precise request for necessary modifications.

8.4.2.3 If an objection has been raised the involved Parties shall discuss how to overcome the justified grounds for the objection on a timely basis (for example by amendment to the planned publication and/or by protecting information before publication) and the objecting Party shall not unreasonably continue the opposition if appropriate measures are taken following the discussion.

The objecting Party can request a publication delay of not more than 90 calendar days from the time it raises such an objection. After 90 calendar days the publication is permitted.

#### **8.4.3 Dissemination of another Party's unpublished Results or Background**

A Party shall not include in any dissemination activity another Party's Results or Background without obtaining the owning Party's prior written approval, unless they are already published.

#### **8.4.4 Cooperation obligations**

The Parties undertake to cooperate to allow the timely submission, examination, publication and defence of any dissertation or thesis for a degree that includes their Results or Background subject to the confidentiality and publication provisions agreed in this Consortium Agreement.

#### **8.4.5 Use of names, logos or trademarks**

Nothing in this Consortium Agreement shall be construed as conferring rights to use in advertising, publicity or otherwise the name of the Parties or any of their logos or trademarks without their prior written approval.

### **9. Section: Access Rights**

#### **9.1 Background included**

9.1.1 In Attachment 1, the Parties have identified and agreed on the Background for the Project and have also, where relevant, informed each other that Access to specific Background is subject to legal restrictions or limits.

Anything not identified in Attachment 1 shall not be the object of Access Right obligations regarding Background.

9.1.2 Any Party may add further own Background to Attachment 1 during the Project by written notice to the other Parties. However, approval of the General Assembly is needed should a Party wish to modify or withdraw its Background in Attachment 1.

#### **9.2 General Principles**

- 9.2.1 Each Party shall implement its tasks in accordance with the Consortium Plan and shall bear sole responsibility for ensuring that its acts within the Project do not knowingly infringe third party property rights.
- 9.2.2 Any Access Rights granted expressly exclude any rights to sublicense unless expressly stated otherwise.
- 9.2.3 Access Rights shall be free of any administrative transfer costs.
- 9.2.4 Access Rights are granted on a non-exclusive basis.
- 9.2.5 Results and Background shall be used only for the purposes for which Access Rights to it have been granted.
- 9.2.6 All requests for Access Rights shall be made in writing. The granting of Access Rights may be made conditional on the acceptance of specific conditions aimed at ensuring that these rights will be used only for the intended purpose and that appropriate confidentiality obligations are in place.
- 9.2.7 The requesting Party must show that the Access Rights are Needed.

### **9.3 Access Rights for implementation**

Access Rights to Results and Background Needed for the performance of the own work of a Party under the Project shall be granted on a royalty-free basis, unless otherwise agreed for Background in Attachment 1.

### **9.4 Access Rights for Exploitation**

- 9.4.1 Access Rights to Results if Needed for Exploitation of a Party's own Results shall be granted on Fair and Reasonable conditions.

Access rights to Results for internal research activities shall be granted on a royalty-free basis.

- 9.4.2 Access Rights to Background if Needed for Exploitation of a Party's own Results, including for research on behalf of a third party, shall be granted on Fair and Reasonable conditions.

- 9.4.3 A request for Access Rights may be made up to twelve months after the end of the Project or, in the case of Section 9.7.2.1.2, after the termination of the requesting Party's participation in the Project.

### **9.5 Access Rights for Affiliated Entities**

Affiliated Entities have Access Rights under the conditions of the Grant Agreement Articles 25.4 and 31.4 if they are identified in [Attachment 4 (Identified Affiliated Entities) to this Consortium Agreement].



Such Access Rights must be requested by the Affiliated Entity from the Party that holds the Background or Results. Alternatively, the Party granting the Access Rights may individually agree with the Party requesting the Access Rights to have the Access Rights include the right to sublicense to the latter's Affiliated Entities [listed in Attachment 4]. Access Rights to Affiliated Entities shall be granted on Fair and Reasonable conditions and upon written bilateral agreement.

Affiliated Entities which obtain Access Rights in return fulfil all confidentiality and other obligations accepted by the Parties under the Grant Agreement or this Consortium Agreement as if such Affiliated Entities were Parties.

Access Rights may be refused to Affiliated Entities if such granting is contrary to the legitimate interests of the Party which owns the Background or the Results.

Access Rights granted to any Affiliated Entity are subject to the continuation of the Access Rights of the Party to which it is affiliated, and shall automatically terminate upon termination of the Access Rights granted to such Party.

Upon cessation of the status as an Affiliated Entity, any Access Rights granted to such former Affiliated Entity shall lapse.

Further arrangements with Affiliated Entities may be negotiated in separate agreements.

## **9.6 Additional Access Rights**

For the avoidance of doubt any grant of Access Rights not covered by the Grant Agreement or this Consortium Agreement shall be at the absolute discretion of the owning Party and subject to such terms and conditions as may be agreed between the owning and receiving Parties.

## **9.7 Access Rights for Parties entering or leaving the consortium**

### **9.7.1 New Parties entering the consortium**

As regards Results developed before the accession of the new Party, the new Party will be granted Access Rights on the conditions applying for Access Rights to Background.

### **9.7.2 Parties leaving the consortium**

#### **9.7.2.1 Access Rights granted to a leaving Party**

##### **9.7.2.1.1 Defaulting Party**

Access Rights granted to a Defaulting Party and such Party's right to request Access Rights shall cease immediately upon receipt by the Defaulting Party of the formal

notice of the decision of the General Assembly to terminate its participation in the consortium.

#### 9.7.2.1.2 Non-defaulting Party

A non-defaulting Party leaving voluntarily and with the other Parties' consent shall have Access Rights to the Results developed until the date of the termination of its participation. It may request Access Rights within the period of time specified in Section 9.4.3.

#### 9.7.2.2 Access Rights to be granted by any leaving Party

Any Party leaving the Project shall continue to grant Access Rights pursuant to the Grant Agreement and this Consortium Agreement as if it had remained a Party for the whole duration of the Project.

### 9.8 Specific Provisions for Access Rights to Software

For the avoidance of doubt, the general provisions for Access Rights provided for in this Section 9 are applicable also to Software.

Parties' Access Rights to Software do not include any right to receive source code or object code ported to a certain hardware platform or any right to receive respective Software documentation in any particular form or detail, but only as available from the Party granting the Access Rights.

## 10. Section: Non-disclosure of information

10.1. All information in whatever form or mode of communication, which is disclosed by a Party (the "Disclosing Party") to any other Party (the "Recipient") in connection with the Project during its implementation and which has been explicitly marked as "confidential" at the time of disclosure, or when disclosed orally has been identified as confidential at the time of disclosure and has been confirmed and designated in writing within 15 calendar days from oral disclosure at the latest as confidential information by the Disclosing Party, is "Confidential Information".

10.2. The Recipients hereby undertake in addition and without prejudice to any commitment on non-disclosure under the Grand Agreement, for a period of 4 years after the end of the Project:

- Not to use Confidential Information otherwise than for the purpose for which it was disclosed;
- not to disclose Confidential Information to any third parties without the prior written consent by the Disclosing Party; bearing in mind that the Identified Affiliated Entities listed in Attachment 4 are not considered parties in this respect;

- to ensure that internal distribution of Confidential Information by a Recipient shall take place on a strict need-to-know basis; and
- to return to the Disclosing Party, or destroy, on request all Confidential Information that has been disclosed to the Recipients including all copies thereof and to delete all information stored in a machine readable form to the extent practically possible. The Recipients may keep a copy to the extent it is required to keep, archive or store such Confidential Information because of compliance with applicable laws and regulations or for the proof of on-going obligations provided that the Recipient comply with the confidentiality obligations herein contained with respect to such copy for as long as the copy is retained or for as long as is permissible under national law.

10.3. The recipients shall be responsible for the fulfilment of the above obligations on the part of their employees or third parties involved in the Project and shall ensure that they remain so obliged, as far as legally possible, during and after the end of the Project and/or after the termination of the contractual relationship with the employee or third party.

10.4. The above shall not apply for disclosure or use of Confidential Information, if and in so far as the Recipient can show that:

- the Confidential Information has become or becomes publicly available by means other than a breach of the Recipient's confidentiality obligations;
- the Disclosing Party subsequently informs the Recipient that the Confidential Information is no longer confidential;
- the Confidential Information is communicated to the Recipient without any obligation of confidentiality by a third party who is to the best knowledge of the Recipient in lawful possession thereof and under no obligation of confidentiality to the Disclosing Party;
- the disclosure or communication of the Confidential Information is foreseen by provisions of the Grant Agreement;
- the Confidential Information, at any time, was developed by the Recipient completely independently of any such disclosure by the Disclosing Party;
- the Confidential Information was already known to the Recipient prior to disclosure, or
- the Recipient is required to disclose the Confidential Information in order to comply with applicable laws or regulations or with a court or administrative order, subject to the provision Section 10.7 hereunder.

10.5. The Recipient shall apply the same degree of care with regard to the Confidential Information disclosed within the scope of the Project as with its own confidential and/or proprietary information, but in no case less than reasonable care.

10.6. Each Party shall promptly advise the other Party in writing of any unauthorised disclosure, misappropriation or misuse of Confidential Information after it becomes aware of such unauthorised disclosure, misappropriation or misuse.

10.7. If any Party becomes aware that it will be required, or is likely to be required, to disclose Confidential Information in order to comply with applicable laws or regulations or with a court or administrative order, it shall, to the extent it is lawfully able to do so, prior to any such disclosure

- notify the Disclosing Party, and
- comply with the Disclosing Party's reasonable instructions to protect the confidentiality of the information.

## **11. Section: Miscellaneous**

### **11.1 Attachments, inconsistencies and severability**

This Consortium Agreement consists of this core text and

Attachment 1 (Background included)

Attachment 2 (Accession document)

Attachment 3 (List of Third Parties for simplified transfer according to Section 8.3.2)

Attachment 4 (Identified Affiliated Entities)

In case the terms of this Consortium Agreement are in conflict with the terms of the Grant Agreement, the terms of the latter shall prevail. In case of conflicts between the attachments and the core text of this Consortium Agreement, the latter shall prevail.

Should any provision of this Consortium Agreement become invalid, illegal or unenforceable, it shall not affect the validity of the remaining provisions of this Consortium Agreement. In such a case, the Parties concerned shall be entitled to request that a valid and practicable provision be negotiated that fulfils the purpose of the original provision.

### **11.2 No representation, partnership or agency**

Except as otherwise provided in Section 6.4.4, no Party shall be entitled to act or to make legally binding declarations on behalf of any other Party or of the consortium. Nothing in this Consortium Agreement shall be deemed to constitute a joint venture, agency, partnership, interest grouping or any other kind of formal business grouping or entity between the Parties.

### **11.3 Notices and other communication**

Any notice to be given under this Consortium Agreement shall be in writing to the addresses and recipients as listed in the most current address list kept by the Coordinator.

Formal notices:

If it is required in this Consortium Agreement (Sections 4.2, 9.7.2.1.1, and 11.4) that a formal notice, consent or approval shall be given, such notice shall be signed by an authorised representative of a Party and shall either be served personally or sent by mail with recorded delivery or telefax with receipt acknowledgement.

Other communication:

Other communication between the Parties may also be effected by other means such as e-mail with acknowledgement of receipt, which fulfils the conditions of written form.

Any change of persons or contact details shall be notified immediately by the respective Party to the Coordinator. The address list shall be accessible to all Parties.

#### **11.4 Assignment and amendments**

Except as set out in Section 8.3, no rights or obligations of the Parties arising from this Consortium Agreement may be assigned or transferred, in whole or in part, to any third party without the other Parties' prior formal approval.

Amendments and modifications to the text of this Consortium Agreement not explicitly listed in Section 6.3.1.2 require a separate written agreement to be signed between all Parties.

#### **11.5 Mandatory national law**

Nothing in this Consortium Agreement shall be deemed to require a Party to breach any mandatory statutory law under which the Party is operating.

#### **11.6 Language**

This Consortium Agreement is drawn up in English, which language shall govern all documents, notices, meetings, arbitral proceedings and processes relative thereto.

#### **11.7 Applicable law**

This Consortium Agreement shall be construed in accordance with and governed by the laws of Belgium excluding its conflict of law provisions.

#### **11.8 Settlement of disputes**

The parties shall endeavour to settle their disputes amicably.

Any dispute, controversy or claim arising under, out of or relating to this contract and any subsequent amendments of this contract, including, without limitation, its formation, validity,

binding effect, interpretation, performance, breach or termination, as well as non-contractual claims, shall be submitted to mediation in accordance with the WIPO Mediation Rules. The place of mediation shall be Brussels unless otherwise agreed upon. The language to be used in the mediation shall be English unless otherwise agreed upon.

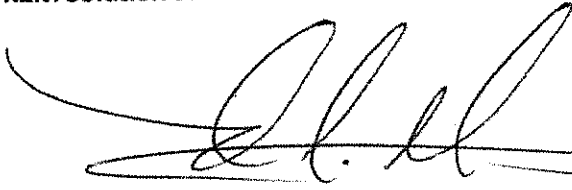
If, and to the extent that, any such dispute, controversy or claim has not been settled pursuant to the mediation within 60 calendar days of the commencement of the mediation, the courts of Brussels shall have exclusive jurisdiction.

## **12. Section Signatures**

### **AS WITNESS:**

The Parties have caused this Consortium Agreement to be duly signed by the undersigned authorised representatives in separate signature pages the day and year first above written.

R2M Solution Srl



**Thomas Messervey**  
Co-Founder & CEO  
Date

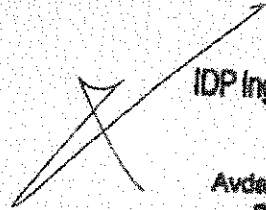


**R2M Solution Srl**  
Via F.lli Cuzio 42 - 27100 Pavia - Italy  
P.IVA 04998380879



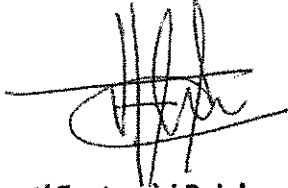
**IDP Ingeniería y Arquitectura Iberia S.L.U.**

**Mr. Jaime Polo Villafaina**  
Co-founder and New Business Management  
Date



**IDP Ingeniería y arquitectura iberia, S.L.**  
B62731807  
Edifici Torre Mil·lennium  
Avda. Francesc Macià, 60 3ª Planta  
08208 Sabadell (Barcelona)

COMSA CORPORACIÓN DE INFRAESTRUCTURAS SL



Valentí Fontserè i Pujol

Technical Director

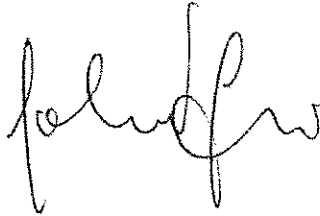
Date

11/05/2018

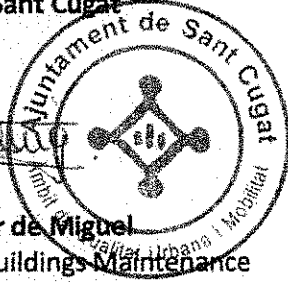
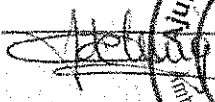


**CONSIGLIO NAZIONALE DELLE RICERCHE**

**Salvatore Vincenzo Freni**  
Institute Director  
Date 14/05/2018

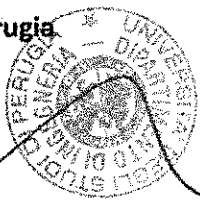
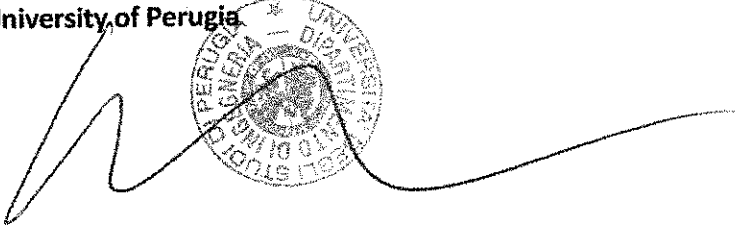


Ajuntament de Sant Cugat



**Ms Carme Ferrer de Miguel**  
Head of Public Buildings Maintenance  
Date

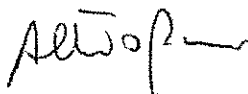
**University of Perugia**



**Giuseppe Saccomandi**  
Director of the department of Engineering – PLSIGN  
Date

**IDS GeoRadar srl**

**Alberto Bicci**  
**Legal Representative**



Date **11 MAG. 2018**



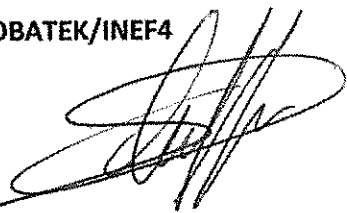
Ochsner Wärmepumpen GmbH



Marco Schäfer  
COO

Date 14 | 05 | 2018

**NOBATEK/INEF4**



**Mr. Olivier SCHEFFER**

Director

Date *14/05/2018*

**NOBATEK/INEF4**

SCIC SA à capital variable

67 Rue de Mirambeau - 64600 ANGLET

Tél. : 05 59 03 61 29

Siret : 451 931 208 00040 - APE : 7112B

**AIT Austrian Institute of Technology GmbH**



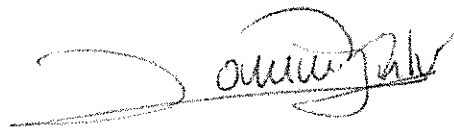
AIT Austrian Institute of Technology GmbH  
Giefinggasse 4 | 1210 Wien, Austria  
T +43 (0) 50550-0 | F +43 (0) 50550-2201  
office@ait.ac.at | www.ait.ac.at

**DI Anton PLIMON**  
Managing Director  
Data

**Dr. Brigitte BACH**  
Head of Center for Energy

14.5.2018

**Catalana de Perforacions, S.A.**

A handwritten signature in black ink, appearing to read 'Domènec Pinto', written over a horizontal line.

**Domènec Pinto**

**Director General**

Date 14/05/2018

**Uponor Corporation**



**Ilari Aho**

VP, New Business Development and CSR

Date 23/5/18

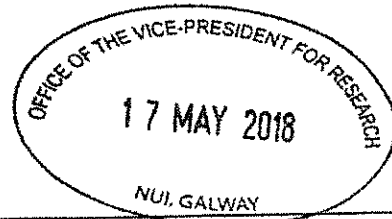
National University of Ireland, Galway



Ian Knight

Head of Research Contracts

Date 17.05.2018



**Fahrenheit GmbH**

~~Walter Mittelbach~~

~~CTO~~

Date May 14, 2018

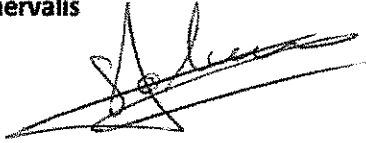


**Matthias Hoene**

CEO



**Enervalis**




**Stefan Lodeweyckx**

CEO

Date

14/5/18

**Luleå University of Technology**

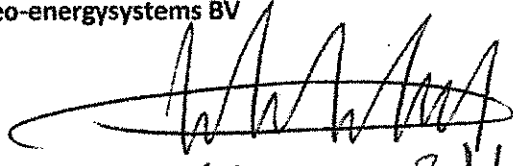
A handwritten signature in black ink, appearing to read 'B. Bergvall-Kåreborn', written in a cursive style.

**Birgitta Bergvall-Kåreborn**

Vice-Chancellor

Date

Groenholland Geo-energysystems BV



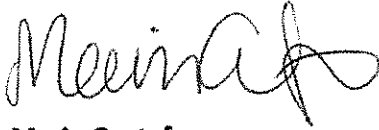
A.J. van Gelder.

Guus van Gelder

Director

Date 14-05-2018

**KTH Royal Institute of Technology**



**Maria Gustafsson**  
Head of Research Office

Date *May 14 2018*



**EURECAT**

A handwritten signature in black ink, appearing to be 'XLR', with a long horizontal stroke extending to the left.

**Xavier López**

Corporate & Operations Managing Director

Date *May 14, 2018*

Comet Technologies



Joan Nuñez  
Director Comercial  
Date

A handwritten signature in black ink, appearing to be "J. Nuñez", is written over the printed name and title.

**Sistemi Informativi Analisi Rischio Territoriale Srl**

*Franco Bobba*



**Franco Bobba**  
Legal Representative  
Date

**Comharchumann Fuinnimh Oileáin Áraan Teoranta**

Dara Ó Maoiládhia

**Dara Ó MAOILDHIA**

Legal Representative

Date 12/5/18



**Carel Industries SpA**

**Luigi Rossi Luciani**  
Legal Representative  
Date 18 MAY 2018

A handwritten signature in black ink, appearing to read "Luigi Rossi Luciani". The signature is written in a cursive style with a large initial 'L'.

**Asociación Española de Normalización**



**UNE**  
Asociación Española de Normalización

Asociación Española de Normalización

**Mr. Javier Garcia Djaz**

Director General of Asociación Española de Normalización, UNE

Date 2018 - 05 - 10

### **Attachment 1: Background included**

According to the Grant Agreement (Article 24) Background is defined as “data, know-how or information (...) that is needed to implement the action or exploit the results”. Because of this need, Access Rights have to be granted in principle, but Parties must identify and agree amongst them on the Background for the project. This is the purpose of this attachment.

**R2M Solution Srl**

As to R2M Solution Srl, it is agreed between the Parties that, to the best of their knowledge:

No data, know-how or information of **R2M Solution Srl** shall be Needed by another Party for implementation of the Project (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

**IDP Ingeniería y Arquitectura Iberia S.L.U.**

As to IDP Ingeniería y Arquitectura Iberia S.L.U., it is agreed between the Parties that, to the best of their knowledge:

The following background is hereby identified and agreed upon for the Project. Specific limitations and/or conditions, shall be as mentioned hereunder:

Describe Background	Specific limitations and/or conditions for implementation (Article 25.2 Grant Agreement)	Specific limitations and/or conditions for Exploitation (Article 25.3 Grant Agreement)
Software, processes and methodologies regarding BIM development of MEP &EE technologies and integration	Royalty free access to project partners where background is required to carry out their role in the work program.	Access to background needed to exploit results of project will be provided under fair and reasonable conditions to be jointly with the Party or Parties in separate agreement.

This represents the status at the time of signature of this Consortium Agreement.

**COMSA CORPORACIÓN DE INFRAESTRUCTURAS SL**

As to COMSA CORPORACIÓN DE INFRAESTRUCTURAS SL, it is agreed between the Parties that, to the best of their knowledge:

No data, know-how or information of **COMSA** shall be Needed by another Party for implementation of the Project (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

**CONSIGLIO NAZIONALE DELLE RICERCHE – Istituto di Tecnologie Avanzate per l’Energia « Nicola Giordano”**

As to CONSIGLION NAZIONALE DELLE RICERCHE, it is agreed between the Parties that, to the best of their knowledge

The following background is hereby identified and agreed upon for the Project. Specific limitations and/or conditions, shall be as mentioned hereunder:

Describe Background	Specific limitations and/or conditions for implementation (Article 25.2 Grant Agreement)	Specific limitations and/or conditions for Exploitation (Article 25.3 Grant Agreement)
Background knowledge developed within the area of Thermal Energy Systems belonging to the CNR-ITAE as needed for the execution of the Project.	Right of access to Consortium Parties during project only. Conditions will be agreed between the party and ITAE	In the event this background is needed for exploitation of a Party’s own results, terms will need to be agreed between the Party and ITAE on fair and reasonable terms.

This represents the status at the time of signature of this Consortium Agreement.

**Ajuntament de Sant Cugat**

As to Ajuntament de Sant Cugat, it is agreed between the Parties that, to the best of their knowledge,

No data, know-how or information of **Ajuntament de Sant Cugat** shall be Needed by another Party for implementation of the Project (Article 25.2 Grant Agreement) or Exploitation of that other Party’s Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

**University of Perugia**

As to University of Perugia, it is agreed between the Parties that, to the best of their knowledge, The following background is hereby identified and agreed upon for the Project. Specific limitations and/or conditions, shall be as mentioned hereunder:

Describe Background	Specific limitations and/or conditions for implementation (Article 25.2 Grant Agreement)	Specific limitations and/or conditions for Exploitation (Article 25.3 Grant Agreement)
Building energy analysis methods. Continuous monitoring and data analysis methods. Case study assessment.	No limitations for implementation of the Article 25.2 of the GA. UNIPG gives access – on a royalty-free basis – to its nackground for what its task manager believes in each task.	No limitations for implementation of the Article 25.2 of the GA. UNIPG gives access – on a royalty-free basis – to its nackground for what its task manager believes in each task.

**IDS GeoRadar srl**

As to IDS GeoRadar srl, it is agreed between the Parties that, to the best of their knowledge (*please choose*)

No data, know-how or information of **IDS GeoRadar srl** shall be Needed by another Party for implementation of the Project (Article 25.2 Grant Agreement) or Exploitation of that other Party’s Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

**Oschner Wärmepumpen GmbH**

As to Oschner Wärmepumpen GmbH, it is agreed between the Parties that, to the best of their knowledge,

No data, know-how or information of **Oschner Wärmepumpen GmbH** shall be Needed by another Party for implementation of the Project (Article 25.2 Grant Agreement) or Exploitation of that other Party’s Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

**NOBATEK/INEF4**

As to NOBATEK/INEF4, it is agreed between the parties that, to the best of their knowledge: The following background is hereby identified and agreed upon for the Project. Specific limitations and/or conditions, shall be as mentioned hereunder:

Describe Background	Specific limitations and/or conditions for implementation (Article 25.2 Grant Agreement)	Specific limitations and/or conditions for exploitation (Article 25.3 Grant Agreement)
Knowledge and expertise related to methodologies, software, processes, implementation for energy efficient building design, monitoring and holistic evaluation.	If needed, for use within the Geofit project only.	Access to NOBATEK/INEF4's background for exploitation purposes and foreground actions undertaken by beneficiaries distinct from NOBATEK/INEF4, will require legal consent of the company and discussion of possible financial terms or copyright terms.
Expertise related to design and simulation of energy technologies implemented at building and district level. (Technologies have been developed within the projects BATISOL, COSYBA and MCPFLEX financed by INEF4).	MCPFlex and Batisol related data will be made available, if necessary, upon written request to the partners dealing with related tasks, for the implementation of the project and have to be treated confidentially. Methods developed in Cosyba will be implemented by NOBATEK/INEF4, and the simulation results formats will be made compatible in some cases with the needs from other partners.	
Expertise related to data collection, gathering, processing and interpretation for monitoring purposes (Part of the technologies have been developed within the H2020-EeB-2015 project HIT2GAP, project 680708).	HIT2GAP related data will be made available, if necessary, upon written request to the partners dealing with related tasks, for the implementation of the project and have to be treated confidentially.	

This represents the status at the time of signature of this Consortium Agreement.

**Austrian Institute of Technology GmbH**

As to AIT Austrian Institute of Technology GmbH, it is agreed between the Parties that, to the best of their knowledge,

The following background is hereby identified and agreed upon for the Project. Specific limitations and/or conditions, shall be as mentioned hereunder:

Describe Background	Specific limitations and/or conditions for implementation (Article 25.2 Grant Agreement)	Specific limitations and/or conditions for Exploitation (Article 25.3 Grant Agreement)
Background knowledge accumulated and developed within the area of Heat Pump Technologies belonging to AIT which is needed for the execution of the Project.	Consortium Parties have the right to access the background knowledge during project only. Conditions will be agreed between the party and AIT.	If this background is needed for exploitation of a Party's own results, terms will need to be agreed between the Party and AIT on fair and reasonable terms.

This represents the status at the time of signature of this Consortium Agreement.

**Catalana de Perforacions, S.A**

As to Catalana de Perforacions, S.A, it is agreed between the Parties that, to the best of their knowledge (*please choose*)

No data, know-how or information of **Catalana de Perforacions, S.A** shall be Needed by another Party for implementation of the Project (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

**Uponor**

As to Uponor, it is agreed between the Parties that, to the best of their knowledge (*please choose*)

No data, know-how or information of Uponor shall be Needed by another Party for implementation of the Project (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.



**National University of Ireland, Galway**

As to National University of Ireland, Galway, it is agreed between the Parties that, to the best of their knowledge (*please choose*)

The following background is hereby identified and agreed upon for the Project. Specific limitations and/or conditions, shall be as mentioned hereunder:

Describe Background	Specific limitations and/or conditions for implementation (Article 25.2 Grant Agreement)	Specific limitations and/or conditions for Exploitation (Article 25.3 Grant Agreement)
<p>Knowledge about grey-box building energy performance modelling and simulation</p>	<p>This know-how will be applied for the development of project tasks related with building and demand response strategies</p> <p>The NUIG know-how and expertise will be available for consulting, usage and adaptations/modifications for project implementation purposes. The partners will not copy, reproduce or otherwise use the NUIG know-how and expertise for any other purposes than the current project implementation. The IPR of all the modifications of the documents and information provided by NUIG will be vested in NUIG after project implementation.</p>	<p>The access to and usage of the NUIG know-how and expertise will be limited only to the project implementation period and will not be available after that period neither for partners nor for the final users of the project results.</p> <p>For the exploitation of this background a specific agreement between the parties must be negotiated aiming for fair and reasonable conditions.</p>
<p>Knowledge and methodology for the validation of project technical results under international standards (IPMVP, ASHRAE-14)</p>	<p>This know-how will be applied for the development of project tasks related with validation of project results aimed at improving market acceptance</p> <p>The NUIG know-how and expertise will be available for consulting, usage and adaptations/modifications for project implementation purposes. The partners will not copy, reproduce or otherwise use the NUIG know-</p>	<p>The access to and usage of the NUIG know-how and expertise will be limited only to the project implementation period and will not be available after that period neither for partners nor for the final users of the project results.</p> <p>For the exploitation of this background a specific agreement between the</p>

	how and expertise for any other purposes than the current project implementation. The IPR of all the modifications of the documents and information provided by NUIG will be vested in NUIG after project implementation.	parties must be negotiated aiming for fair and reasonable conditions.
--	---	---

This represents the status at the time of signature of this Consortium Agreement.

**Fahrenheit GMBH**

As to Fahrenheit GMBH, it is agreed between the Parties that, to the best of their knowledge:

The following background is hereby identified and agreed upon for the Project. Specific limitations and/or conditions, shall be as mentioned hereunder:

Describe Background	Specific limitations and/or conditions for implementation (Article 25.2 Grant Agreement)	Specific limitations and/or conditions for Exploitation (Article 25.3 Grant Agreement)
Solid substance sorption heat pump (EP 1495272)	IP provided if and as needed upon request royalty free to any partner requiring said IP to perform their tasks but protected within the scope of the patent description	Commercial use only in agreement with Fahrenheit and in line with normal patent licensing terms and conditions.
Adsorption apparatus comprising a heat recovery System (EP 1831617)	IP provided if and as needed upon request royalty free to any partner requiring said IP to perform their tasks but protected within the scope of the patent description	Commercial use only in agreement with Fahrenheit and in line with normal patent licensing terms and conditions.
Compact sorption cooling unit (EP 2118588)	IP provided if and as needed upon request royalty free to any partner requiring said IP to perform their tasks but protected within the scope of the patent description	Commercial use only in agreement with Fahrenheit and in line with normal patent licensing terms and conditions.
Method for operating a cyclically working thermal adsorption heat or refrigeration system and device (EP 2710311)	IP provided if and as needed upon request royalty free to any partner requiring said IP to perform their tasks but protected within the scope of the patent description	Commercial use only in agreement with Fahrenheit and in line with normal patent licensing terms and conditions.

This represents the status at the time of signature of this Consortium Agreement.

**Enervalis**

As to Enervalis, it is agreed between the Parties that, to the best of their knowledge (*please choose*)

No data, know-how or information of **Enervalis** shall be Needed by another Party for implementation of the Project (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

**Luleå University of Technology**

As to Luleå University of Technology, it is agreed between the Parties that, to the best of their knowledge,

No data, know-how or information owned by the attending Researchers at **Luleå University of Technology** shall be Needed by another Party for implementation of the Project (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

**Groenholland NV**

As to Groenholland Geo-energysystems BV, it is agreed between the Parties that, to the best of their knowledge,

The following background is hereby identified and agreed upon for the Project. Specific limitations and/or conditions, shall be as mentioned hereunder:

Describe Background	Specific limitations and/or conditions for implementation (Article 25.2 Grant Agreement)	Specific limitations and/or conditions for Exploitation (Article 25.3 Grant Agreement)
Experience in advanced multi-pulse thermal response testing and data evaluation, design of TRT test equipment	none	Commercial use only in agreement with Groenholland
Developed in-house calculation methods for borehole heat exchanger that may be applied to earth-baskets and other types of novel heat exchangers	none	Commercial use only in agreement with Groenholland

### **KTH Royal Institute of Technology**

As to KTH Royal Institute of Technology, it is agreed between the Parties that, to the best of their knowledge,

No data, know-how or information of **KTH Royal Institute of Technology** shall be Needed by another Party for implementation of the Project (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

### **EURECAT**

As to EURECAT, it is agreed between the Parties that, to the best of their knowledge,

No data, know-how or information of **EURECAT** shall be Needed by another Party for implementation of the Project (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

### **Comet Technologies**

As to Comet Technologies, it is agreed between the Parties that, to the best of their knowledge,

No data, know-how or information of **Comet Technologies** shall be Needed by another Party for implementation of the Project (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

### **Sistemi Informativi Analisi Rischio Territoriale Srl**

As to Sistemi Informativi Analisi Rischio Territoriale Srl, it is agreed between the Parties that, to the best of their knowledge (*please choose*)

No data, know-how or information of **Sistemi Informativi Analisi Rischio Territoriale Srl** shall be Needed by another Party for implementation of the Project (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

#### **Comharchumann Fuinnimh Olleáin Áraan Teoranta**

As to Comharchumann Fuinnimh Olleáin Áraan Teoranta, it is agreed between the Parties that, to the best of their knowledge (*please choose*)

No data, know-how or information of **Comharchumann Fuinnimh Olleáin Áraan Teoranta** shall be Needed by another Party for implementation of the Project (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

#### **Carel Industries SPA**

No data, know-how or information of **Carel Industries SPA** shall be Needed by another Party for implementation of the Project (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

#### **Asociación Española de Normalización**

As to Asociación Española de Normalización, it is agreed between the Parties that, to the best of their knowledge,

No data, know-how or information of **Asociación Española de Normalización** shall be Needed by another Party for implementation of the Project (Article 25.2 Grant Agreement) or Exploitation of that other Party's Results (Article 25.3 Grant Agreement).

This represents the status at the time of signature of this Consortium Agreement.

Attachment 2: Accession document

ACCESSION

of a new Party to

**[Acronym of the Project] Consortium Agreement, version [..., YYYY-MM-DD]**

**[OFFICIAL NAME OF THE NEW PARTY AS IDENTIFIED IN THE Grant Agreement]**

hereby consents to become a Party to the Consortium Agreement identified above and accepts all the rights and obligations of a Party starting [date].

**[OFFICIAL NAME OF THE COORDINATOR AS IDENTIFIED IN THE Grant Agreement]**

hereby certifies that the consortium has accepted in the meeting held on [date] the accession of [the name of the new Party] to the consortium starting [date].

This Accession document has been done in 2 originals to be duly signed by the undersigned authorised representatives.

**[Date and Place]**

**[INSERT NAME OF THE NEW PARTY]**

Signature(s)

Name(s)

Title(s)

**[Date and Place]**

**[INSERT NAME OF THE COORDINATOR]**

Signature(s)

Name(s)

Title(s)

Attachment 3: List of Third Parties for simplified transfer according to Section 8.3.2.

For R2M Solution, affiliated third parties within the R2M Group consist of R2M Solution SL (Spain), R2M Solution France SAS, R2M Solution Ltd (UK) and R2M Energy s.r.l.

For IDS Georadar:

HEXAGON Group companies in EU countries, EU associated countries and extra-EU countries

**Attachment 4: Identified Affiliated Entities according to Section 9.5]**

For R2M Solution, affiliated third parties within the R2M Group include R2M Solution SL (Spain), R2M Solution France SAS, R2M Solution Ltd (UK) and R2M Energy s.r.l.

For IDS Georadar:

HEXAGON Group companies in EU countries, EU associated countries and extra-EU countries



Allegato N. 3 al punto  
dell'ordine del giorno N. 16

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*Ministero dell'Istruzione dell'Università e della Ricerca*

Dipartimento per la formazione superiore e per la Ricerca

Direzione Generale per il Coordinamento, la promozione e la valorizzazione della Ricerca

PRIN: PROGETTI DI RICERCA DI RILEVANTE INTERESSE NAZIONALE – Bando 2017

Prot. 20172FSCH4

**PART A**

*1. Action line*

Young line/Linea Giovani

*2. Research project title*

Towards the NEXT generation of multiphysics and multidomain environmental COMfort models: theory elaboration and validation experiment

*3. Duration (months)*

36 months

*4. Main ERC field*

PE - Physical Sciences and Engineering

*5. Possible other ERC field*

*6. ERC subfields*

1. PE8\_6 Energy processes engineering
2. PE8\_3 Civil engineering, architecture, maritime/hydraulic engineering, geotechnics, waste treatment
- 3.

7. Key Words

n°	Testo Inglese
1.	indoor environment engineering
2.	environmental comfort
3.	energy efficiency
4.	metrology and measurement
5.	behaviour
6.	whole-comfort

8. Principal Investigator

<b>FABRIZIO</b> (Surname)	<b>ENRICO</b> (Name)
<b>Professore Associato (L. 240/10)</b> (Category)	
<b>21/05/1978</b> (Date of birth)	<b>FBRNRC78E21L219P</b> (Personal identification code)
<b>Politecnico di TORINO</b> (University)	
<b>+390110904465</b> (telephone number)	<b>enrico.fabrizio@polito.it</b> (E-mail address)

9. List of the Research Units

n°	Associated Investigator	Category	University/ Research Institution	Registered office (address)	e-mail address
1.	FABRIZIO Enrico	Professore Associato (L. 240/10)	Politecnico di TORINO	Corso Duca degli Abruzzi, 24 - TORINO (TO)	enrico.fabrizio@polito.it

2.	PISELLO Annalaura	Ricercatore a t.d. - t.pieno (art. 24 c.3-a L. 240/10)	Università degli Studi di PERUGIA	P.zza dell' Università', 1 - PERUGIA (PG)	anna.pisello@unipg.it
3.	BUONOMANO Annamaria	Ricercatore a t.d. (art. 24 c.3-b L. 240/10)	Università degli Studi di Napoli Federico II	C.so Umberto I, 40 - NAPOLI (NA)	annamaria.buonomano@unina.it
4.	ARNESANO Marco	Ricercatore a t.d. - t.pieno (art. 24 c.3-a L. 240/10)	Università Politecnica delle MARCHE	P.zza Roma, 22 - ANCONA (AN)	m.arnesano@univpm.it

### 10. Brief description of the research proposal

NEXT.COM will develop a frontier breakthrough of comfort investigation in the built environment by testing and validating a brand new **multiphysics, multidomain and multisensorial** comfort experimental protocol and exhaustive analytic interpretation model. Answers to the key research issues motivating occupancy behaviour, driving and reducing energy needs and improving wellbeing conditions within the built environment will be provided. To this aim, the project will exploit the full potential of a new generation of monitoring apparatus (e.g. skin temperature sensors, galvanic skin response sensors, brain activity, activity/posture, augmented-virtual reality, etc.) that are currently used in other domains but have not been completely exploited in building physics yet. The comfort interpretation model will be integrated into some of the most common ready-to-use and customized dynamic building energy simulation tools to assess also the potentialities of the approach in terms of energy saving in new and existing buildings. The research outcomes of NEXT.COM will be fully exploited for integration into international protocols for sustainable/healthy buildings and outdoor investigations for healthier and more resilient buildings of the future.

### 11. Total cost of the research project, per single item

Associated Investigator	item A.1	item A.2.1	item B	item C	item D	item E	sub-total	item F	Total
FABRIZIO Enrico	29.049	75.000	62.429	5.000	0	12.000	183.478	20.144,34	203.622,34
PISELLO Annalaura	0	90.000	54.000	18.000	0	30.000	192.000		192.000
BUONOMANO Annamaria	0	80.000	48.000	10.000	0	10.000	148.000		148.000
ARNESANO Marco	0	75.000	45.000	10.000	0	18.000	148.000		148.000
<b>Total</b>	<b>29.049</b>	<b>320.000</b>	<b>209.429</b>	<b>43.000</b>	<b>0</b>	<b>70.000</b>	<b>671.478</b>	<b>20.144,34</b>	<b>691.622,34</b>

- item A.1: Enhancement of months/person of permanent employees
- item A.2.1: Cost of contracts of non-employees, specifically to recruit
- item B: Overheads (flat rate equal to 60% of the total cost of staff, A.1 + A.2.1, for each research unit)
- item C: Cost of equipment, instruments and software
- item D: Cost of consulting services and similar
- item E: Other operating costs
- item F: Prize (automatically calculated as 3% of total cost of the project)

## PART B

### B.1

## 1. Abstract

In the last ten years new monitoring equipment and sensors have been released for the analysis of human wellbeing, neural and physiological sensations and also indoor environmental quality (IEQ) of living spaces, while consolidated theories have been applied for investigating indoor comfort and its consequences on occupancy behavior and energy consumption. Together with classic environmental sensors aimed at measuring physical parameters, other novel sensors are now widely available for measuring human-related parameters and forcing, such as heart rate monitors, breath frequency sensors, skin temperature sensors, galvanic skin response sensors, activity/posture trackers, augmented-virtual reality scenarios, and they are used in different domains (physics, medicine, marketing, robotics, etc.) for characterizing human physiology, psychology, societal reactions to a variety of stimuli.

NEXT.COM starts from the evidence that measurements from such new fields may be precious for better characterizing the indoors from the perspective of users' perception. In fact, existing comfort models have not yet integrated these key variables. The potentiality of such new sensors and integrated data analysis theories needs to be exploited in a new comfort theory definition, which both the scientific community and the professional world are looking forward to experiencing in new building design and retrofit towards the zero-energy target.

Starting from this premise, NEXT.COM will develop a frontier breakthrough of comfort investigation, by testing and validating a brand new **multiphysics, multidomain and multisensorial comfort experimental protocol** (hereinafter whole-comfort) and **exhaustive analytic interpretation model**.

A novel approach will be theorized and experimentally and numerically demonstrated, in order to investigate and identify the key human comfort drivers that are able to determine personal perception in the built environment and, consequently, to trigger energy-related occupancy behaviour, reducing energy needs and improving wellbeing conditions.

A large data collection of personal surveys and experimental field campaigns will be carried out, while integrating the key results elaborated within physical environments (test-room and real buildings) and re-created environmental conditions (based on augmented and virtual reality) in several geoclusters.

Then, a data-driven modelling approach will be proposed by identifying the key variables and eventually widening the boundary of the physical-only based comfort model. Therefore, an exhaustive, open-data, reliable sensitivity analysis and final elaboration will be done.

Such whole-comfort interpretation model, mainly data-driven, will be exploited for further integration into ready-to-use and customized dynamic building energy simulation tools in order to assess also the potentialities of the approach in terms of energy efficiency targets in new and existing buildings.

The project is organized into 8 different Work Packages that address the preliminary research activities, the experimental set-up and test sites, the model development, its validation and the exploitation stages.

NEXT.COM consortium is made of 4 Research Units (RUs) whose complementary skills, within the building physics framework, consist of the assessment of the IEQ in both indoors and outdoors, the building energy modelling and the thermal, physiological, medical measurements. Each RU has a track record of research on the NEXT.COM topic and operating facilities and sensors to be used during the project development. Each RU already cooperates with foreign highly qualified universities in the field of NEXT.COM: foreigner outstanding young scientists will be further contributing to the project development into other geoclusters and new experimental setups put at disposal of this project.

As a key multidisciplinary and multidomain impact, the project results will be ready for implementation into the new generation of international protocols for sustainable/healthy buildings (Well, LEED, etc.).

Furthermore, the resulting model may be tailored for the outdoor IEQ assessment, a research area that is currently even less widely explored and consolidated than the indoor IEQ assessment.

The project scopes are also in line with EU Horizon 2020 targets toward the promotion of a deep societal challenge in determining well-being and sustainable development in the built environment. They also fit the scopes of both the 2nd recast of the Energy Performance of Buildings Directive and the European Environmental Action Programme.

In this framework, NEXT.COM will respond to a broad social opportunity and tremendous challenge, such as to shape the new frontier of energy efficient, comfortable and sustainable building design and retrofit, while creating healthier and more productive conditions and improved quality of life for occupants in resilient cities.

## 2. Detailed description of the project: targets that the project aims to achieve and their significance in terms of advancement of knowledge, state of the art and proposed methodology

### MOTIVATION

Indoor comfort is strongly dependent on local climate, human physiology and behaviour, as well as cultural and psycho-sociological aspects. Although occupants' satisfaction with dynamic surrounding conditions is a subjective matter, it needs to be properly quantitatively investigated when designing and operating a living built environment.

Together with classic environmental sensors aimed at measuring physical parameters, other novel sensors are now available for measuring human-related parameters, such as heart rate monitors, breath frequency sensors, skin temperature sensors, galvanic skin response sensors, brain activity sensors, activity/posture trackers (e.g. through accelerometers). These sensors are currently used in different domains (physics, medicine, etc.) for characterizing human physiology, psychology etc., but they may be used as well to better characterize the indoor environment from the perspective of the user perception and to increase the awareness of comfort of occupants/users. Until now, comfort models have not yet integrated these variables and the potential of these new sensors is yet to be exploited in an integrated comfort theory definition that goes beyond the "traditional" different comfort domains such as thermal, visual, acoustic, IAQ. This is much needed from the scientific community and the professional world designing and retrofitting the buildings towards the near zero energy target. At the same time, there is the need to make a step forward from the results achieved in the '70s and based on 4 environmental variables completely quantifiable through physical measurements and 2 user properties inputted by the user.

### PROJECT OBJECTIVE AND TARGETS

The scope of the project is to develop a brand new multiphysics, multidomain and multisensorial comfort (hereinafter whole-comfort) experimental protocol and exhaustive interpretation model, in order to answer the key research issue motivating occupancy behaviour, energy need, health conditions within the built environment. Therefore, a breakthrough approach will be theorized and experimentally, analytically and numerically demonstrated, while responding to a key, still **unanswered research question**: the investigation and identification of key human comfort drivers able to determine personal perception in the built environment and, consequently, to trigger energy-related occupancy behaviour. The **framework hypothesis** consists in assuming that these personal and society driven behaviours cannot be exhaustively explained by only measuring key instantaneous or historical environmental parameters. Therefore, by taking advantage of engineering and health expertise of the NEXT.COM consortium, and exploiting the potential of new sensors already available in different domains, an innovative experimental protocol and a comprehensive interpretation model is here developed for the first time, while synergistically combining four main complimentary research areas all playing with indoor-outdoor occupancy, i.e.: (i) energy and environmental sustainability of the built environment; (ii)

indoor-outdoor environmental quality; (iii) new big data analytics and virtual-augmented reality science; and (iv) health-related issues and human resilience.

New consolidated insights motivating the way people perform specific energy-related actions in the surrounding built environment are expected. In this view, a large data collection of personal surveys and experimental field campaigns will be carried out, while integrating the key results elaborated within physical environments (test-room), real buildings, and re-created environmental conditions (based on augmented-and-virtual reality). Then, a data-driven modelling approach is proposed by identifying the key variables and finally sprawling the boundary of the only-physical based monitoring and survey campaigns. Therefore, an exhaustive, open-data, resolutive sensitivity analysis and final elaboration is provided.

From a larger perspective, NEXT.COM aims at responding to a broad social opportunity and a tremendous challenge, such as to shape the new generation of buildings by supporting their energy efficient, comfortable and sustainable development, while creating healthier and more productive conditions and improved quality of life for occupants.

NEXT.COM objective will be pursued by means of a concrete methodology, elaborated for the scope of the project, as specified below, that consists of setting up a complete framework which will provide new theoretical and practical knowledge in terms of monitoring and modelling tools, databases, and methods towards the establishment of a novel whole-comfort approach and data-driven interpretation model. The long term view clarified by the project will indeed support current EU and extra-EU policies about health and comfort level in the built environment, consistently with the urgent needs of energy consumption reduction, as driven by the 2nd recast of the Energy Performance of Buildings Directive and the European Environmental Action Programme (EU-EAP), and with the Horizon 2020 targets toward the promotion of well-being and sustainable development.

#### STATE OF THE ART

Until now, each aspect of comfort in buildings has been addressed by as specific set of quantities and experimental protocols at both design and verification stages.

The evaluation of thermal comfort conditions, for example, starts with the definition of occupants' acceptability in terms of hygrothermal parameters ranges, which depend on adaptive opportunities to modify physiological and behavioural conditions such as the ability to change clothing or activity level, which will allow individuals to get closer to more comfortable perception. In this view, in order to comprehend occupancy adaptive behaviour aimed to meet comfort conditions in a more exhaustive manner, exploration and modelling of a more extensive set of factors triggering occupants to certain actions is much needed [1].

Even though there has been an increasing acceptance of the behavioural, or adaptive approach to comfort based on surveys in the field, much is still unknown about the motivation of building occupants to interact with the building envelope and systems [2]. Next to physical and time-related factors, it is necessary to take into account "individual" factors of occupants [2], such as the personal background, energy-related attitudes, perception or personal preferences related to the indoor environment. Also the physiological condition of the occupant plays an important role, such as age, gender or health conditions. Next to physical and time-related drivers, occupant age, gender, culture/race, educational level, social grade, household size, family income, thermal sensation, perceived IAQ and noise, health, heating attitudes, and energy use awareness are listed in literature [3] as potential driving factors.

Moreover, scientists and practitioners, experts not only in the health sector, recognized and demonstrated that holistic environmental conditions play a significant effect on building occupants' health, although the general public has only recently started to understand the effect that this relationship can have on their day-to-day lives and well-being [4-5].

Besides, in recent times, challenges related to rising energy costs, targets for reducing energy consumption in buildings, extreme weather and power outages need to be addressed while creating comfortable and healthy indoor environments at the same time. In current practice, the results of dynamic building energy performance simulation tools have shown to be not yet reliable and gaps have been found between predicted and real energy consumption and indoor environmental conditions [6]. In fact, the ability of a simulation program to calculate real energy use in buildings is undermined by a poor representation of stochastic variables that reflect human interactions with building controls and the regulation of the indoor environmental conditions, and thus comfort. Discrepancy between simulated and real energy use or indoor environmental quality in buildings is often due to the deterministic approaches (i.e. predefined, fixed and sometimes unrealistic schedules) for describing control actions by users [7]. In this context, the problem of modeling users' interaction with building indoor environmental control systems - in order to implement new and more flexible comfort models into building energy simulations - is particularly relevant [7, 8].

The main outcome of an adaptive approach to comfort was to introduce the human conscious (or semi-conscious) capability to implement actions aimed at modifying tolerability in the indoors in order to better actively meet their (thermal) comfort target criteria. In this approach, building occupants take conscious actions together with involuntary physiological responses of the body to achieve thermal well-being regulation and by taking advantage of human natural adaptation potential. A lot of work has been done in order to understand how such environmental controls work, how they are triggered and how they can be accounted for in modelling and design processes, based on potential deterministic or stochastic forcing.

One of the key factors in comfort science relies therefore upon a better understanding of the mechanisms and relationships between involuntary response driven by the physiological system and human conscious interaction with the built environment. To characterize the conditions for human heat balance, also physiology has played an important role for developing thermal comfort theory. Next to the thermal conditions in the built environment, also indoor air quality plays a significant effect on human health, well-being and productivity.

In the last ten years, while new monitoring equipment and sensors has been made available for the analysis of indoor environmental conditions of living spaces, consolidated theories have been applied for investigating thermal comfort of indoors and its consequences on occupancy behaviour and energy consumption. Moreover, various studies have shown the limitations of the current thermal comfort approach developed in the '70s and based on 4 environmental variables derived from physical measurements and 2 user properties inputted by the user [9-11].

Within the context and needs of the heating, ventilation and air-conditioning (HVAC) industry, the science of comfort developed in the last century proposed a steady tightening of air temperature and humidity control in buildings, assuming that this is what occupants ask for. Indeed, for many years the main goal of HVAC design and the regulation of indoor environments was to create a steady-state of mind labelled neutral, or rather to obtain the complete absence of any negative or positive thermal sensation by the occupants [11]. Actually, a number of open issues could arise since the first comfort approach was developed. As an example, a primary challenge could be to quantify "temperature detection thresholds", or rather "the minimum thermal energy required to trigger a sensation" [11]. In combination with these questions, a better understanding about whether these thresholds vary with different starting skin temperatures and/or with dynamic conditions of exposure is urgently required from both the scientific and professional worlds.

**One particular aspect of the limitations of the current thermal comfort approach theory is the single-domain approach.** In the reality, a direct dependence between non-thermal parameters and thermal sensation was detected, also identifiable by means of wearable sensors and physiological detectors. For instance, thermal sensation is clearly correlated to colour temperature [12;13] and the increase of CO<sub>2</sub> concentration rate [14;15], as well as heterogeneous indoor conditions (i.e. radiant asymmetry and thermal stratification, etc.) [16].

This **multi-domain observation** suggests to develop a new generation of exhaustive comfort studies, aimed at developing a new effective multi-domain approach with the twofold purpose (i) to better investigate occupants' perception about the surrounding environment and (ii) to explore new human-based chances for energy saving in buildings, that for a large part is still to be developed [17]. Such models are not yet recognized by international standards on comfort [18-21].

Most of the observations available in the current pertinent literature come from analyses of surveys conducted on real operating conditions, while only a few studies that adopt a multi-domain and a multi-physics approach are available as start-point of this research. This has also been acknowledged, at international level, by the merging between Annex 66 [22] and Annex 69 [23] activities within the framework of the IEA in the next Annex preparation.

**METHODOLOGY**

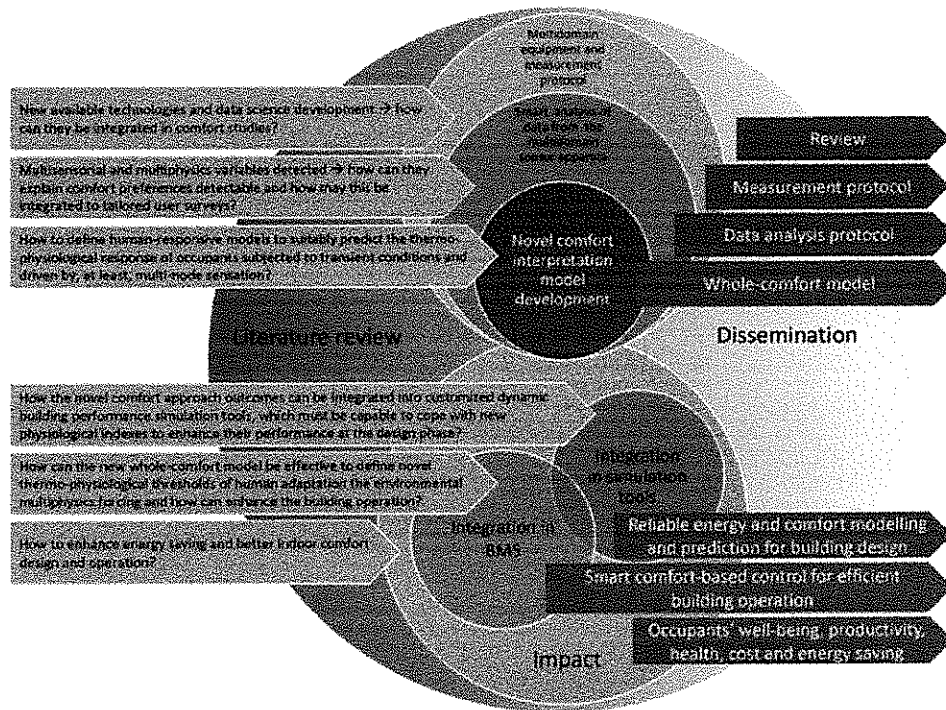
NEXT.COM methodology consists of a novel synergic multidisciplinary interaction aimed at theoretically and operatively fertilize a common research ground to seed the next generation of multiphysics and multidomain whole-comfort approach, based on both

(i) a frontier experimental protocol and

(ii) a new data-driven modelling effort that needs the pro-active interaction among multidisciplinary efforts involved in NEXT.COM.

To this aim, specific propaedeutic research questions that NEXT.COM will answer are as follows:

1. How can new multidomain sensors and data analytics techniques be used to assess human energy-impacting preference and to enhance comfort conditions of building users?
2. How do multisensorial and multiphysics variables detected by new and classic sensors explain comfort preferences detectable and how may this be integrated to tailored user surveys?
3. How to define human-responsive models to suitably predict the thermo-physiological response of occupants subjected to transient conditions and driven by, at least, multi-mode sensation?
4. How can the new whole-comfort model be effective to define novel thermo-physiological thresholds of human adaptation to outdoor – indoor environmental multiphysics forcing?
5. How the novel comfort approach outcomes can be integrated into customized dynamic building performance simulation tools, which must be capable to cope with new physiological indexes?
6. How the novel comfort model can be integrated into user-friendly computational tools also accessible to professionals for energy saving and better indoor comfort design?



Research questions and results

To this aim, the following specific intermediate objectives will be achieved (for the specifications of WP see next section):

- Definition of the experimental equipment and measurement protocol and its integration with classic microclimate equipment, surveys, multidisciplinary sensors (health, physiologic, neural).

augmented-and-virtual reality, etc.) – this will be completed in WP 2;

- Development of a new system architecture for the integration of sensors and data processing aimed to automatic smart analysis of measurements from such multidomain sensor apparatus – this objective also will be the outcome of WP 2 and the complete set of experimental equipment, measurement protocol and system architecture will be ready for the experimental investigations in WP 3;
- Investigation of multiphysics and multidomain parameters and mutual sensitivity analysis by means of brand new experimental strategies of virtual reality and augmented reality environments, aimed at simulating a variety of triggers, which sensitivity role will be identified – these investigations will be conducted in WP 3;
- Elaboration of a procedure to analyse such complex variety of monitored data and let them proactively interact for the very first time, in order to draft the new comfort model (experimental and analytical approach) for an energy efficient building design – this will be the main outcome of WP 4;
- Integration of the new proposed comfort model into both well established and also tailored dynamic thermal-energy simulation tools, necessary to also perform hardware-in-the-loop simulations, finally enabling a consistent scalable modelling of building HVAC and control systems – this will be addressed in WP 5;
- Integration of the comfort interpretation model supported by the package of sensors available in real-life conditions (e.g. wearables, distributed sensors networks), real-simulated environmental forcing and the control equipment, into building management system (BMS) for real applications, for monitoring and controlling comfort conditions and increasing the energy efficiency of the whole building system (building and HVAC) – the methodology to apply the new comfort model for buildings operation will be provided in WP 6;
- Integration of indoor comfort model with tailored considerations aimed at extending such results up to the inter-space and outdoor-space environments – this work will be conducted into a dedicated WP (WP 7) and the effectiveness and the impact of the project assessed through dedicated Key Performance Indicators (KPIs). WP 7 will address also the impact of the results on the occupant's well-being, productivity and health and on the estimation of energy savings and cost savings triggered by the novel comfort model.

The main outcome of the project consists of a novel comprehensive approach made of three main research activity clusters consisting of:

- large framework, basic background investigation and preliminary hypothesis;
  - specific application and validation with an integrated experimental and analytical effort;
  - final exploitation and impact analysis by again a circular framework and repositioning in order to see the large picture that NEXT.COM has framed.
- In fact, the interpretation and prediction of whole-comfort and energy-related occupancy behaviour proposed framework will be ready for implementation by building physicists, green building designers, avantgarde construction companies, and potentially urban designers.

To this aim, the approach will be developed and tested on real scale enclosures characterized by different user types in a classic controlled environment (test-room) where virtual reality scenarios, namely commercial buildings like offices, schools, and sport facilities where different user conditions are expected. In order to better reproduce different environments and geoclusters. Moreover, given the strong multidisciplinary approach of the project, the research team will benefit of relevant external collaborations with universities and institutes. PoliTo will exploit the cooperation with Fraunhofer ISE, UniPg with Princeton University, UniNa with Concordia University and UnivPM with British Columbia Institute of Technology. These collaborations are already active in the fields addressed by NEXT.COM.

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### *3. Project development, with identification of the role of each research unit with regards to expected targets, and related modalities of integration and collaboration*

#### **WP 0 – Project management (leader: PoliTo)**

The aim of this WP is to ensure both efficient communication and continuous coordination among the research units, and strategic technical risk analysis. The project management will also assure a feedback synergy loop between different WPs, to respect scientific and administrative deadlines with adequate quality control. All the partners will contribute to the revision of the Deliverables. Periodical in person meetings will be organized at least twice per year, and web meetings once every bimester.

#### **WP 1 – Literature analysis and identification of research questions (leader: UniNa)**

Scope of this WP is to analyse and update the state of the art on: i) methodological approaches regarding the determination of comfort, as a function of somatotype features, variability in physiological parameters, well-being and stress, related to the dynamic conditions of exposure, the circadian rhythm, the level of physical activity/workload, the environment; ii) sensors and actuators networks.

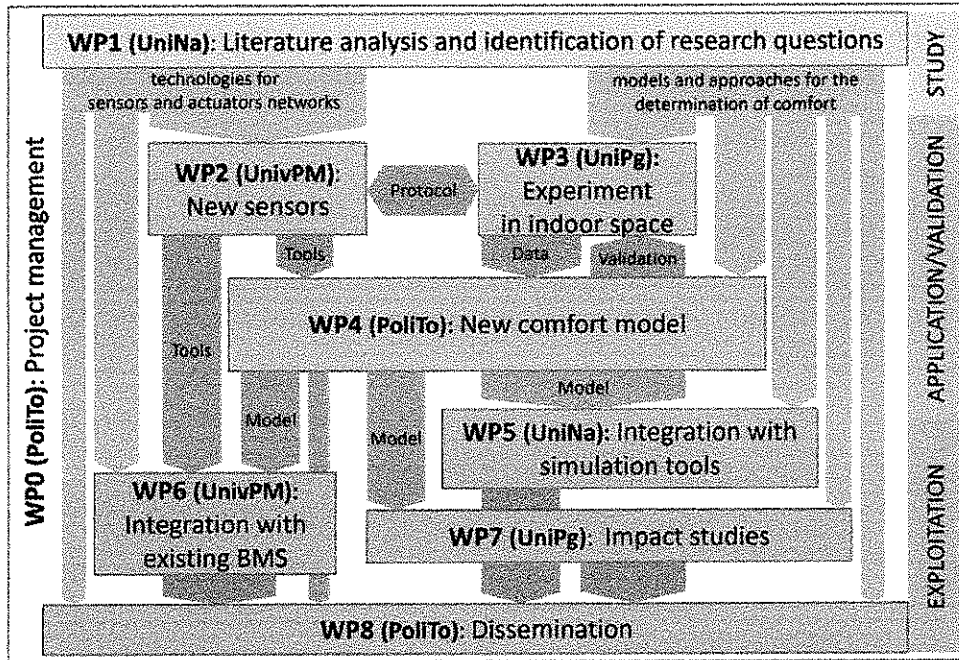
The literature review aims to identify:

- main advantages and drawbacks of the available comfort models and sensors;
- possible physiological and/or biological indicators of comfort status to be assessed at individual and group levels, in heterogeneous indoor conditions and virtual/augmented reality environments;
- human behaviour, physiological, and psychological adjustments taken to achieve adaptation to climate, and control different environmental conditions;
- gap between simulated results and practical application.

The main outcome of this WP (D 1.1) will be a comprehensive open access review article written by the partners.

#### **WP 2 – New sensors testing, measurements and system architecture (leader: UnivPM)**

Scope of this WP is to set out a package of sensors that satisfies the requirements provided by WP1 and as output for WP3. The selected sensors will be used to measure physical quantities pertaining to both the indoor climate – not only thermal environment but also IAQ, noise/sound, smell, illuminance – and the human-related parameters (mainly physiological). A dedicated architecture will be developed to acquire and process the data gathered from the sensor network. The use of IoT, augmented/virtual reality and other wearable devices will be investigated to enlarge the spectrum of technologies available for the experimentation.



WPs organization

**WP 3 – Experiment in indoor spaces (leader: UniPg)**

Scope of this WP is to implement the comprehensive multiphysics and multidomain experimental activities in a full-scale lab-controlled environment (test-room), a virtual/augmented reality experience and at least one real test site in a non-residential building. The experimental activity will be conducted through both physical and non-physical measurements, dedicated field and via-web surveys developed in this WP, and by simulating virtual environments and augmented reality forcing (supported by promising apparatus such as Oculus, Vive, Emotiv, ComfortEye, etc.) in the UniPg test-room facility with the purpose to identify the sensitivity of each driver. Weighted comparative analysis and sensitivity multiparameter analysis will be performed in order to identify triggers and driving environmental forcing (thermal, acoustic, visual, smell, air pollution) and, at the same time, to quantify the role of non-physical stimuli (virtual panorama, social and psychological triggers) in the whole-comfort experience. The results will be made available to the interested audience through a dedicated data sharing platform and by means of open access publication (Nature Scientific Data, etc.).

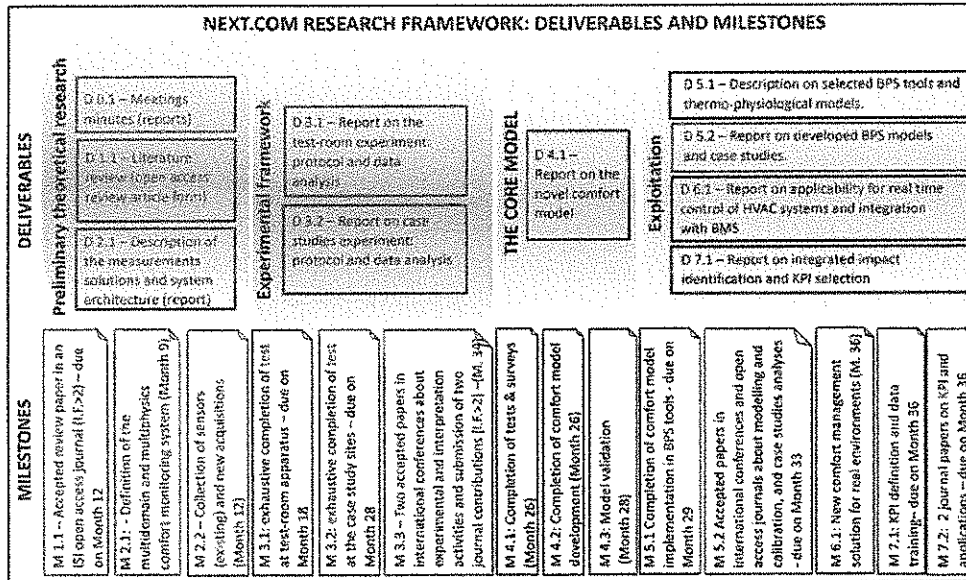
**WP 4 – Development of the novel comfort model (leader: Polito)**

Scope of this WP is to define the comfort model that properly fits comfort preferences. This model will be developed based on both the literature review and experimental analysis on pilot case-studies as dynamic and interactive outcomes from WP2 and WP3. Replicability will be tested and validated through a recursive loop with varying key physical and non-physical drivers in different geocluster scenarios (i.e. climatic conditions, cultural, and personal habits, etc.).

The activities of this WP will be:

- Definition of a survey methodology (thermal comfort, IAQ, lighting and acoustics comfort preferences);
- Development of a complete database on comfort-related and occupant-related parameters by keeping separated identity and personal information of large participants' clusters (>500);
- Elaboration of the comfort model (parameters selection, relations/equations, output).
- Definition of a cross-validation strategy.





Milestones and deliverables

**WP 5 – Integration with calculation tools (leader: UniNa)**

Scope of this WP is to integrate the novel whole-comfort model (defined by WP4) into ready-to-use and customized dynamic Building Performance Simulation (BPS) tools. According to the identified indexes and comfort equations, once selected some dynamic BPS tools for a modular and flexible implementation, the activities of WP5 will be:

- definition of thermo-physiological models, from simple (one-node) to more complex (multi-node) human models;
- development of real-time hardware-in-the-loop simulations for scalable and dynamic modelling of building HVAC and control systems.

Expected outcomes will be BPS units (for co-simulation) or customized tools, generation of case studies, and calibration of the model.

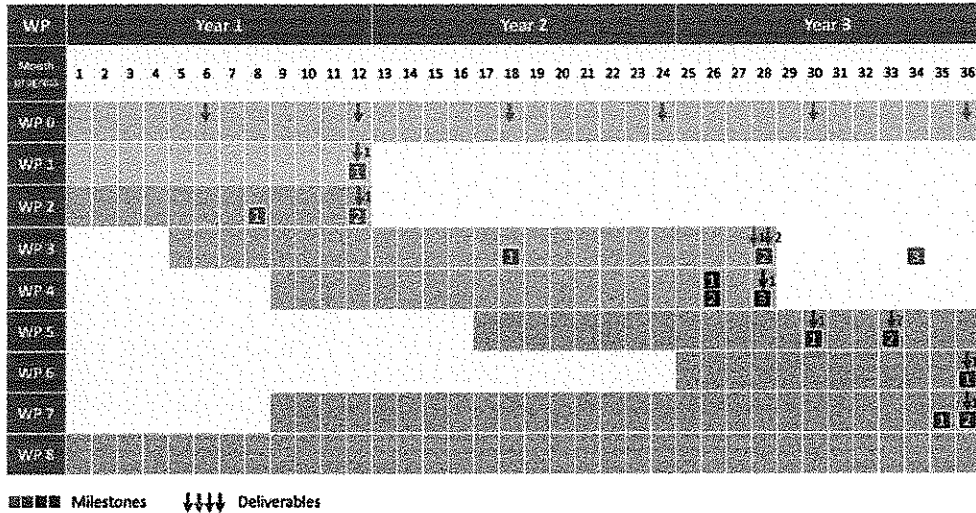
**WP 6 – Integration with existing BMS (leader: UnivPM)**

The scope of this WP is to investigate the scalability of the proposed comfort measurements for integration with building management systems (BMS). Given the reduced measuring possibilities in real buildings, the new comfort model and required monitoring solution will be scaled down from the experimental set (WP3) to be applied into real environments. The outcome of this WP will be the new comfort monitoring and controlling technique for real-world BMS.

**WP 7 – Impact study (leader: UniPg)**

The aim of this WP is to exploit the potentialities of the research outcomes into a variety of domains. The research core of this WP will be devoted to operatively study the scientific and professional impacts of the project findings on the following topics:

- Development of new modelling and simulation protocols for integration into international protocols for sustainable/healthy buildings
- Generation of model and monitoring system for exploiting the model replicability in the outdoors, thanks to the collaboration of Princeton University team.
- Exhaustive analysis of whole comfort-based design in terms of economic impact for the management of the built environment in terms of occupants' productivity and adaptability to energy-saving practices.



Gantt diagram

**WP 8 – Scientific dissemination (PoliTo)**

- Participation to conferences and panels such as Clima by REHVA, IBPC, Healthy Buildings, IAQVEC, ICAE, ECOS, SDEWES, Materials & Sustainability Committee by ECTP (coordinated by UnivPM).
- Organization of special sessions/workshops/topical issues in selected conferences (>1/year)
- Publication of open access research papers in high impact international journals.

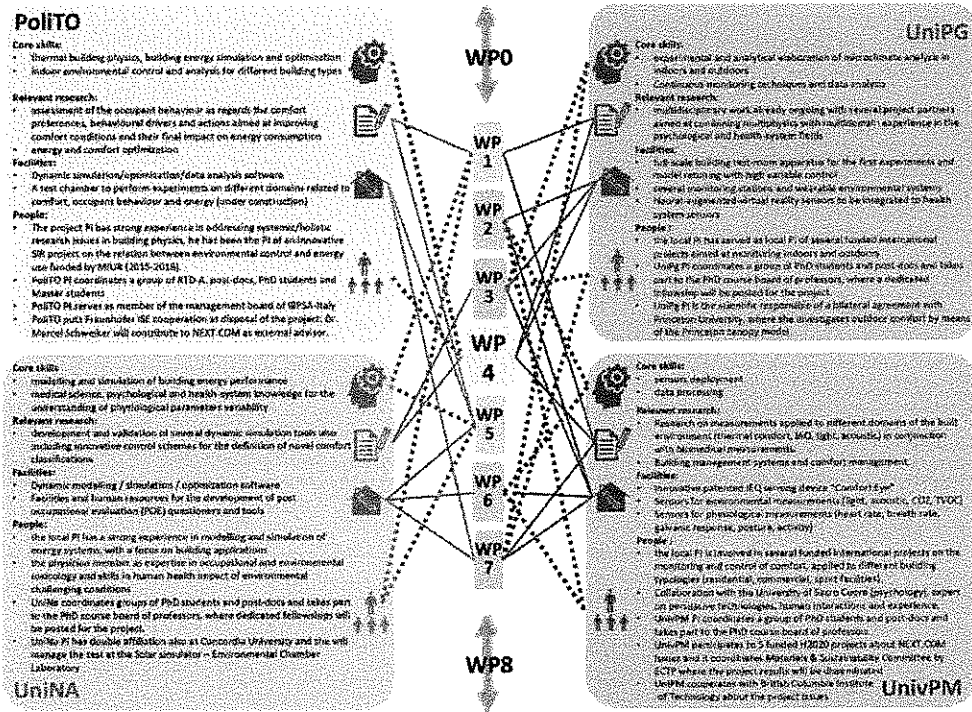
**ROLE OF EACH RESEARCH UNIT**

PoliTo skills are related to the thermal building physics. They cover the fundamentals and application of indoor environmental control and analysis for different types of buildings as well as the building energy simulation and optimization. Several activities on the assessment of indoor environments have been carried out since more than 10 years by the research team in different comfort-related domains. One of the main strengths of the PoliTo group is the assessment of the occupant behaviour as regards comfort preferences, behavioural drivers and actions aimed at improving comfort conditions and their final impact on energy consumption.

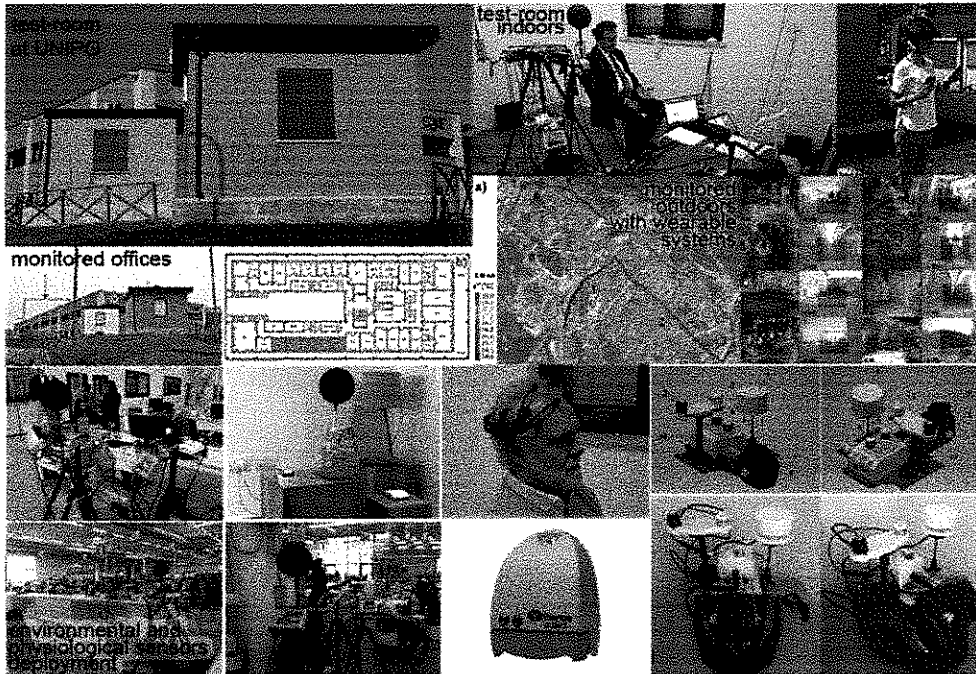
UnivPg skills cover both experimental and analytical elaboration of microclimate analysis in indoors and outdoors. The team already works with multidisciplinary approach with several project partners aimed at combining multiphysics (their own skill) with multidomain experience in the psychological and health-system fields. UnivPg puts at disposal of the project (i) the full-scale building test-room apparatus for the first experiments and model retuning with high variable control, (ii) several monitoring stations and neural sensors to be integrated to health system sensors.

UnivNa skills cover i) modelling and simulation of building energy performance tools, also coupled to experimental investigations for model validation; ii) psychological and health-system knowledge, with a focus on human adaptation to environmental challenges (a member of the team is an occupational health scientist with expertise in occupational and environmental toxicology and human health impact of environmental conditions), with the aim at enhancing the capability of the partnership toward the understanding of physical parameters and thermo-physiological models.

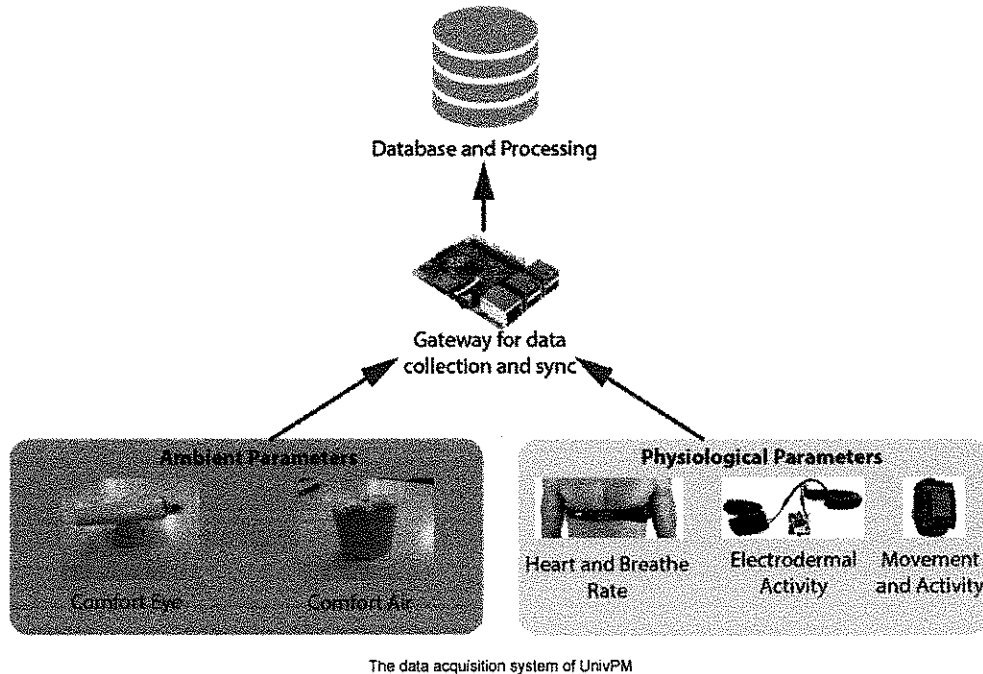
UnivPM: Sensors and Measurements Research Group of UnivPM will cover skills required for sensors and data processing. UnivPM is performing research on measurements applied to different domains of the built environment (thermal, IAQ, light, acoustic) in conjunction with biomedical measurements. UnivPM will make available the innovative IEQ sensing device Comfort Eye (patent) together with sensors for both environmental (lighting, acoustic, CO2, VOC) and physiological (heart rate, breath rate, galvanic response, posture, activity) measurements.



Research Units main responsibilities, integration and collaboration



The measurements apparatus and test room already in place at UniPg



The data acquisition system of UnivPM

#### 4. Possible application potentialities and scientific and/or technological and/or social and/or economic impact of the project

##### Strategic impact

Considering that there are still uncertainties on how comfort is effectively perceived by occupants and on the consequences on their productivity and energy performance of buildings, the outcomes of NEXT.COM will be:

- The whole assessment of indoor comfort conditions, depending on the identified multi-domain-physical and non-physical environment, to be measured by means of brand new monitoring equipment, dedicated novel surveys and multidomain sensors (nowadays available in other fields and potentially suitable for the exhaustive investigation of indoors and outdoors), never specifically exploited in this field;
  - The development of a novel comfort model to be implemented in modelling tools for the whole building performance simulation for the direct and aware use of professionals and policy makers who will be able to appreciate the economic benefits of a whole comfort-based design (demonstrated by improved occupancy productivity and satisfaction levels by >10%);
  - The creation of good practices and target indicators for design, construction, maintenance and indoor management by considering the integrated assessment modelling toward comfort and energy targets;
  - The huge transition toward a non-strictly physical approach will allow to incorporate key personal and societal variables, hugely affecting human perception, adaptation capability, and energy needs. Such outcome will prepare the common scientific ground for engineers (civil, mechanical, ICT, etc.), building physicists but also social and health scientists, big data analytics experts.
- These outcomes will be of great impact in various scientific fields and real-life applications. Within the EU initiatives regarding the building stock and correlated practices, the impact of this project will benefit the growing restrictions regarding energy saving and increase of comfort levels, health and well-being of occupants, contributing to EU policy (e.g. EPBD Directive, EAP). NEXT.COM is also consistent with Horizon 2020 and PNR 2015-2020 programs targets of the strategic thematic areas "Smart living technologies" and "Sustainable development".

##### Expected scientific and technological impact

Goals and impacts of NEXT.COM will be achieved through an integrated multi-disciplinary approach across several research fields, taking advantage of expertise, research findings, and innovative facilities of all the participants. This approach will provide new ground breaking understanding of the key issue of occupants comfort and its impact on the energy performance of the new generation of buildings.

NEXT.COM is designed to combine different major lab-based and field-based studies (WP 1, 2, 3) and integrated assessments (WP 4, 5, 6) aiming at highly enhancing the impact of the study on scientific, societal and technological fields in at least three geoclusters.

To this regard, the challenges are:

- *technological development* - to offer an alternative to standard comfort monitoring technologies (instruments, sensors and protocols), to ensure occupancy satisfaction while reducing the gap between predicted and measured energy need (by at least 10%);
- *scientific advances* - to define the boundaries and features of geo-clusters of buildings to test the novel comfort model and to provide useful information for scientists in this multidisciplinary field and policy makers.

Databases, novel methods and tools could be integrated in previous and on-going studies for the development of sensitivity analyses of possible scenarios of indoor environments, occupancy expectations, energy performance, and standards.

The modelling activity will help prediction and interpretation of the whole-comfort, achieving the desired project impact (e.g. wellbeing, productivity, health, energy saving), while enhancing: i) awareness of the connected issues, ii) knowledge transfer; iii) market opportunities, in co-operation with all stakeholders.

#### Social and economic impact

Comfort science has become an important issue valuable for human health, well-being and productivity (by >10% in terms of better tolerability and positive influence played by non-physical parameters), and energy efficient buildings, being linked to three main social areas related to the occupancy behaviour, i.e. energy demand, indoor environmental quality and health. Moreover, discomfort contributes to generate extra-costs related to lack of productivity and efficiency, with psychological, societal and economic implications at large. The aim of NEXT.COM is to further provide a positive economic and social impact thanks to the novel implemented approach. A clear economic impact of whole comfort-based assessment will be quantified such as the positive expected effect on the reduction of energy consumptions, improvement of comfort and well-being in buildings, and further benefits in fostering EU policies towards a better prediction of occupants behaviour, and energy targets.

#### 5. Costs and fundings, for each research unit (automatically calculated)

n°	Associated or principal investigator	Total cost (euro)	Co-funding (Item A.1) (euro)	MIUR funding (other Items) (euro)
1.	FABRIZIO Enrico	203.622,34	29.049	174.573,34
2.	PISELLO Anna Laura	192.000	0	192.000
3.	BUONOMANO Annamaria	148.000	0	148.000
4.	ARNESANO Marco	148.000	0	148.000
<b>Total</b>		<b>691.622,34</b>	<b>29.049</b>	<b>662.573,34</b>

#### 6. Bibliography

- [1] Schweiker, M., 2017. Understanding Occupants' Behaviour for Energy Efficiency in Buildings. Current Sustainable/Renewable Energy Reports, pp. 1–7.
- [2] Fabi, V., Andersen, R.V., Corgnati, S.P., Olesen, B.W. 2012. Occupants' window opening behaviour: A literature review of factors influencing occupant behaviour and models. Building and Environment, 58, pp 188–198.
- [3] Wei, S., Jones, R. and De Wilde, P., 2014. Driving factors for occupant-controlled space heating in residential buildings. Energy and Buildings, 70, pp. 36–44
- [4] Kingma B & van Marken Lichtenbell W. 2015. Energy consumption in buildings and female thermal demand. Nature Climate Change Epub.
- [5] Maichaire, J., d'Ambrosio, F.R., Palella B.I. 2017. Evaluation of the metabolic rate based on the recording of the heart rate. Industrial Health. Vol. 55. Pag.219-232.
- [6] Corgnati S.P.; Fabrizio E.; Raimondo D.; Filippi M. 2011. Categories of indoor environmental quality and building energy demand for heating and cooling. In: BUILDING SIMULATION, vol. 4 n. 2, pp. 97-105.
- [7] Andersen, R.K., Fabi V., Corgnati S.P. 2016. Predicted and actual indoor environmental quality: verification of occupants' behaviour models in residential buildings. Energy and Buildings 127, pages 105-115.
- [8] Fabi V., Andersen R.V.; Corgnati S.P.; Olesen B.W. 2013. A methodology for modelling energy-related human behaviour: Application to window opening behaviour in residential buildings. In: BUILDING SIMULATION, vol. 6 n. 4, pp. 415-427.
- [9] d'Ambrosio, F. R., Olesen, B.W., Palella B.I. 2016. Standardization of the Field of the Thermal Environment. Proceedings of the 2nd International Conference of the History of Engineering Napoli Cuzzolin Vol.1, pag.295-306 ISBN:978-88-86638-33-3.
- [10] d'Ambrosio F.R., Olesen, B.W., Palella B.I., Riccio G. 2014. Thermal comfort: Design and assessment for energy saving. ENERGY AND BUILDINGS. Vol. 81. Pag.326-336.

- [11] Nicol J.F, Roaf S., 2017. Rethinking thermal comfort. *Building research and information*, 45:7, 711-716.
- [12] Huebner, G. M., Shipworth, D. T., Gauthier, S., Witzel, C., Raynham, P., & Chan, W. 2016. Saving energy with light? Experimental studies assessing the impact of colour temperature on thermal comfort. *Energy Research & Social Science*, 15, 45-57.
- [13] Grote, V., Keiz, C., Goswami, N., Stossier, H., Tafeit, E., & Moser, M., 2013. Cardio-autonomic control and wellbeing due to oscillating color light exposure. *Physiology & behavior*, 114, 55-64.
- [14] Kumar A. and Hancke, G. P., 2014. "An Energy-Efficient Smart Comfort Sensing System Based on the IEEE 1451 Standard for Green Buildings," in *IEEE Sensors Journal*, vol. 14, no. 12, pp. 4245-4252.
- [15] Gauthier S., Liu B., Huebner G. and Shipworth D., 2015. Investigating the effect of CO2 concentration on reported thermal comfort Scartezzini, Jean-Jouis (ed.) In *Proceedings of CISBAT 2015 International Conference on Future Buildings and Districts - Sustainability from Nano to Urban Scale - Vol. I*. InfoScience., pp. 315-320.
- [16] Mishra A.K., Loomans M.G.L.C., Hensen J.L.M. 2016. Thermal comfort of heterogeneous and dynamic indoor conditions — An overview, *Building and Environment*, vol. 109, pp. 82-100.
- [17] Pisello, A.L., Asdrubali, F. 2014. Human-based energy retrofits in residential buildings: A cost-effective alternative to traditional physical strategies. *Applied Energy*, 133, pp. 224-235. DOI: 10.1016/j.apenergy.2014.07.049.
- [18] UNI EN ISO 7730, 2006. Ergonomia degli ambienti termici - Determinazione analitica e interpretazione del benessere termico mediante il calcolo degli indici PMV e PPD e dei criteri di benessere termico locale.
- [19] UNI EN 15251, 2008. Criteri per la progettazione dell'ambiente interno e per la valutazione della prestazione energetica degli edifici, in relazione alla qualità dell'aria interna, all'ambiente termico, all'illuminazione e all'acustica.
- [20] ASHRAE Standard 55, 2013. Thermal Environmental Conditions for Human Occupancy.
- [21] ASHRAE Standard 62.1, 2016. Ventilation for Acceptable Indoor Air Quality.
- [22] IEA-EBC Annex 66. Definition and simulation of Occupant Behavior in Buildings.
- [23] IEA EBC Annex 69 - Strategy and Practice of Adaptive Thermal Comfort in Low Energy Buildings.

## B.2

### 1. PI's Curriculum Vitae

#### PERSONAL INFORMATION

FAMILY NAME, FIRST NAME: Fabrizio, Enrico

ORCID: <http://orcid.org/0000-0002-7221-2796>

BIRTH DATE: May 21st, 1978

NATIONALITY: Italian

URL: [https://www.swas.polito.it/rubrica/scheda\\_pers.asp?matricola=013648](https://www.swas.polito.it/rubrica/scheda_pers.asp?matricola=013648)

#### BIBLIOMETRIC INDEXES

H INDEX: 19 (Google Scholar), 14 (Scopus)

NUMBER OF CITATIONS: 1455 (Google scholar), 719 (Scopus)

#### EDUCATION

2008: PhD in Energy Technology, Politecnico di Torino, SCUODO Doctoral School

2008: PhD in Génie Civil (Thermique du Batiment), Institut National des Sciences Appliquées de Lyon (diplôme INSALYO 6804459), MEGA Doctoral School

#### CURRENT AND PREVIOUS POSITIONS

2015-current: Associate professor (L. 240) in Environmental Applied Physics (ING-IND/11), Politecnico di Torino, Department of Energy

2008-2015: Assistant Professor/Researcher at the University of Torino, Department of Agricultural, Forest and Environmental Economics and Engineering

2006-2007: PhD fellow, CETHIL, Centre de Thermique de Lyon, INSA de Lyon

2005-2008: PhD fellow, DENER – Department of Energy, Politecnico di Torino

#### SUPERVISION/MENTORSHIP OF UNDERGRADUATE, GRADUATE, PHD AND POST-DOC FELLOWS:

2008-current: supervision of more than 30 master students at the Politecnico di Torino

2010-2013: co-supervisor of the PhD thesis "Rational use of energy flow and material in industrial settings, discussed" in 2013 at Politecnico di Torino.

2012-2015: co-supervisor of the PhD thesis "Scalable dynamic simulation-based methodology for the energy retrofit of existing buildings", discussed in 2015 at Politecnico di Torino.

2015-current: co-supervisor of the PhD thesis "Multi-source multi-product systems for the food industry, to be discussed at University of Torino (XXX cycle).

2015-current: supervisor of the PhD thesis "Simulation-based optimization of high performing buildings in future energy scenarios", to be discussed at Politecnico di Torino (XXX cycle).

2018-current: supervisor of the PhD thesis "Smart farm: the role of climate control", to be discussed at Politecnico di Torino (XXXIII cycle).

**INTERNATIONAL TEACHING ACTIVITIES**

2015-2017 : Lecturer (enseignant temporaire) at the ESTP Paris (Ecole Spéciale des Travaux Publics, du Bâtiment et de l'Industrie de Paris) within the GECD2 degree course, subject : "Simulation thermique dynamique", 17 hours (2015), 12.5 hours (2016), 14 hours (2017).

2016: Lecturer (enseignant vacataire) at the Université Claude Bernard Lyon 1, IUT 1, within the "Bâtiment à Haute Efficacité Énergétique" Master, unit of teaching : "Qualité des Ambiances et Environnement du Bâtiment", 4 hours.

**ACTIVITY AS CHAIRMAN, INVITED SPEAKER, PLENARY SPEAKER, MEMBER OF THE SCIENTIFIC AND ORGANIZING COMMITTEE IN INTERNATIONAL CONFERENCES**

2009 - current: He has been invited as a chairperson at:

- International Conference Energy Forum in Brixen, 2009 edition "Solar Architecture & Urban Planning Building"
- International Conference Energy Forum in Brixen, 2010 edition "Solar Skins"
- Clima 2013 World Congress, Prague, June 2013.
- ISHVAC 2013, Xi'an, China
- IBPC 2015 International Building Physics Conference, Torino, Italy
- PLEA 2015 Passive and Low Energy Architecture, Bologna, Italy
- SEB-16 Sustainability in Energy and Buildings, Torino, Italy
- BSA2017 Building Simulation Application, Bolzano, Italy

2011 – current: He has been invited to present the following speeches:

- Sistemi energetici integrati per l'edilizia residenziale, Convegno AICARR "Verso gli edifici a "energia quasi-zero": le tecnologie disponibili", Bologna 6 October 2011, pp. 69-89 (ISBN 978-88-95620-10-7); invited paper and invited speech.
- Reference buildings for cost optimal analysis, REHVA Task Force on "Reference buildings for cost optimal analysis", REHVA Offices, Brussels, 8 March 2012.
- Overview on HVAC and DHW energy systems for residential ZEB, Convegno AICARR-REHVA "Zero Energy Buildings", Fiera Milano Quartiere Rho, 28 March 2012.
- The Italian reference buildings case studies, workshop "Reference Buildings for Energy and Cost Optimal Analysis" at the Clima 2013 Conference, Prague.
- Reference building modeling for Annex 59, IEA ECBS Annex 59 Workshop on "High Temperature Cooling & Low Temperature Heating -- Annex 59", Beijing (China), 16 October 2013.
- Energy savings in farm buildings and agro-industry buildings, Lifelong Learning Programme Conference "Renewable Energies for Sustainable Food", Nichelino (TO), 22 novembre 2013 – in English.
- The role of building simulation towards nZEB target: case studies, AICARR-REHVA Seminar "Towards nearly-Zero Energy Retrofitted Buildings", Fiera Milano Quartiere Rho, 18 March 2014.
- Energy demand profiles assessment for the management of energy storage at the district level, IEA ECES Annex 31 "Energy storage with Energy Efficient Buildings and Districts: Optimization and Automation" 2nd Expert Meeting, Milan, 16 October 2014.
- Multi-source Multi-product Systems in Buildings: Renewable Energy vs. zero Energy, Public Lectures "Renewable Energy in Buildings", Ecole Polytechnique Fédérale de Lausanne, Faculté de l'Environnement Naturel, Architectural et Construit, 19 March 2015.
- Possibilities and limitations of simulation-based optimization methods for ZEBs design, Daikin Konwakai Europe Meeting 2017, Ghent, 13 February 2017.
- Integrated optimization of the building, systems and renewable energy sources for the nZEB buildings design, IEA (International Energy Agency) - ECES Annex 31 "Energy Storage with Energy Efficient Buildings and Districts: Optimization and Automation" Workshop #8 Expert Meeting at Concordia University, Montréal, 14 November 2017.

2009-2018: He has been in the Reviewers Board of the following international conferences:

- CIFIQ 2009 - IXème Colloque inter-universitaire Franco-Québécois sur la thermique des systèmes, Lille, 2009
- Building Simulation 2013, Chambéry
- Clima 2013, Prague
- Sustainability in Energy and Buildings 2014, Cardiff
- BSA 2014, Bozen
- Building Simulation 2015, Hyderabad
- ATI 2015, Roma
- SBE16, 2016, Tallinn and Helsinki
- Building Simulation 2017, S. Francisco
- ATI 2017, Lecce
- PLEA 2018, Hong Kong

2007 – current: Presenter of original research papers in 32 international conferences (organized by IABP, IBPSA, REHVA, etc.) and 14 national conferences (organized by ATI – Associazione Termotecnica Italiana, AICARR, AITA).

**PEER REVIEW OF PROJECT PROPOSALS**

MIUR - BANDO 2017



2018: Reviewer of project proposals for the Provincia Autonoma di Trento e Bolzano.  
2017: Reviewer of project proposals for the Estonian Research Council.  
2015: Reviewer of project proposals for the Chilean Research Agency.  
2014: In charge of the evaluation of the full proposals of the UE COST Open Call oc-2013-2 in the domain of Transport and Urban Development; participation to the External Expert Panel meeting (Brussels, 24-25 February 2014).  
2014: Reviewer for the Swiss National Science Foundation in the research program NRP 70 "Energy Turnaround".  
2013: Reviewer of project proposals for the Estonian Research Council.  
2010: Reviewer for the French National Research Agency ANR in the CEA research program HABISOL "Habitat et solaire intelligent photovoltaïque".

#### MEMBER OF SCIENTIFIC SOCIETIES AND COMMISSIONS OF TRUST

2011 – current : founding member of IBPSA-ITALY, Italian Section of the International Building Performance Simulation Association, member of its Board, Treasurer of the association (2011-2014) and Secretary of the association (2015-2018).  
2006 – current: Member of AICARR - Italian Association of Air Conditioning, Heating & Refrigeration member since 2006.  
2014-2017: Participation to the IEA (International Energy Agency) Annex 31 "Energy storage with energy efficient buildings and districts: optimization and automation".  
2014-2016: Member of the PhD Course in "Technological Innovation of the Built Environment" of the Politecnico di Torino.  
2013-2015: Member of the Research Commission of the Department of Agricultural, Forest and Food Sciences of the University of Torino.  
2012-2015: Participation to the IEA (International Energy Agency) Annex 59 "High temperature cooling and low temperature heating in buildings".  
2012-2014: Member of the Scientific Committee of the Master "Sustainable building and energy efficiency" of the Politecnico di Torino.  
2012-2013: Participation to the REHVA task force "Reference buildings for cost optimal analysis".  
2010: Participation to the Technical Commission for the awarding of the tender for the provision of services issued by the Regione Autonoma Valle d'Aosta for the construction of the new university campus in Aosta (starting bid: 3.882 M€) as an expert member of building energy efficiency.  
2016: Member of "Associazione della Fisica Tecnica Italiana"

2015: Invited Jury Member of the PhD final dissertations at Universitat La Salle Ramon Llud, Barcelona.  
2017: invited Jury Member of the Master Degree in Architecture at INSA de Strasbourg, Département d'Architecture, Strasbourg, 28-29 September 2017.  
2017: Internal Jury Member of the PhD final dissertations at Politecnico di Torino, PhD Course in Energetics, Torino.

#### PARTICIPATION TO RESEARCH PROJECTS

2014 - 2016: Co-responsible of the PoliTo research unit of the "YouBEE" project funded by Piedmont Region on the modeling and optimization of electricity storages for a micro-smart grid building.  
2013: Co-responsible of the PoliTo research unit of the COOPERA project funded by Région Rhone-Alpes (France) on the technical and financial optimization of zero-energy buildings.  
2011-2013: Co-responsible of the PoliTo research unit of the "BEE - Building Energy Ecosystems" project funded by Piedmont Region.  
2009-2011: Co-responsible of the PoliTo research unit of the research project "Financial, energy and environmental optimization of innovative energy systems for district heating networks" funded by Regione Autonoma Valle d'Aosta.

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#### *1.a National and international grants (as Principal Investigator)*

2015-2018: Principal Investigator of the **SIR 2014** (Scientific Independence of Young Researcher) project EPAnHaus (Energy Performance of Animal Housing) funded by MIUR (project funding: 132 k€).  
2016 - 2018: Principal Investigator of Starting Grant research project funded by Compagnia di San Paolo at Politecnico di Torino (95 k€).  
2018 – 2019: Principal Investigator of the PoliTo research Unit of the project CRYOFOOD funded by Regione Piemonte (POR/FESR) on the design and testing of an innovative air cycle for freezing (PoliTo budget 100 k€).  
2017-2019: Principal Investigator for Politecnico di Torino of the research agreement on "Fighting energy poverty" between Politecnico di Torino, S-Nodi Caritas, University of Torino and Leroy Merlin Italia Spa.  
2016-2017: Principal Investigator of the PoliTo partner of the I-TOWN - Italian Training qualificatiOn Workforce in building project under the BUILD UP SKILLS Pillar II EU program (project budget: 60 k€).  
2011-2014: Principal Investigator of the UniTo research unit of the project "SolHePCM" funded by Regione Piemonte (POR/FESR) on the design and testing of an innovative solar collector using slurry PCM (project budget: 49 k€).  
2015-2017: Co-supervisor of the ESR-9 on the topic "Energy Supply and Demand Management through Energy Storage" under the FP7 Marie Curie Initial Training Network (ITN) "Cinergy – Smart cities with

sustainable energy systems" at Politecnico di Torino.

2017-2019: PI of the research contracts between Politecnico di Torino and Leroy Merlin Italia Spa for the implementation of the project "Fighting energy poverty" (5 k€) and for the definition of a package of energy savings devices and training activities (5 k€).

2014-2016: PI of the research "Development and validation of a tool for the determination of the indoor environmental conditions and the energy consumption of broiler houses" funded by Munters Italy Spa at University of Torino (9 k€).

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### 1.b National and international acknowledgments

Award: **YOUNG SCIENTIST REHVA AWARD** - Awarded by: **REHVA** - Country: BEL - Description: Young Scientist Award from the Federation of European Heating, Ventilation and Air Conditioning Associations – (International Relevance) - URL: [www.rehva.eu](http://www.rehva.eu) - Year: 2014 - Motivation: In recognition of his outstanding scientific achievements and for his contributions to improve energy efficiency and the indoor environment of buildings

2015: Best poster award at the AIIA (Italian Society of Agricultural Engineering) 2015 International Mid-Term Conference, Naples, June 22-23, 2015.

2018-current: **Associate Editor at Sustainable Cities and Society** (Elsevier, IF 1.777, Editor-in-chief: prof. Fariborz Haghighat)

2018-current: Member of the editorial board of **Advances in Building Energy Research** (Taylor&Francis)

2016-17: Guest editor at **Sustainable Cities and Society** (Elsevier, IF 1.777)

2018: Guest editor at **Applied Sciences** (MPDI, IF: 1.679)

2012: Scientific qualification as **Maitre des Conférences** by the French Ministry of Education in the following sector: 60 - Mécanique, génie mécanique, génie civil.

2017 – current: Member of the Local Organizing Committee (LOC) of the International Conference of the Building performance simulation association, BS 2019, Rome, September 2019.

2016: He was within the Organizing Committee and Chair of the General track session #2 of the SEB16 (Sustainability in Energy and Buildings) Conference in Torino.

2016: Member of the Scientific Committee of the International Conference "SBE16 Tallinn and Helsinki Conference Build Green and Renovate Deep" (9-11 September 2016).

2015: He was within the Organizing Committee of the 2015 IBPC (International Building Physics Conference) in Torino, 14-17 June 2015.

### 2. Principal scientific publications of PI

1. Fabrizio Enrico, Branciforti Valeria, Costantino Andrea, Filippi Marco, Barbero Silvia, Tecco Giuseppe, Mollo Paolo, Mofino Andrea (2017). Monitoring and managing of a micro-smart grid for renewable sources exploitation in an agro-industrial site. **SUSTAINABLE CITIES AND SOCIETY**, vol. 28, p. 88-100, ISSN: 2210-6707, doi: 10.1016/j.scs.2016.08.026 - **Articolo in rivista**
2. Kazas Georgios, Fabrizio Enrico, Perino Marco (2017). Energy demand profile generation with detailed time resolution at an urban district scale: A reference building approach and case study. **APPLIED ENERGY**, vol. 193, p. 243-262, ISSN: 0306-2619, doi: 10.1016/j.apenergy.2017.01.095 - **Articolo in rivista**
3. Azaza M., Tanougast C., Fabrizio E., Mami A. (2016). Smart greenhouse fuzzy logic based control system enhanced with wireless data monitoring. **ISA TRANSACTIONS**, vol. 61, p. 297-307, ISSN: 0019-0578, doi: 10.1016/j.isatra.2015.12.006 - **Articolo in rivista**
4. Azaza Maher, Echaieb Kamel, Fabrizio Enrico, Iqbal Atif, Mami Abdelkader (2016). An intelligent system for the climate control and energy savings in agricultural greenhouses. **ENERGY EFFICIENCY**, vol. 9, p. 1241-1255, ISSN: 1570-646X, doi: 10.1007/s12053-015-9421-8 - **Articolo in rivista**
5. Ferrara Maria, Fabrizio Enrico, Virgone Joseph, Filippi Marco (2016). Energy systems in cost-optimized design of nearly zero-energy buildings. **AUTOMATION IN CONSTRUCTION**, vol. 70, p. 109-127, ISSN: 0926-5805, doi: 10.1016/j.autcon.2016.06.007 - **Articolo in rivista**
6. Azaza Maher, Echaieb Kalem, Tadeo Fernando Rico, Fabrizio Enrico, Iqbal Atif, Mami Abdelkader (2015). Fuzzy decoupling control of greenhouse climate. **THE ARABIAN JOURNAL FOR SCIENCE AND ENGINEERING. SECTION B, ENGINEERING**, vol. 40, p. 2805-2812, ISSN: 1319-8025, doi: 10.1007/s13369-015-1719-5 - **Articolo in rivista**

7. BECCHIO C., FABRIZIO E., DABBENE P., MONETTI V., FILIPPI M. (2015). Cost optimality assessment of a single family house: Building and technical systems solutions for the nZEB target. *ENERGY AND BUILDINGS*, vol. 90, p. 173-187, ISSN: 0378-7788, doi: 10.1016/j.enbuild.2014.12.050 - **Articolo in rivista**

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8. Fabrizio Enrico, Monetti Valentina (2015). Methodologies and advancements in the calibration of building energy models. *ENERGIES*, vol. 8, p. 2548-2574, ISSN: 1996-1073, doi: 10.3390/en8042548 - **Articolo in rivista**

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9. Fabrizio E., Seguro F., Filippi M. (2014). Integrated HVAC and DHW production systems for Zero Energy Buildings. *RENEWABLE & SUSTAINABLE ENERGY REVIEWS*, vol. 40, p. 515-541, ISSN: 1364-0321, doi: 10.1016/j.rser.2014.07.193 - **Articolo in rivista**

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10. Ferrara M., Fabrizio E., Virgone J., Filippi M. (2014). A simulation-based optimization method for cost-optimal analysis of nearly Zero Energy Buildings. *ENERGY AND BUILDINGS*, vol. 84, p. 442-457, ISSN: 0378-7788, doi: 10.1016/j.enbuild.2014.08.031 - **Articolo in rivista**

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11. BAYRAKTAR M., FABRIZIO, Enrico, PERINO M. (2012). The "extended building energy hub": A new method for the simultaneous optimization of energy demand and energy supply in buildings. *HVAC&R RESEARCH*, vol. 18, p. 67-87, ISSN: 1078-9669, doi: 10.1080/10789669.2011.588300 - **Articolo in rivista**

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12. FABRIZIO, ENRICO, CORGNATI, STEFANO PAOLO, Causone F., FILIPPI, Marco (2012). Numerical comparison between energy and comfort performances of radiant heating and cooling systems versus air systems. *HVAC&R RESEARCH*, vol. 18, p. 692-708, ISSN: 1078-9669, doi: 10.1080/10789669.2011.578700 - **Articolo in rivista**

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13. Fabrizio Enrico (2012). Energy reduction measures in agricultural greenhouses heating: Envelope, systems and solar energy collection. *ENERGY AND BUILDINGS*, vol. 53, p. 57-63, ISSN: 0378-7788, doi: 10.1016/j.enbuild.2012.07.003 - **Articolo in rivista**

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14. Corgnati S.P., Fabrizio E., Raimondo D., Filippi M. (2011). Categories of indoor environmental quality and building energy demand for heating and cooling. *BUILDING SIMULATION*, vol. 4, p. 97-105, ISSN: 1996-3599, doi: 10.1007/s12273-011-0023-x - **Articolo in rivista**

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15. FABRIZIO, Enrico, CORRADO V., FILIPPI M. (2010). A model to design and optimize multi-energy systems in buildings at the design concept stage. *RENEWABLE ENERGY*, vol. 35, p. 644-655, ISSN: 0960-1481, doi: 10.1016/j.renene.2009.08.012 - **Articolo in rivista**

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16. Chiabrando Roberto, Fabrizio Enrico, Gamero Gabriele (2009). The territorial and landscape impacts of photovoltaic systems: Definition of impacts and assessment of the glare risk. *RENEWABLE & SUSTAINABLE ENERGY REVIEWS*, vol. 13, p. 2441-2451, ISSN: 1364-0321, doi: 10.1016/j.rser.2009.06.008 - **Articolo in rivista**

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17. FABRIZIO, Enrico, FILIPPI M., VIRGONE J. (2009). An hourly modelling framework for the assessment of energy sources exploitation and energy converters selection and sizing in buildings. *ENERGY AND BUILDINGS*, vol. 41, p. 1037-1050, ISSN: 0378-7788, doi: 10.1016/j.enbuild.2009.05.005 - **Articolo in rivista**

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18. FABRIZIO, Enrico, FILIPPI M., VIRGONE J. (2009). Trade-off between environmental and economic objectives in the optimization of multi-energy systems. *BUILDING SIMULATION*, vol. 2, p. 29-40, ISSN: 1996-3599, doi: 10.1007/S12273-009-9202-4 - **Articolo in rivista**

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19. RAFFENEL Y., FABRIZIO, Enrico, VIRGONE J., BLANCO E., FILIPPI M. (2009). Integrated solar heating systems: From initial sizing procedure to dynamic simulation. *SOLAR ENERGY*, vol. 83, p. 657-663, ISSN: 0038-092X, doi: 10.1016/j.solener.2008.10.021 - **Articolo in rivista**

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20. CORGNATI S.P., FABRIZIO E., FILIPPI M. (2008). The impact of indoor thermal conditions, system controls and building types on the building energy demand. *ENERGY AND BUILDINGS*, vol. 40, Issue 4, p. 627-636, ISSN: 0378-7788, doi: 10.1016/j.enbuild.2007.04.017.017 - **Articolo in rivista**

3. *Hindex of PI (only for the scientific fields in which the use of the H-index is usually adopted)*

H-Index	Source
14	Scopus

#### 4. Associated investigators' Curriculum Vitae

##### **1. PISELLO Annalaura**

###### PERSONAL INFORMATION

FAMILY NAME, FIRST NAME: Pisello, Anna Laura

ORCID: <http://orcid.org/0000-0002-4527-6444>

BIRTH DATE: 1985-05-03

NATIONALITY: Italian, GENDER: Female

URL: <https://www.unipg.it/pagina-personale?n=anna.pisello>

###### BIBLIOMETRY

H INDEX: 24 (Google), 22 (Scopus)

CITATIONS: 1683 (Google scholar), 1267 (Scopus)

###### EDUCATION

2013: PhD in Energy Engineering, University of Perugia

2010-2011: Visiting scholar at Columbia University, Baruch College and Virginia Tech

2009: Master Degree cum laude, in Building Engineering at Politecnico di Milano

2007: Bachelor Degree in Building Engineering at Politecnico di Milano

###### CURRENT AND PREVIOUS POSITIONS

2014-current: Assistant professor of Environmental Applied Physics (ING-IND/11), University of Perugia

2017: Visiting scientist at Princeton University

2013-2014: Post-doc fellow in Environmental Applied Physics, University of Perugia

2009-2013: PhD fellow, CIRIAF Research centre – Dept. of Industrial engineering, University of Perugia

###### AWARDS AND HONORS

2017 (March): Associate professorship national qualification in Applied Physics (09/C2 sector)

1. 2017: Best publication award for young scientist 2016 at University of Perugia in the Engineering and Agricultural School.

2. 2016: IC2UHI Conference Award at the 4th IC2UHI International Conference on Countermeasures to Urban heat Islands. NUS, Singapore.

3. 2014: AIPT Award: Award of the Italian Association of thermal-physical properties "Thermal-physical assessment of innovative roof systems for application in historic buildings". Terni, Italy

4. 2014: IC2UHI Award: Best paper award (first author) at the 3rd International Conference on Countermeasures to Urban Heat Island for the paper "EXPERIMENTAL ANALYSIS OF THE THERMAL-OPTICAL PROPERTIES OF POLYURETHANE WATERPROOF LIQUID MEMBRANES FOR COOL ROOF APPLICATION", Prize for the unique experimental approach for the UHI countermeasures. Venice.

5. 2013: H2CU Award in Energy Engineering in recognition of having contributed to H2CU academic and scientific excellence in the U.S.A. with her outstanding achievement in the field of Energy Engineering, earned at the Consolato Italiano in New York, USA.

6. 2013: Selected as the best idea to be presented at MED Solutions - The UN SDSN Center for Mediterranean Hosted by the University of Siena. "ALBEDO CONTROL AND COOL ROOFS AS A STRATEGY TO MITIGATE GLOBAL WARMING IN ECONOMICAL CRISIS PHASE" Siena, Italy.

###### SUPERVISION/MENTORSHIP

2010-2018: 35 master students at University of Perugia

2012-2018: 12 co-mentored PhD student at University of Perugia, La Sapienza University of Rome, Virginia Tech, University of Lleida (5 co-tutelage PhDs)

2016-2019: 3 mentored PhD students at University of Perugia (1 co-tutelage with University of Lleida)

2018-2020: 1 post-doc researcher at University of Perugia (ING-IND/11) in Environmental Applied Physics

###### TEACHING

2016-17, 17-18: Appointed teacher of Impianti (Energy systems), University of Perugia

2016-17: Appointed teacher of "Toward near zero energy buildings" and "Thermal-energy adaptive dynamics: from the material to the inter-building scale". Doctoral school at University of Perugia

2014-15 AND 2015-16: Appointed teacher of "Thermal energy efficiency in buildings". Doctoral school at University of Perugia, Italy

2014-15: Appointed co-teacher of Performance Based Design of Buildings' Networks: Radiative - Convective Modelling of Urban Microclimates. Inter-doctoral Ph.D. course at

Politecnico di Milano

2014-17: Appointed teacher of several courses at International Summer of Thematic Schools (International Building Physics summer school, INNOSTORAGE school, GBCI, etc.)

CHAIRMAN, INVITED SPEAKER, PLENARY SPEAKER, MEMBER OF THE SCIENTIFIC AND ORGANIZING COMMITTEE IN INTERNATIONAL CONFERENCES

2018: Member of the scientific committee and moderator of the International Conference Noon to noon with energy and environmental challenges. University of Perugia, about 60 participants.

2018: Member of the scientific committee of the 14th IEA ECES (Energy Conservation through Energy Storage) Stock Conference – 2018 at Cukurova University, Turkey.

2017: Plenary invited speaker at 10<sup>o</sup> Congreso Nacional Ingeniería Termodinámica (Lleida)

2017: Member of the International committee, Session Chair (invited organizer) at Sustainability in Energy and Buildings, SEB-17 Crete, Greece.

2016: Member of the International committee, Chairman and presenter at the 8th International Conference on Sustainability in Energy and Buildings (SEB 2016) in Turin, Italy.

2016: Moderator, plenary speaker at the conference opening session at the Green Urbanism Conference (Roma, Italy) organized by IEREK.

2016: Moderator, plenary speaker, speaker of the final conference summary at the IC2UHI-2016 in Singapore. Countering urban heat island (UHI) and climate change through mitigation and adaptation, NUS Singapore.

2016: Co-Organizer and Co-Chair of the international session "Research perspectives in thermal-energy storage" at the 16th CIRIAF conference in Assisi, Italy.

2015: Invited speaker at the International Conference "Freshwater and Culture Water Resources Management and Culture Padiglione KIP International School EXPO Milano 2015

2015: Co-Organizer of the session "Italian alliance for innovative building skin solutions and "cool" materials" at the 15th CIRIAF conference in Perugia, Italy.

2013: Invited speaker (paid) at 44th International Congress and Exhibition on HVAC&R Integrated Design and Healthy Zero CO2 Emission Buildings, Belgrade 2013.

2013: Chairman at 2013 AIVC - TightVent - Cool Roofs - venticool Conference. Athens, 2013.

2014: Program Technical Committee participant at 3rd ScienceOne International Conference on Environmental Sciences ICES 2014, Dubai.

2014: Conference Co-chair and member of the scientific and planning committee at Third International Conference on Countermeasures to Urban Heat Island, Venice, 2014.

2014: Chairman at 6th International Conference on Applied Energy – ICAP2014, Taipei, 2014.

2014-2018: Member of organizing and scientific committees of other 8 international conferences.

2014-2018: Invited speaker at more than 5 international conferences (36th AIVC, UNESCO Chair, etc.)

2011-2018: Presenter of original research papers in 28 international conferences.

2012-2018: Reviewer of more than 30 international scientific journals indexed in Scopus and/or ISI.

#### EDITORIAL ACTIVITIES

2017-current: Member of the editorial board of Energy and Buildings (Elsevier, I.F. 4.1.)

2017-18: Guest editor at Energy and Buildings (Elsevier), Solar Energy (Elsevier, I.F. 4.018) and Materials (MPDI, I.F. 2.654), International Journal of Low-Carbon Technologies.

2017: Guest editor at Sustainability (MPDI, IF: 1.789)

2017-current: Editor in chief of the Environmental Sciences and Sustainable Development Journal (IEREK)

2016-current: Member of the editorial board of Energy Science & Engineering (Society of Chemical Industry and John Wiley & Sons, Ltd) – IF: 2.172

2015-2018 Member of the editorial board of other 15 international scientific journals

#### MEMBER OF SCIENTIFIC SOCIETIES, COMMISSIONS OF TRUST

2016-2018: Member of the Board of Professors of the PhD course in Energy and Sustainable Development at Univ. of Perugia

2016-18: Member of 3 scientific committees for the final defense of PhD dissertations of University of Lleida, Spain and Virginia Tech (USA)

2015-2018: External scientific reviewer of more than 5 PhD thesis from Italian and Foreign universities

2017: CIRIAF representative member of the ECTP Platform in Bruxelles

2011-2018: Member of: IEREK Research & Knowledge Enrichment, CIB (International Council for Building), AICARR Associazione Italiana Condizionamento dell'Aria Riscaldamento e Refrigerazione; IEA EBC ANNEX 66: Definition and Simulation of Occupant Behavior in Buildings; Associazione Fisica Tecnica Italiana

#### NATIONAL AND INTERNATIONAL PROJECTS

##### 7.1 EUROPEAN COMPETITIVE FUNDED PROJECTS

1. Call H2020-LCE-2014-2. PhD on Innovation Pathways for TES. 657466. INPATH-TES. Task leader and reference proposal contact 2014-2018.

2. Call H2020-EE-2015-1-PPP. Achieving near Zero and Positive Energy Settlements in Europe using Advanced Energy Technology. 678407. ZERO-PLUS. Scientific Task and Work Package leader and reference proposal contact 2015-2019.

3. Call H2020-DRS-2015. HERitage Resilience Against CLimate Events on Site. 700395. HERACLES. Scientific Task leader and reference proposal contact for CIRIAF - Univ. of Perugia. 2016-2019.

4. Call H2020- Fast Track to Innovation 2016. COLD ENERGY – Subcontracting unit scientific task leader 2017-2018.

5. Call H2020-MSCA-ITN-2017. 765057. SAFERUP. Sustainable, Accessible, Safe, Resilient and Smart Urban Pavements. Scientific Task leader and reference proposal contact 2018-2022.

6. Call H2020-LCE-2016-2017. 764025-2. SWS-HEATING. Development and Validation of an Innovative Solar Compact Selective-Water-Sorbent-Based Heating System – Scientific

responsible person, Task leader and Work Package leader and reference proposal contact 2018-2022.

7. Call H2020-LCE-2016-2017. 792210. GeoFit. Deployment of novel GEothermal systems, technologies and tools for energy efficient building retrofitting – Scientific responsible person, Task leader and Work Package leader and reference proposal contact 2018-2022.

#### NATIONAL PROJECTS

2017: Scientific leader of the CIRIAF research group of PRIN 2015 - SMART-BRICK: Novel strain-sensing nano-composite clay brick enabling self-monitoring masonry structures

2017-18: Scientific responsible person of 2 national projects supported by private institutions

2014-18: Member of the research team of ore than 20 national projects supported by Italian Ministries, Bank Foundations, Public and Private Institutions.

## 2. BUONOMANO Annamaria

### PERSONAL INFORMATION

FAMILY NAME, FIRST NAME: Buonomano, Annamaria

ORCID: [orcid.org/0000-0002-8254-580X](https://orcid.org/0000-0002-8254-580X)

BIRTH DATE: November 25th, 1982

NATIONALITY: Italian

URL: [www.docenti.unina.it/annamaria.buonomano](http://www.docenti.unina.it/annamaria.buonomano)

### BIBLIOMETRIC INDEXES

H INDEX: 14 (Google Scholar), 13 (Scopus)

NUMBER OF CITATIONS: 663 (Google scholar), 519 (Scopus)

### EDUCATION

2010: PhD in Energetics, University of Palermo

2009: Visiting scholar at Energy Performance of Buildings Group del Lawrence Berkeley National Laboratory, LBNL (Berkeley - CA, USA)

2006: Master Degree summa cum laude in Engineering Management (curriculum Energy Management) at University of Naples Federico II

2006: Erasmus Student at the Department of Chemical Engineering of University Rovira i Virgili (Spain)

2004: Bachelor Degree summa cum laude in Engineering Management of Logistics and Production (curriculum Energy Management) at University of Naples Federico II

### CURRENT AND PREVIOUS POSITIONS

2017-current: Assistant professor (tenured – RTD-B) in Environmental Applied Physics (ING-IND/11), University of Naples Federico II

2017-current: Affiliate assistant professor in the Department of Building, Civil and Environmental Engineering of the Concordia University (Canada)

2015, 2016 and 2017: Visiting Scholar at the Department of Building, Civil and Environmental Engineering of the Concordia University (Canada)

2014-2017: Assistant professor (un-tenured – RTD-A) in Environmental Applied Physics (ING-IND/11), University of Naples Federico II

2011: Research fellow at the Ben Gurion National Solar Energy Center, Jacob Blaustein Institutes for Desert Research (Israel)

2010-2014: Post-doc research fellow in Environmental Applied Physics, University of Naples Federico II

2010: Post-doc research scholar at ENEA (Ente per le Nuove tecnologie l'Energia e l'Ambiente) in collaboration with University of Naples Federico II

2007-2010: PhD fellow, University of Palermo

### AWARDS AND OTHER HONORS

2017 (March): Associate professorship national scientific qualification in Applied Physics (09/C2 sector)

2016 -November: Nomination as Affiliate Assistant Professor at the Department of Building, Civil and Environmental Engineering of Concordia University (Canada) for the significant contribution to students mentoring and related work on smart solar facades and net-zero energy buildings.

2016 - September: Best poster award at the 11th Conference on Sustainable Development of Energy, Water and Environment Systems – SDEWES Conference (Portugal) for the paper "Solar Heating and Cooling Systems for Residential Applications: a Comparison among Different System Layouts and Technologies" (authors: Buonomano A., Calise F., Forzano C., Palombo A., Vicidomini M.).

2009 - October: Best paper award at the 30th AIVC Conference Trends in High Performance Buildings and the Role of Ventilation (Germany) for the paper "Analysis of residential hybrid ventilation performance in U.S. climates" (authors: Buonomano A., Sherman M.).

### SUPERVISION/MENTORSHIP OF UNDERGRADUATE, GRADUATE, PHD AND POST-DOC FELLOWS:

2007-2018: more than 50 master students at University of Naples Federico II and Concordia University (Canada)

2017: 1 co-mentored PhD student at University of Naples Federico II

2015-2016: 1 mentored PhD research fellow at University of Naples Federico II

### TEACHING ACTIVITIES

MIUR - BANDO 2017

2017-current: Teacher of bachelor degree's course of Fisica Tecnica (Applied Thermodynamics and Heat Transfer), University of Naples Federico II  
2016-17: Appointed teacher of master's course of Progettazione di Impianti Meccanici in Ambiente BIM (Design of Mechanical Installations in BIM Environment), University of Naples Federico II  
2015-2016, 2016-17, and 2017-18: Co-teacher of master degree's course of Impianti di Climatizzazione (HVAC systems), University of Naples Federico II  
2014-17: Appointed teacher of several courses on Modelling building integrated solar systems at Training Schools within the framework of the European COST Action T7 on Building Integration of Solar Thermal systems  
2017: invited teacher on Towards Nearly Zero-Energy Buildings (NZEB) in Europe: technologies and applications within the Second Training Session of the TrainERGY Project Multiplier Event on Technologies supporting sustainability and Energy Efficient Operations

**ACTIVITY AS CHAIRMAN, INVITED SPEAKER, PLENARY SPEAKER, MEMBER OF THE SCIENTIFIC AND ORGANIZING COMMITTEE IN INTERNATIONAL CONFERENCES**

2018-current: Member of the scientific advisory board of the 13th SDEWES Conference on Sustainable Development of Energy, Water and Environment Systems (Palermo)  
2017: Member of the scientific committee and chairman of the BIREs 2017 - First international Conference on Building Integrated Renewable Energy Systems Conference (Dublin, Ireland)  
2007-2018: Presenter of original research papers in many international conferences and symposia  
2010-2018: Reviewer of more than 10 international scientific journals indexed in Scopus and/or ISI

**EDITORIAL ACTIVITIES**

2018-current: Member of the editorial board of Renewable Energy (Elsevier, I.F. 4.4.)  
2017-current: Guest editor of the special Issue Building Integration of Renewable Energy Systems at Renewable Energy (Elsevier, I.F. 4.4.)  
2017-current: Member of the editorial board of The Open Fuels & Energy Science Journal (Bentham open)  
2016-current: Guest editor of the special issues Solar Cooling and Heating and Solar Cooling and Heating 2018 at Energies (MPDI, IF: 2.3)  
2016-current: Guest editor of the special issue Renewable Energy, Environmental Engineering, Architectural and Civil Engineering, Sustainable Energy of American Journal of Engineering and Applied Sciences (Science Publications)

**MEMBER OF SCIENTIFIC SOCIETIES AND COMMISSIONS OF TRUST**

2017-current: Member of the Board of Professors of the PhD course in Sustainable Energy and Technology at Free University of Bolzano  
2014-2014: Member of the Management Committee of Action T7 (Building Integration of Solar Thermal Systems, BISTS) of the European COST (Cooperation in Science and Technology), Transport and Urban Development (TUD)  
2016: Substitute member of 1 scientific committee for the final defense of PhD dissertations in Fluid Thermodynamic Engineering, University of Tarragona Rovira i Virgili (Spain)

**DEGREE OF SUCCESS IN NATIONAL AND INTERNATIONAL PROJECTS**

2016 – 2018 Participants of POR project on "Strengthening and critical analysis of the school building registry of the Campania Region (energetic aspects)" (FESR 2014-2020) Innovation Call - Regional Operational Program for Campania Region funded by Italian Ministry for Education University and Research (European Fund for the Regional Development).  
2014 – 2016 Participants of POR project on "Mobility platform based on intelligent multi-agent systems" (FESR 2007-2013) Innovation Call - Regional Operational Program for Campania Region funded by Italian Ministry for Education University and Research (European Fund for the Regional Development).  
2013 – 2016 Participants of PON project on "Innovative multi-functional solutions for the optimization of primary energy consumption and indoor comfort in buildings" (PON03PE\_00093\_1, SMART CASE). National Operative Program for Research and Competitiveness funded by Italian Ministry for Education University and Research (European Fund for the Regional Development).

**3. ARNESANO Marco**

**PERSONAL INFORMATION**

Family name, First name: Arnesano, Marco  
Researcher unique identifier: ORCID - <http://orcid.org/0000-0003-1700-3075>  
Date of birth: April 10th 1982  
Nationality: Italian  
URL for web site: <http://apps.nia.univpm.it/iris/index.php?docente=MARCO%20ARNESANO&facolta=INGEGNERIA>

**BIBLIOMETRIC INDICATORS h index:**

6 (google scholar), 5 (scopus)  
Total number of citations: 116 (google scholar), 63 (scopus)

**EDUCATION**

2013: PhD in Mechanical Engineering, Università Politecnica delle Marche, Italy

2009: Master Degree in Thermomechanical Engineering, cum laude, Università Politecnica delle Marche, Italy  
2006: Bachelor Degree in Mechanical Engineering, Università Politecnica delle Marche, Italy

#### CURRENT POSITION

2017: Researcher, DIISM, Università Politecnica delle Marche, Italy  
2017: Adjunct Professor at Università Telematica eCampus, Italy

#### PREVIOUS POSITIONS

2013 – 2017: Postdoc Fellow, DIISM, Università Politecnica delle Marche, Italy  
2010 – 2013: PhD fellow, DIISM, Università Politecnica delle Marche, Italy  
2006 – 2007: Engineering Manager at TecnoPlast Group, Italy

#### SUPERVISION OF GRADUATE STUDENTS AND POSTDOCTORAL FELLOWS

2010-2018: 16 Master Students  
2012-2018: 5 co-mentored PhD students at Università Politecnica delle Marche, Italy

#### TEACHING ACTIVITIES

2017 – 2018: Appointed Teacher – Measurement and Control of Buildings Efficiency, Università Telematica eCampus, Italy  
2017 – 2018: Appointed Teacher – Sensors for UAV, Università Telematica eCampus, Italy

#### ACTIVITY AS CHAIRMAN, INVITED SPEAKER, MEMBER OF THE SCIENTIFIC AND ORGANIZING COMMITTEE IN INTERNATIONAL AND NATIONAL CONFERENCES

2018: Organizer and chairman of the workshop "Verso la Piscina 4.0" at ForumPiscine 21/02/2018, Bologna (Italy).  
2017: Invited speaker at "Research and Innovation Activities in Nanotechnology Concerning Energy Efficient Buildings" in the Energy in Buildings Conference, 21/10/2017, Athens (Greece).  
2017: Invited speaker at "The Heat is On: Future Proofing Building for Climate Changes in Smart Buildings and Energy Efficiency sectors" at the Beyond Energy Efficiency Conference, 18/05/2017, San Leandro (USA).  
2017: Co-authored invited speaking entitled "Integrate Your Body: Human Physiological Responses as a Potential Driving Factor in IEQ Controls" at the ASHRAE Annual Conference 2017, Long Beach (USA).  
2017: Organizer and chairman of the workshop "Focus: Impianti efficienti per ridurre consumi e costi energetici" at ForumPiscine, 16/02/2017, Bologna (Italy).  
2016: Invited speaker at "Building Smart – Progettare e realizzare oggi l'infrastruttura del futuro", 31/05/2016, Ancona (Italy).  
2016: Invited Speaker at "Palazzetti per l'Italia-Atto II", 04/03/2016, Rimini (Italy).  
2016: Organizer and chairman of the workshop "Efficienza Energetica" at ForumPiscine 2016, 18/02/2016, Bologna (Italy).  
2015: Invited Speaker at "CONI: Ottimizzare la gestione energetica degli impianti sportivi complessi", 12/06/2015, Firenze (Italy).  
2015: Co-organizer and Invited Speaker at "CONI: Ottimizzare la gestione energetica degli impianti sportivi", 18/04/2015, Ancona (Italy).  
2015: Invited Speaker at "ForumPiscine", 19/02/2015, Bologna (Italy).  
2014: Invited Speaker at the workshop "Advanced Energy Management Solutions for Commercial/Public Buildings", 03/07/2014, Cardiff (UK).  
2013: Invited Speaker at the workshop "Sport Facilities: a challenge for energy efficiency", 21/11/2013, Bilbao (ES).  
2011-2018: Presenter of original research papers in 11 international and national conferences.  
2012-2018: Reviewer of 8 international scientific journals indexed in Scopus and/or ISI.

#### MEMBER OF SCIENTIFIC SOCIETIES AND COMMISSIONS OF TRUST

2018: Member of the Board of Professors of the PhD course in Industrial Engineering at Università Politecnica delle Marche.  
2017: Member of the National Group of Mechanical and Thermal Measurements (MMT).

#### DEGREE OF SUCCESS IN ITALIAN OR INTERNATIONAL PREVIOUS PROJECTS

##### FUNDED EUROPEAN PROJECTS

- 1- Call FP7-2010-NMP-ENV-ENERGY-ICT-EeB. Name of the proposal: Intelligent Management System to integrate and control energy generation, consumption and exchange for European Sport and Recreation Buildings. Proposal number: 260124, Project acronym: SportE2. Topic: EeB-ICT-2010.10.2. Type of action: CP 2007-2013. ROLE: Work Package and Task leader. Duration: 2010-2014.
- 2- Call FP7-2011-NMP-ENV-ENERGY-ICT-EeB. Name of the proposal: Cost-Effective Tools for Better Indoor Environment in Retrofitted Energy Efficient Buildings. Proposal number: 285623, Project acronym: CETIEB. Topic: EeB.ENV.2011.3.1.5-1. Type of action: CP 2007-2013. ROLE: Task leader. Duration: 2010-2014.
- 3- Call H2020-EeB-2015. Name of the proposal: New integrated methodology and Tools for Retrofit design towards a next generation of ENergy efficient and sustainable buildings and Districts. Proposal number: 680474, Project acronym: NewTREND. Topic: EeB-05-2015. Type of action: IA 2015-2016. ROLE: Task. Duration: 2015-2018.



- 4- Call H2020-EE-2016-PPP. Name of the proposal: Plug-and-Play product and process innovation for Energy-efficient building deep renovation. Proposal number: 723391, Project acronym: P2Endure. Topic: EE-10-2016. Type of action: IA 2016-2017. ROLE: Work Package, Task leader and support to Scientific Coordination. Duration: 2016-2020.
- 5- Call H2020-EEB-2017. Name of the proposal: Accelerating Energy renovation solution for Zero Energy buildings and Neighbourhoods. Proposal number: 768718, Project acronym: RenoZEB. Topic: EEB-05-2017. Type of action: IA 2016-2017. ROLE: SubTask leader. Duration: 2017-2021.

#### NATIONAL RESEARCH PROJECTS

- 1- Call POR MARCHE FESR 2014-2020. Name of the proposal: Sistema per il monitoraggio ed audit continuo di edifici finalizzato alla creazione di piani energetici condivisi mediante sistemi informativi territoriali. Project acronym: energis+-. Topic: Asse 1 Os 1 – Azione 1.1 Promozione della ricerca e dello sviluppo negli ambiti della specializzazione intelligente. ROLE: Work Package and Task leader. Duration: 2016-2018.
- 2- Strategic Projects of Università Politecnica delle Marche. Name of the proposal: Multitemporal and Interdisciplinary Approach to the Post-Seismic Reconstruction. Name of the proposal: MIA. ROLE: reference contact person of DIISM.

#### 5. Principal scientific publications of associated investigators

##### 1. PISELLO Anna Laura

1. Anna Laura Pisello, Iliaria Pigliautile (2018). A new wearable monitoring system for investigating pedestrians' environmental conditions: Development of the experimental tool and start-up findings. *SCIENCE OF THE TOTAL ENVIRONMENT*, vol. 630, p. 690-706, ISSN: 0048-9697, doi: 10.1016/j.scitotenv.2018.02.208 - **Articolo in rivista**
2. Castaldo, Veronica Lucia, Pisello, Anna Laura (2018). Uses of dynamic simulation to predict thermal-energy performance of buildings and districts: a review. *WILEY INTERDISCIPLINARY REVIEWS. ENERGY AND ENVIRONMENT*, vol. 7, ISSN: 2041-8396, doi: 10.1002/wene.269 - **Articolo in rivista**
3. D'Alessandro, Antonella, Pisello, Anna Laura, Fabiani, Claudia, Uberini, Filippo, Cabeza, Luisa F., Cotana, Franco (2018). Multifunctional smart concretes with novel phase change materials: Mechanical and thermo-energy investigation. *APPLIED ENERGY*, vol. 212, p. 1448-1461, ISSN: 0306-2619, doi: 10.1016/j.apenergy.2018.01.014 - **Articolo in rivista**
4. Fabiani, C., Pisello, A. L. (2018). Coupling controlled environmental forcing and transient plane source method: An innovative thermal characterization procedure for building insulation materials. *APPLIED THERMAL ENGINEERING*, vol. 130, p. 254-263, ISSN: 1359-4311, doi: 10.1016/j.applthermaleng.2017.10.155 - **Articolo in rivista**
5. Pisello Anna Laura, Fortunati Elena, Fabiani Claudia, Mattioli Samantha, Dominici Franco, Torre Luigi, Cabeza Luisa F., Cotana Franco (2017). PCM for improving polyurethane-based cool roof membranes durability. *SOLAR ENERGY MATERIALS AND SOLAR CELLS*, vol. 160, p. 34-42, ISSN: 0927-0248, doi: 10.1016/j.solmat.2016.09.036 - **Articolo in rivista**
6. Pisello Anna Laura (2017). State of the art on the development of cool coatings for buildings and cities. *SOLAR ENERGY*, vol. 144, p. 660-680, ISSN: 0038-092X, doi: 10.1016/j.solener.2017.01.068 - **Articolo in rivista**
7. Akbari Hashem, Cartalis Constantinos, Kolokotsa Denia, Muscio Alberto, Pisello Anna Laura, Rossi Federico, Santamouris Matheos, Synnefa Afroditi, Wong Nyuk Hien, Zinzi Michele (2016). Local climate change and urban heat island mitigation techniques - The state of the art. *JOURNAL OF CIVIL ENGINEERING AND MANAGEMENT*, vol. 22, p. 1-16, ISSN: 1392-3730, doi: 10.3846/13923730.2015.1111934 - **Articolo in rivista**
8. Asdrubali Francesco, Pisello Anna Laura, D'Alessandro Francesco, Bianchi Francesco, Fabiani Claudia, Cornicchia Matteo, Rotoli Antonella (2016). Experimental and numerical characterization of innovative cardboard based panels: Thermal and acoustic performance analysis and life cycle assessment. *BUILDING AND ENVIRONMENT*, vol. 95, p. 145-159, ISSN: 0360-1323, doi: 10.1016/j.buildenv.2015.09.003 - **Articolo in rivista**
9. Han Yilong, Taylor John Eric, Pisello Anna Laura (2016). Exploring mutual shading and mutual reflection inter-building effects on building energy performance. *APPLIED ENERGY*, ISSN: 0306-2619, doi: 10.1016/j.apenergy.2015.10.170 - **Articolo in rivista**
10. Pisello A.L., Fortunati E., Mattioli S., Cabeza L.F., Barreneche C., Kenny J.M., Cotana F. (2016). Innovative cool roofing membrane with integrated phase change materials: Experimental characterization of morphological, thermal and optic-energy behavior. *ENERGY AND BUILDINGS*, vol. 112, p. 40-48, ISSN: 0378-7788, doi: 10.1016/j.enbuild.2015.11.061 - **Articolo in rivista**
11. Pisello A.L., Castaldo V.L., Pignatta G., Cotana F., Santamouris M. (2016). Experimental in-lab and in-field analysis of waterproof membranes for cool roof application and urban heat island mitigation. *ENERGY AND BUILDINGS*, vol. 114, p. 180-190, ISSN: 0378-7788, doi: 10.1016/j.enbuild.2015.05.026 - **Articolo in rivista**
12. Pisello Anna Laura, Castaldo Veronica Lucia, Fabiani Claudia, Cotana Franco (2016). Investigation on the effect of innovative cool tiles on local indoor thermal conditions: Finite element modeling and continuous monitoring. *BUILDING AND ENVIRONMENT*, vol. 97, p. 55-68, ISSN: 0360-1323, doi: 10.1016/j.buildenv.2015.11.038 - **Articolo in rivista**
13. Pisello Anna Laura, Castaldo Veronica Lucia, Piselli Cristina, Fabiani Claudia, Cotana Franco (2016). How peers' personal attitudes affect indoor microclimate and energy need in an institutional building: Results from a continuous monitoring campaign in summer and winter conditions. *ENERGY AND BUILDINGS*, vol. 126, p. 485-497, ISSN: 0378-7788, doi: 10.1016/j.enbuild.2016.05.053 - **Articolo in rivista**
14. Pisello Anna Laura, Castaldo Veronica Lucia, Taylor John Eric, Cotana Franco (2016). The impact of natural ventilation on building energy requirement at inter-building scale. *ENERGY AND BUILDINGS*, vol. 127, p. 870-883, ISSN: 0378-7788, doi: 10.1016/j.enbuild.2016.06.023 - **Articolo in rivista**
15. Rosso Federica, Pisello Anna Laura, Cotana Franco, Ferrero Marco (2016). On the thermal and visual pedestrians' perception about cool natural stones for urban paving: A field survey in summer conditions. *BUILDING AND ENVIRONMENT*, vol. 107, p. 198-214, ISSN: 0360-1323, doi: 10.1016/j.buildenv.2016.07.028 - **Articolo in rivista**
16. Han Yilong, Taylor John E, Pisello Anna Laura (2015). Toward mitigating urban heat island effects: Investigating the thermal-energy impact of bio-inspired retro-reflective building envelopes in dense urban settings. *ENERGY AND BUILDINGS*, vol. 102, p. 380-389, ISSN: 0378-7788, doi: 10.1016/j.enbuild.2015.05.040 - **Articolo in rivista**
17. A.L. Pisello, F. Cotana (2014). The thermal effect of an innovative cool roof on residential buildings in Italy: Results from two years of continuous monitoring. *ENERGY AND BUILDINGS*, vol.

- 69, p. 154-164, ISSN: 0378-7788, doi: 10.1016/j.enbuild.2013.10.031 - **Articolo in rivista**
18. Anna Laura Pisello, Franco Cotana, Andrea Nicolini, Cinzia Buratti (2014). Effect of dynamic characteristics of building envelope on thermal-energy performance in winter conditions: in field experiment. ENERGY AND BUILDINGS, vol. 80, p. 218-230, ISSN: 0378-7788, doi: 10.1016/j.enbuild.2014.05.017 - **Articolo in rivista**
19. Pisello Anna Laura, Asdrubali Francesco (2014). Human-based energy retrofits in residential buildings: a cost-effective alternative to traditional physical strategies. APPLIED ENERGY, vol. 133, p. 224-235, ISSN: 0306-2619, doi: 10.1016/j.apenergy.2014.07.049 - **Articolo in rivista**
20. A. L. Pisello, M. Goretti, F. Cotana (2012). A method for assessing buildings' energy efficiency by dynamic simulation and experimental activity. APPLIED ENERGY, vol. 97, p. 419-429, ISSN: 0306-2619, doi: 10.1016/j.apenergy.2011.12.094 - **Articolo in rivista**

## 2. BUONOMANO Annamaria

1. Athienitis, Andreas K., Barone, Giovanni, Buonomano, Annamaria, Palombo, Adolfo (2018). Assessing active and passive effects of façade building integrated photovoltaics/thermal systems: Dynamic modelling and simulation. APPLIED ENERGY, vol. 209, p. 355-382, ISSN: 0306-2619, doi: 10.1016/j.apenergy.2017.09.039 - **Articolo in rivista**
2. Buonomano, A., Forzano, C., Kalogirou, S. A., Palombo, A. (2018). Building-façade integrated solar thermal collectors: Energy-economic performance and indoor comfort simulation model of a water based prototype for heating, cooling, and DHW production. RENEWABLE ENERGY, ISSN: 0960-1481, doi: 10.1016/j.renene.2018.01.059 - **Articolo in rivista**
3. Buonomano, Annamaria, Calise, Francesco, Palombo, Adolfo (2018). Solar heating and cooling systems by absorption and adsorption chillers driven by stationary and concentrating photovoltaic/thermal solar collectors: Modelling and simulation. RENEWABLE & SUSTAINABLE ENERGY REVIEWS, vol. 82, p. 1874-1908, ISSN: 1364-0321, doi: 10.1016/j.rser.2017.10.059 - **Articolo in rivista**
4. BUONOMANO, ANNAMARIA, CALISE, FRANCESCO, PALOMBO, ADOLFO, VICIDOMINI, MARIA (2017). Adsorption chiller operation by recovering low-temperature heat from building integrated photovoltaic thermal collectors: Modelling and simulation. ENERGY CONVERSION AND MANAGEMENT, vol. 149, p. 1019-1036, ISSN: 0196-8904, doi: 10.1016/j.enconman.2017.05.005 - **Articolo in rivista**
5. BUONOMANO, ANNAMARIA, MONTANARO, Umberto, PALOMBO, ADOLFO, SANTINI, STEFANIA (2017). Temperature and humidity adaptive control in multi-enclosed thermal zones under unexpected external disturbances. ENERGY AND BUILDINGS, vol. 135, p. 263-285, ISSN: 0378-7788, doi: 10.1016/j.enbuild.2016.11.015 - **Articolo in rivista**
6. BUONOMANO, ANNAMARIA, CALISE, FRANCESCO, DENTICE D'ACCADIA, MASSIMO, FERRUZZI, GABRIELE, Frascogna, Sabrina, PALOMBO, ADOLFO, Russo, Roberto, Scarpellino, Marco (2016). Experimental analysis and dynamic simulation of a novel high-temperature solar cooling system. ENERGY CONVERSION AND MANAGEMENT, vol. 109, p. 19-39, ISSN: 0196-8904, doi: 10.1016/j.enconman.2015.11.047 - **Articolo in rivista**
7. BUONOMANO, ANNAMARIA, CALISE, FRANCESCO, PALOMBO, ADOLFO, VICIDOMINI, MARIA (2016). BIPVT systems for residential applications: an energy and economic analysis for European climates. APPLIED ENERGY, vol. 184, p. 1411-1431, ISSN: 0306-2619, doi: 10.1016/j.apenergy.2016.02.145 - **Articolo in rivista**
8. BUONOMANO, ANNAMARIA, Giuseppina De Luca, MONTANARO, Umberto, PALOMBO, ADOLFO (2016). Innovative technologies for NZEBs: an energy and economic analysis tool and a case study of a non-residential building in Mediterranean climate. ENERGY AND BUILDINGS, vol. 121, p. 318-343, ISSN: 0378-7788, doi: 10.1016/j.enbuild.2015.08.037 - **Articolo in rivista**
9. BUONOMANO, ANNAMARIA, MONTANARO, Umberto, PALOMBO, ADOLFO, SANTINI, STEFANIA (2016). Dynamic building energy performance analysis: A new adaptive control strategy for stringent thermohygro-metric indoor air requirements. APPLIED ENERGY, vol. 163, p. 361-386, ISSN: 0306-2619, doi: 10.1016/j.apenergy.2015.10.182 - **Articolo in rivista**
10. Buonomano Annamaria (2016). Code-to-code validation and application of a dynamic simulation tool for the building energy performance analysis. ENERGIES, vol. 9, p. 301-329, ISSN: 1996-1073, doi: 10.3390/en9040301 - **Articolo in rivista**
11. BUONOMANO, ANNAMARIA, CALISE, FRANCESCO, PALOMBO, ADOLFO, VICIDOMINI, MARIA (2015). Energy and economic analysis of geothermal-solar trigeneration systems: a case study for a hotel building in Ischia. APPLIED ENERGY, vol. 138, p. 224-241, ISSN: 0306-2619, doi: 10.1016/j.apenergy.2014.10.076 - **Articolo in rivista**
12. BUONOMANO, ANNAMARIA, DE LUCA, GIUSEPPINA, Figaj, Rafal Damian, VANOLI, LAURA (2015). Dynamic simulation and thermo-economic analysis of a Photovoltaic/Thermal collector heating system for an indoor-outdoor swimming pool. ENERGY CONVERSION AND MANAGEMENT, vol. 99, p. 176-192, ISSN: 0196-8904, doi: 10.1016/j.enconman.2015.04.022 - **Articolo in rivista**
13. BUONOMANO, ANNAMARIA, MONTANARO, Umberto, PALOMBO, ADOLFO, SANTINI, STEFANIA (2015). Adaptive control for building thermo-hygro-metric analysis: A novel dynamic simulation code for indoor spaces with multi-enclosed thermal zones. ENERGY PROCEDIA, vol. 78, p. 2190-2195, ISSN: 1876-6102, doi: 10.1016/j.egypro.2015.11.316 - **Articolo in rivista**
14. Annamaria Buonomano, Francesco Calise, Gabriele Ferruzzi, Laura Vanoli (2014). A novel renewable polygeneration system for hospital buildings: Design, simulation and thermo-economic optimization. APPLIED THERMAL ENGINEERING, vol. 67, p. 43-60, ISSN: 1359-4311, doi: 10.1016/j.applthermaleng.2014.03.008 - **Articolo in rivista**
15. BUONOMANO, ANNAMARIA, CALISE, FRANCESCO, Gabriela Ferruzzi, PALOMBO, ADOLFO (2014). Dynamic energy performance analysis: Case study for energy efficiency retrofits of hospital buildings. ENERGY, vol. 78, p. 555-572, ISSN: 0360-5442, doi: 10.1016/j.energy.2014.10.042 - **Articolo in rivista**
16. BUONOMANO, ANNAMARIA, PALOMBO, ADOLFO (2014). Building energy performance analysis by an in-house developed dynamic simulation code: an investigation for different case studies. APPLIED ENERGY, vol. 113, p. 788-807, ISSN: 0306-2619, doi: 10.1016/j.apenergy.2013.08.004 - **Articolo in rivista**
17. Annamaria Buonomano, Francesco Calise, Gabriele Ferruzzi (2013). Thermo-economic analysis of storage systems for solar heating and cooling systems: A comparison between variable-volume and fixed-volume tanks. ENERGY, vol. 59, p. 600-616, ISSN: 0360-5442, doi: 10.1016/j.energy.2013.06.063 - **Articolo in rivista**
18. Annamaria Buonomano, Francesco Calise, Massimo Dentice d'Accadia, Laura Vanoli (2013). A novel solar trigeneration system based on concentrating photovoltaic/thermal collectors. Part 1: Design and simulation model. ENERGY, vol. 61, p. 59-71, ISSN: 0360-5442, doi: 10.1016/j.energy.2013.02.009 - **Articolo in rivista**
19. BUONOMANO, ANNAMARIA, CALISE, FRANCESCO, PALOMBO, ADOLFO (2013). Solar heating and cooling systems by CPVT and ET solar collectors: a novel transient simulation model. APPLIED ENERGY, vol. 103, p. 588-608, ISSN: 0306-2619, doi: 10.1016/j.apenergy.2012.10.023 - **Articolo in rivista**
20. BUONOMANO, ANNAMARIA, CALISE, FRANCESCO, PALOMBO, ADOLFO (2012). Buildings dynamic simulation: water loop heat pump systems analysis for european climates. APPLIED ENERGY, vol. vol. 91, p. 222-234, ISSN: 0306-2619, doi: 10.1016/j.apenergy.2011.09.031 - **Articolo in rivista**

3. ARNESANO Marco

1. Naspi, Federica, Arnesano, Marco, Zampetti, Lorenzo, Stazi, Francesca, Revel, Gian Marco, D'Orazio, Marco (2018). Experimental study on occupants interaction with windows and lights in Mediterranean offices during the non-heating season. BUILDING AND ENVIRONMENT, vol. 127, p. 221-238, ISSN: 0360-1323, doi: 10.1016/j.buildenv.2017.11.009 - **Articolo in rivista**
2. Zampetti, L., Arnesano, M., Revel, G. M. (2018). Experimental testing of a system for the energy-efficient sub-zonal heating management in indoor environments based on PMV. ENERGY AND BUILDINGS, vol. 166, p. 229-238, ISSN: 0378-7788, doi: 10.1016/j.enbuid.2018.02.019 - **Articolo in rivista**
3. ARNESANO, MARCO, REVEL, Gian Marco, SERI, FEDERICO (2016). A tool for the optimal sensor placement to optimize temperature monitoring in large sports spaces. AUTOMATION IN CONSTRUCTION, vol. 68, p. 223-234, ISSN: 0926-5805, doi: 10.1016/j.autcon.2016.05.012 - **Articolo in rivista**
4. G.M. Revel, M. Arnesano, F. Pietroni, J. Frick, M. Reichert, K. Schmitt, J. Huber, M. Ebermann, U. Battista, F. Alessi (2015). COST-EFFECTIVE TECHNOLOGIES TO CONTROL INDOOR AIR QUALITY AND COMFORT IN ENERGY EFFICIENT BUILDING RETROFITTING. ENVIRONMENTAL ENGINEERING AND MANAGEMENT JOURNAL, vol. 14, p. 1487-1494, ISSN: 1582-9598 - **Articolo in rivista**
5. Petri Ioan, Rezzoui Yacine, Beach Tom, Li Haijiang, Arnesano Marco, Revel Gian Marco (2015). A semantic service-oriented platform for energy efficient buildings. CLEAN TECHNOLOGIES AND ENVIRONMENTAL POLICY, vol. 17, p. 721-734, ISSN: 1618-954X, doi: 10.1007/s10098-014-0628-2 - **Articolo in rivista**
6. G.M. Revel, M. Arnesano (2014). Perception of the thermal environment in sports facilities through subjective approach. BUILDING AND ENVIRONMENT, vol. 77, p. 12-19, ISSN: 0360-1323 - **Articolo in rivista**
7. G.M. Revel, M. Arnesano, F. Pietroni (2014). Misurare il comfort termo-igrometrico in ambienti indoor. Un sistema innovativo basato su sensori IR. TUTTO MISURE, vol. 3/14, p. 177-180, ISSN: 2038-6974 - **Articolo in rivista**
8. Gian Marco Revel, Marco Arnesano, Filippo Pietroni, Jürgen Frick, Manuela Reichert, Markus Krüger, Katrin Schmitt, Jochen Huber, Martin Ebermann, Luc Pockelà (2014). THE MONITORING OF INDOOR AIR QUALITY AND COMFORT: THE EXPERIENCE OF THE PROJECT CETIEB. PROCEDIA ENVIRONMENTAL SCIENCE, ENGINEERING AND MANAGEMENT, vol. 1, p. 87-92, ISSN: 2392-9537 - **Articolo in rivista**
9. Revel G.M., Arnesano M. (2014). Measuring overall thermal comfort to balance energy use in sports facilities. MEASUREMENT, vol. 55, p. 382-393, ISSN: 0263-2241, doi: 10.1016/j.measurement.2014.05.027 - **Articolo in rivista**
10. Revel G.M., Arnesano M., Pietroni F. (2014). Development and validation of a low-cost infrared measurement system for real-time monitoring of indoor thermal comfort. MEASUREMENT SCIENCE & TECHNOLOGY, vol. 25, ISSN: 0957-0233, doi: 10.1088/0957-0233/25/8/085101 - **Articolo in rivista**
11. G.M. Revel, M. Arnesano, F. Pietroni, J. Frick, M. Reichert, M. Krüger, K. Schmitt, J. Huber, M. Ebermann, L. Pockelà, A. Khanlou, A. Ekonomakou, J. Balau, C. Pascale, F. De Falco, R. Lando, U. Battista, J. Stuart (2013). ADVANCED TOOLS FOR THE MONITORING AND CONTROL OF INDOOR AIR QUALITY AND COMFORT. ENVIRONMENTAL ENGINEERING AND MANAGEMENT JOURNAL, vol. 12, p. 228-232, ISSN: 1582-9598 - **Articolo in rivista**
12. G.M. Revel, E. Sabbatini, M. Arnesano (2012). Development and experimental evaluation of a thermography measurement system for real-time monitoring of comfort and heat rate exchange in the built environment. MEASUREMENT SCIENCE & TECHNOLOGY, vol. 23 (2012) 035005, ISSN: 0957-0233, doi: 10.1088/0957-0233/23/3/035005 - **Articolo in rivista**
13. G.M. Revel, F. Pietroni, S. Casaccia, L. Scalise, M. Arnesano, F. Seri, L. Zampetti, E.P. Tomasini (2015). SENSORS FOR HOME AND BUILDING APPLICATIONS: SOME RESEARCH PROJECTS. In: Atti del XIV Convegno di Misure Meccaniche e Termiche - XXII Congresso di Misure Elettriche ed Elettroniche. Lecco, 10-12 settembre 2015 - **Contributo in Atti di convegno**
14. G.M. Revel, M. Arnesano, F. Pietroni, M. Schmidt, O. Kaschtschejewa (2014). Evaluation in a controlled environment of a low-cost IR sensor for indoor thermal comfort measurement. In: Proceedings QIRT2014. Bourdeaux, July 2014 - **Contributo in Atti di convegno**
15. Gian Marco Revel, Marco Arnesano, Filippo Pietroni (2014). A method to employ low-cost IR sensors for the indoor thermal comfort measurement - Application in a classroom. In: Proceedings of IX Congress National Group of Mechanical and Thermal Measurements. p. 87-94, ISBN: 9788897683681, Ancona, Italy, Settembre 2014 - **Contributo in Atti di convegno**
16. G.M. Revel, M. Arnesano (2013). Design of a comfort-based monitoring approach for energy efficiency in Sport & Recreational buildings. In: Proceedings of IECEB'12. p. 603-614, European Commission - Joint Research Centre, ISBN: 9789279282225, Francoforte, 18-19 Aprile 2012 - **Contributo in Atti di convegno**
17. G.M. Revel, M. Arnesano, F. Pietroni (2013). A low-cost sensor for real-time monitoring of indoor thermal comfort for Ambient Assisted Living. In: Atti del 4o Forum Italiano per l'Ambient Assisted Living. Ancona, 23-25 ottobre 2013 - **Contributo in Atti di convegno**
18. G.M. Revel, M. Arnesano, F. Pietroni (2013). An Innovative Low Cost IR System For Real-Time Measurement of Human Thermal Comfort. In: Atti del Convegno Astrae IAQ 2013. Vancouver, Canada, 15-18 ottobre 2013 - **Contributo in Atti di convegno**
19. G. REVEL, E. SABBATINI, M. ARNESANO (2010). A new thermography based system for real-time energy balance in the built environment. In: atti del Convegno internazionale CLIMA 2010 Rehva World Congress. Antalya, 9-12 Maggio 2010 - **Contributo in Atti di convegno**
20. G.M. Revel, M. Arnesano, F. Pietroni (2015). Integration of real-time metabolic rate measurement in a low-cost tool for the thermal comfort monitoring in AAL environments. In: Ambient Assisted Living Italian Forum 2014. vol. 11, p. 101-110, Springer, ISBN: 978-3-319-18373-2, doi: 10.1007/978-3-319-18374-9 - **Contributo in volume (Capitolo o Saggio)**

6. Hindex of associated investigators (only for the scientific fields in which the use of the H-index is usually adopted)

n°	Surname Name	H-Index	Source
1.	PISELLO Anna Laura	22	Scopus
2.	ARNESANO Marco	5	Scopus
3.	BUONOMANO Annamaria	13	Scopus

7. Main staff involved (max 10 professors/researchers for each research unit, in addition to the PI or associated investigator), highlighting the time commitment expected

List of the Research Units

Unit 1 - FABRIZIO Enrico

Personnel of the research unit

n°	Surname Name	Category	University/ Research Institution	e-mail address	Months/person expected
1.	FABRIZIO Enrico	Professore Associato (L. 240/10)	Politecnico di TORINO	enrico.fabrizio@polito.it	5,0
2.	FABI Valentina	Ricercatore a t.d. - t.pieno (art. 24 c.3-a L. 240/10)	Politecnico di TORINO	valentina.fabi@polito.it	3,0
3.	BECCHIO Cristina	Ricercatore a t.d. - t.pieno (art. 24 c.3-a L. 240/10)	Politecnico di TORINO	cristina.becchio@polito.it	2,0
4.	FERRARA Maria	Assegnista	Politecnico di TORINO	maria.ferrara@polito.it	2,0

Unit 2 - PISELLO Annalaura

Personnel of the research unit

n°	Surname Name	Category	University/ Research Institution	e-mail address	Months/person expected
1.	PISELLO Annalaura	Ricercatore a t.d. - t.pieno (art. 24 c.3-a L. 240/10)	Università degli Studi di PERUGIA	anna.pisello@unipg.it	6,0
2.	PIGLIAUTILE Iliaria	Dottorando	Università degli Studi di PERUGIA	ilaria.pigliautile@studenti.unipg.it	4,0
3.	FABIANI Claudia	Dottorando	Università degli Studi di PERUGIA	claudia.fabiani@studenti.unipg.it	2,0

**Unit 3 - BUONOMANO Annamaria**

*Personnel of the research unit*

n°	Surname Name	Category	University/ Research Institution	e-mail address	Months/person expected
1.	BUONOMANO Annamaria	Ricercatore a t.d. (art. 24 c.3-b L. 240/10)	Università degli Studi di Napoli Federico II	annamaria.buonomano@unina.it	6,0
2.	LESO Veruscka	Ricercatore a t.d. - l.pieno (art. 24 c.3-a L. 240/10)	Università degli Studi di Napoli Federico II	veruscka.jeso@gmail.com	3,0

**Unit 4 - ARNESANO Marco**

*Personnel of the research unit*

n°	Surname Name	Category	University/ Research Institution	e-mail address	Months/person expected
1.	ARNESANO Marco	Ricercatore a t.d. - l.pieno (art. 24 c.3-a L. 240/10)	Università Politecnica delle MARCHE	m.arnesano@univpm.it	6,0
2.	ZAMPETTI Lorenzo	Assegnista	Università Politecnica delle MARCHE	lorenzo.zampetti1@gmail.com	2,0

**8. Major new contracts for staff specifically to recruit**

n°	Associated or principal Investigator	Number of contracts RTD expected	Number of research grants expected	Number of PhD expected	Predictable overall time commitment (months)
1.	FABRIZIO Enrico	0	2	0	36
2.	PISELLO Annalaura	0	2	0	43
3.	BUONOMANO Annamaria	0	2	0	38
4.	ARNESANO Marco	0	2	0	36

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Total	0	8	0	153
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### 9. Statement by the Principal Investigator

Con la sottomissione della presente proposta, consapevole della responsabilità civile e penale, attesto l'assenza di duplicazione degli obiettivi e dei contributi richiesti con altri progetti in corso o già conclusi

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"I dati contenuti nella domanda di finanziamento sono trattati esclusivamente per lo svolgimento delle funzioni istituzionali del MIUR. Incaricato del trattamento è il CINECA - Business Unit MIUR. La consultazione è altresì riservata agli atenei e agli enti di ricerca (ciascuno per le parti di propria competenza), al MIUR - D.G. per il Coordinamento e lo Sviluppo della Ricerca - Ufficio V, al CNGR e al CdS. Il MIUR potrà anche procedere alla diffusione dei principali dati economici e scientifici relativi ai progetti finanziati".

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Date 28/03/2018 ore 21:11

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