



# Digital Transformation in Enel Thermal Generation

**Nicola Rossi** - Head of Innovation Generation Technologies and IoT

Workshop ANIMP

Milan, 19 April 2017



# Enel today<sup>1</sup>

Global diversified operator



## North and Central America

- Capacity: 3.5 GW

## Latin America

- Capacity: 18.6 GW
- Networks: 0.32 mn km
- End users: 15.3 mn

■ = Enel presence<sup>2</sup>

## Enel Group

- Capacity: 87 GW
- Networks: 1.9 mn km
- End users: 61.5 mn
- Free customers: 23.1 mn

## Italy

- Capacity: 27.8 GW
- Networks: 1.14 mn km
- End users: 31.6 mn
- Free customers: 10.5 mn

## Iberia

- Capacity: 22.8 GW
- Networks: 0.32 mn km
- End users: 11.9 mn
- Free customers: 12.5 mn

## Europe and North Africa

- Capacity: 14 GW
- Networks: 0.09 mn km
- End users: 2.7 mn
- Free customers: 0.1 mn

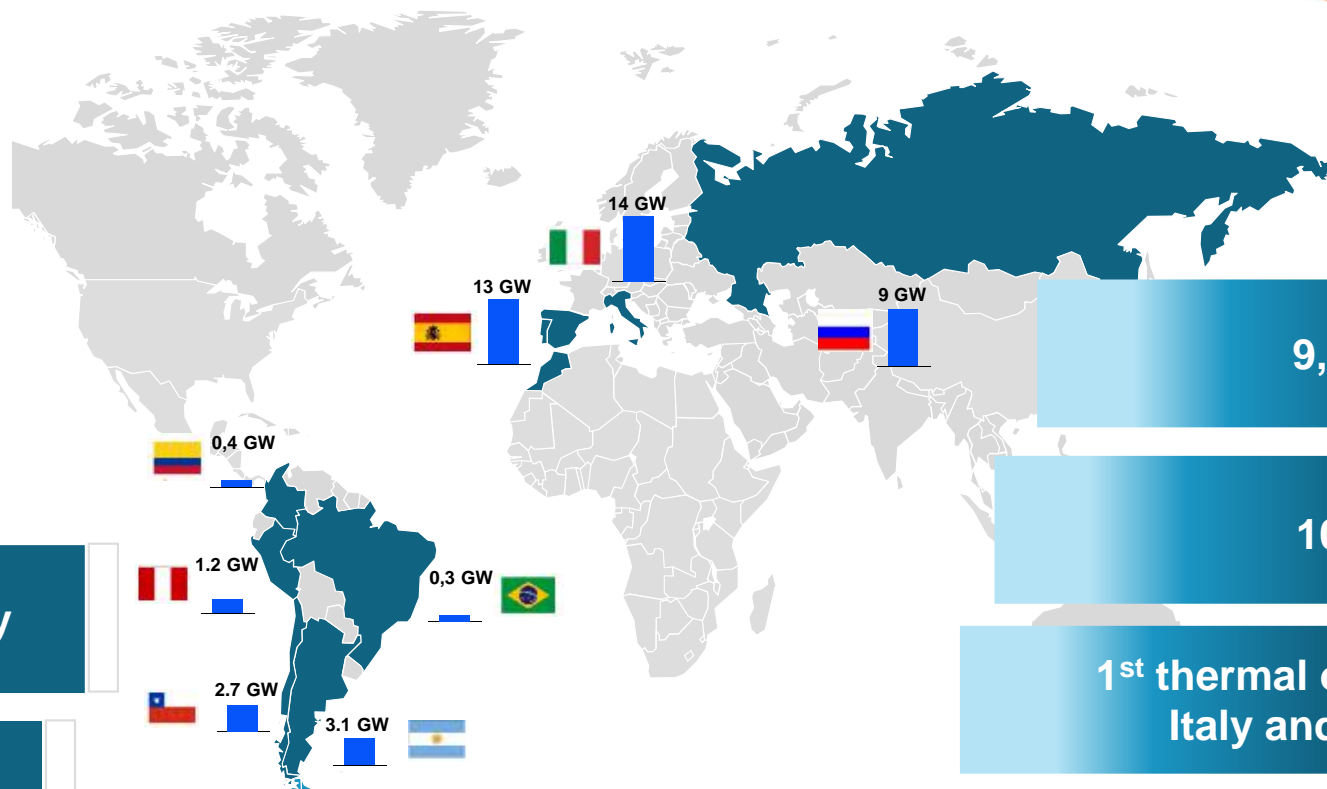
## Sub-Saharan Africa - Asia

- Capacity: 0.3 GW

1. As of 30<sup>th</sup> June 2016

2. Presence with operating assets

# Thermal Generation – Key figures @ 2016



44 GW capacity

142 TWh production

1,2 Bn€ EBITDA

9,000 people

100 plants

1<sup>st</sup> thermal operator in Italy and Spain

# Enel Thermal Generation focuses



## IT infrastructure



Warehouses management  
Access control  
Predictive maintenance  
Smart Wireless Sensor Networks  
Robotics  
Documents management  
Virtual reality  
People localization - biometrics

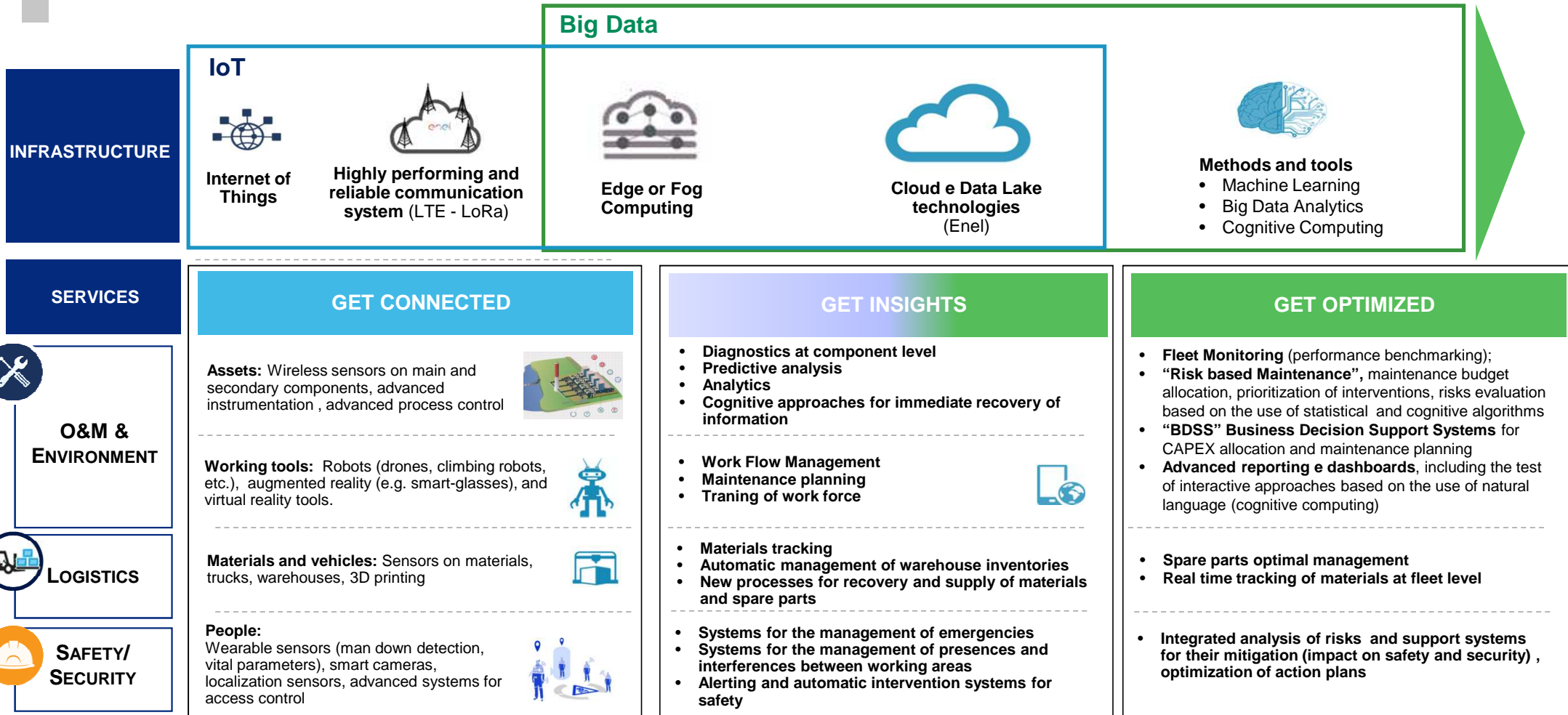
## Technologies integration

## Monitoring rooms

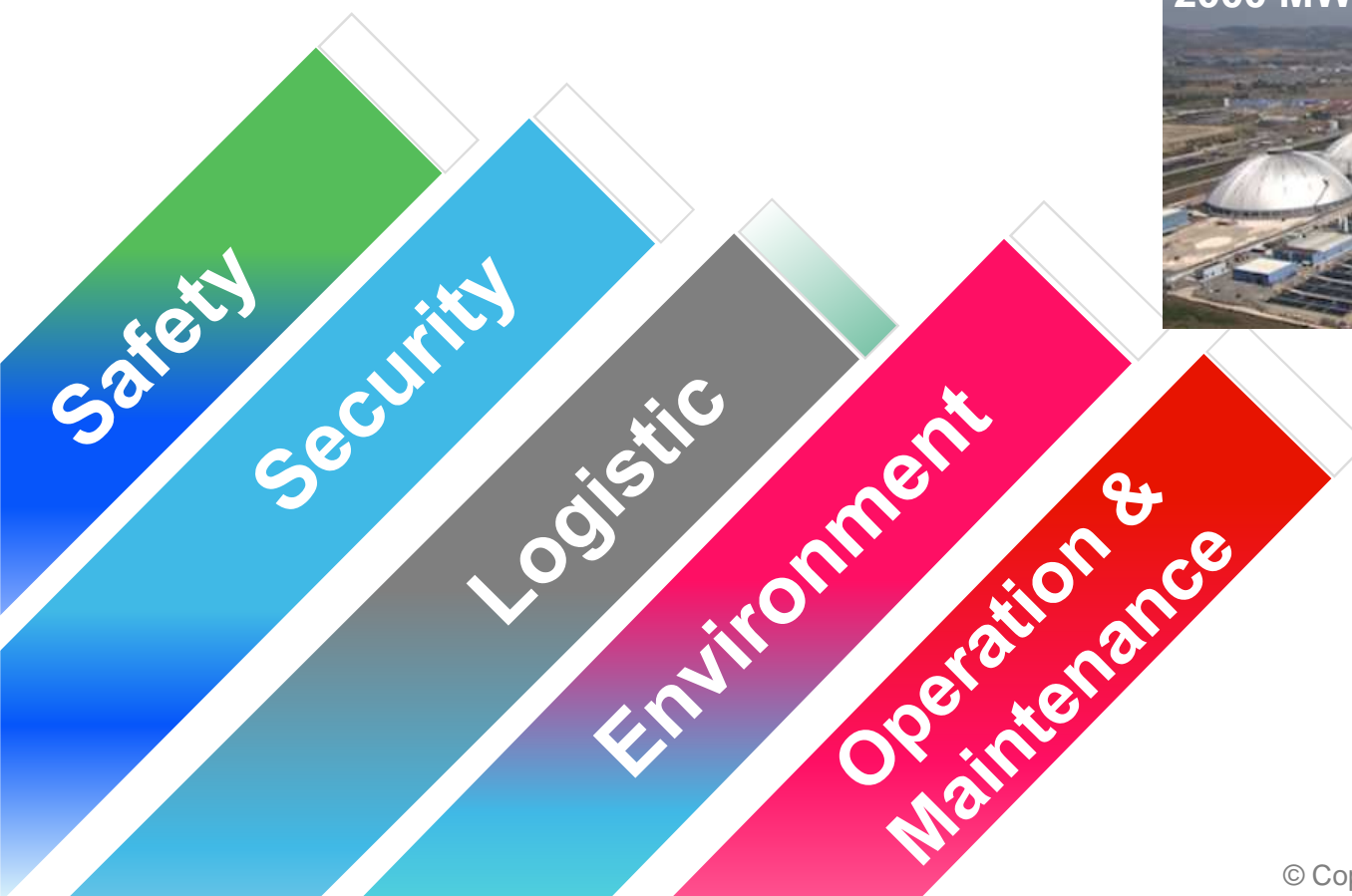
**Global deployment plan 11 GW @ 2019**

## Digital Transformation

# IT infrastructures and technologies



# Digital pilots – Scope and areas of interest



## Civitavecchia – Coal

2000 MWe

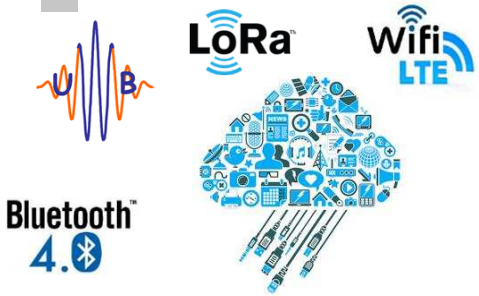


## Besos – GTCC

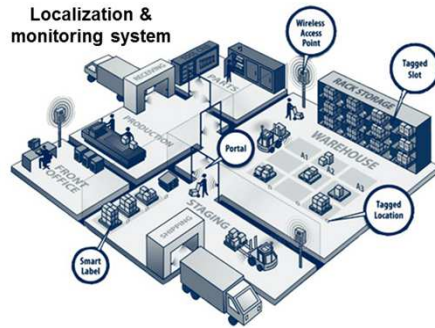


1260 MWe

# Pilot implementation plan - 2017



Communication and data management infrastructure



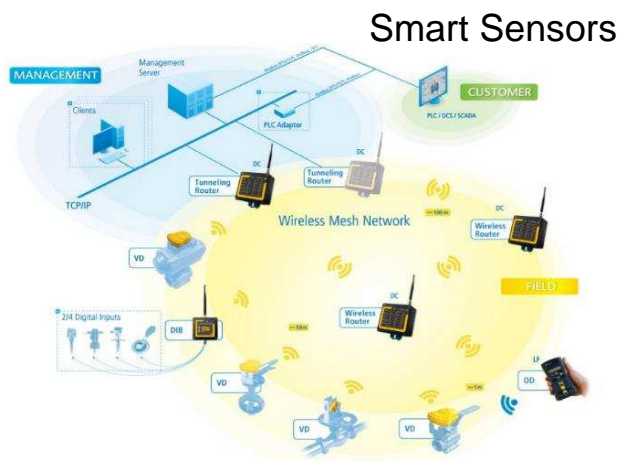
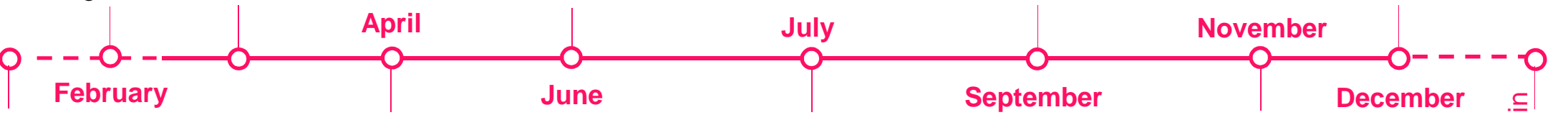
Material / trucks tracking and management



Wearable, people localization and technologies for safety



Robots, Augm. and Virtual Reality for O&M and training



Smart Sensors



Advanced Process Control



Analytics for predictive diagnostic

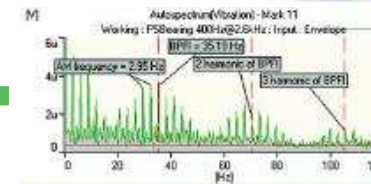
2016 - Design of pilots

2018 - Pilots full operation in parallel with deployment

# Smart sensors

## Smart Vibration Node

- On-board elaboration of the vibration spectrum for detecting damage (high frequency, trend analysis)



## Wireless Valve Position Node

- Innovative communication protocol (Lora, Zigbee)
- Accurate real time information, full range position (0-100%)
- Predictive valve maintenance
- Available for any valve, any actuator
- Remotely configurable

Gateway



Valve position sensor

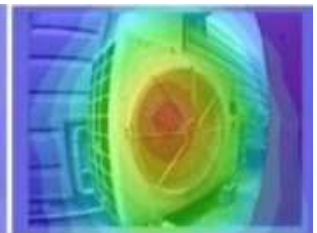
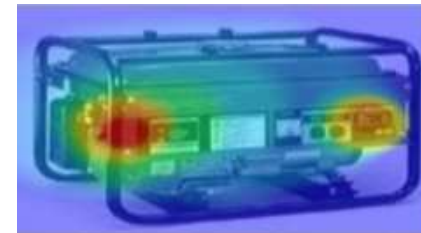


## Electronic Ear

- On-board automatic detection of anomaly noises
- Localization of noise sources



Microphone MEMS

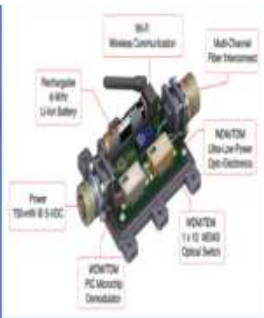




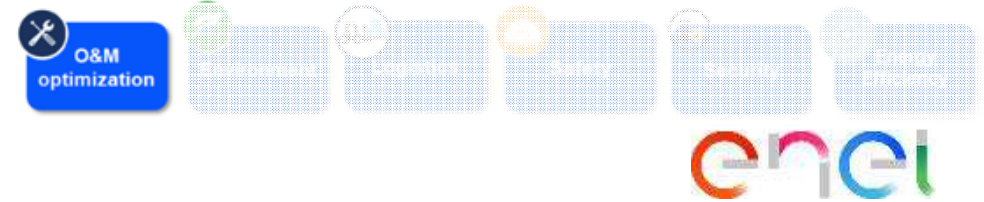
# Smart sensors

## Temperature sensors

- ❑ **Thermocouples and fiber optic sensors** for temperature monitoring on critical components of boilers
- ❑ On line component life assessment for timely decisions:
  - Component inspection need and schedule
  - Run/repair/replace decisions for detected damage
  - Impact of plant operating modes on component life
- ❑ Stress, damage and crack growth projections based on actual plant operating data



**Fiber optic sensor electronics**



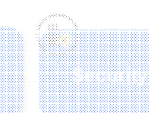
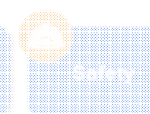
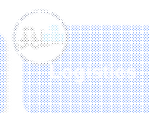
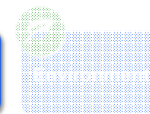
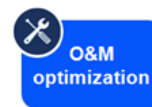
**Fiber optic to measure temperature installed in HRSG header Unit 3**



**Skin point thermocouples installed in superheater header Unit 3**



**Thermocouples electronics**



# Smart sensors

## Visual and IR Cameras

- ❑ Video recording to feed new diagnostic analytics and evaluate influence of light and night conditions

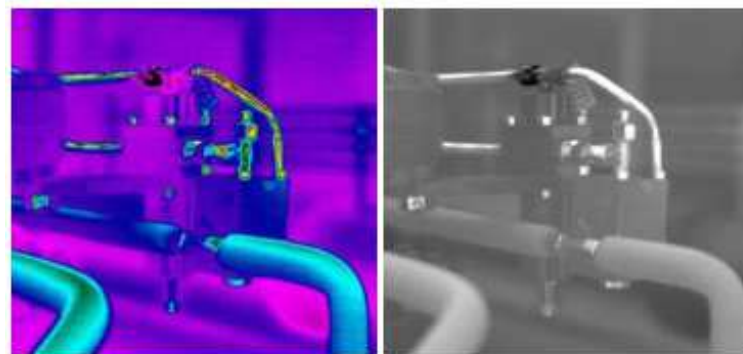
Main transformers



Besos river



Outcomes of video recording tests



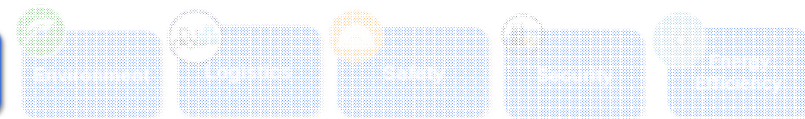
Spectral cameras



## Cameras for Natural Gas leakage detection

- ❑ Spectrally adapted infrared cameras





# Remote surveillance system



## Camera + RFID to detect unauthorized or unsafe access

If people entering certain areas do not have permission or safety equipment



Remote alarm with photo



## Camera recognizing oil leakages

If two subsequent images have different contrast in the ground area



Remote alarm with photo

Sensor automatic reading (analog → digital)



## Thermo-camera recognizing temperature anomalies

If pixels detect overheating vs. normal operation



Remote alarm with photo with highlighted hot-spot

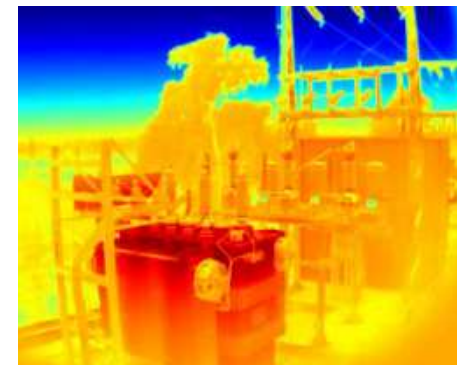


Image during normal operation

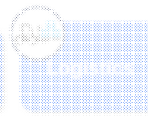
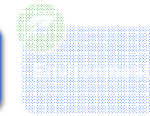


Hot spot highlighted

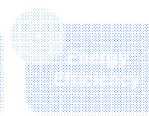
Photo sent to remote operator in case of anomalies



O&M optimization



Safety

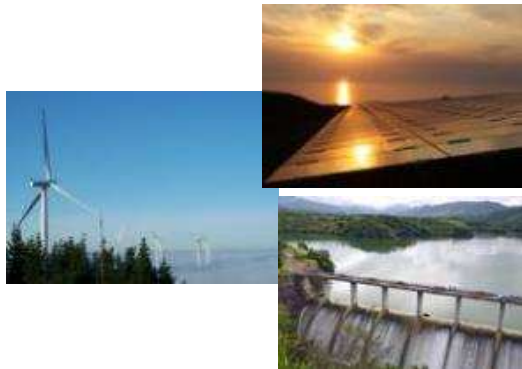


# Unmanned aerial vehicle (UAV)

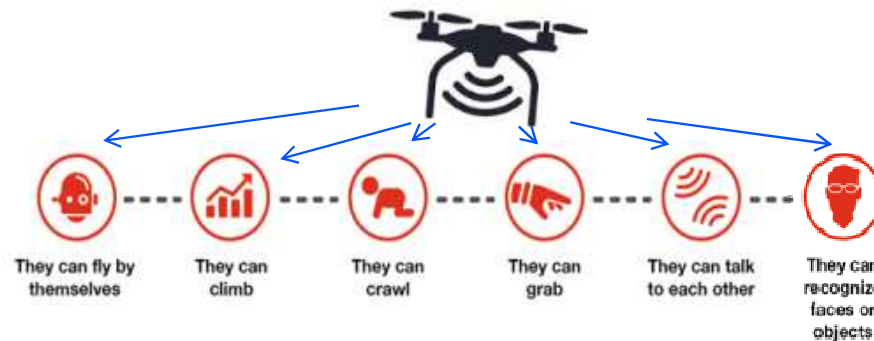
## Electric utility applications

Drones can be integrated in electric utility business to meet some needs in **O&M, Safety and Security**

- ❑ design and implement new and innovative techniques to **optimize operation and maintenance**
- ❑ **reduce costs and the time** related execution of **inspections**
- ❑ substitute human workers during inspections **at height and in confined areas**
- ❑ **monitor construction sites and materials deposits**
- ❑ **support security** function through automatic **anti-intrusion** inspection



Renewable Energies

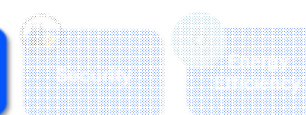
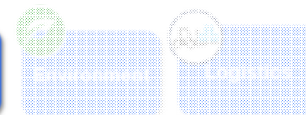


Thermal Generation



Infrastructure and Network





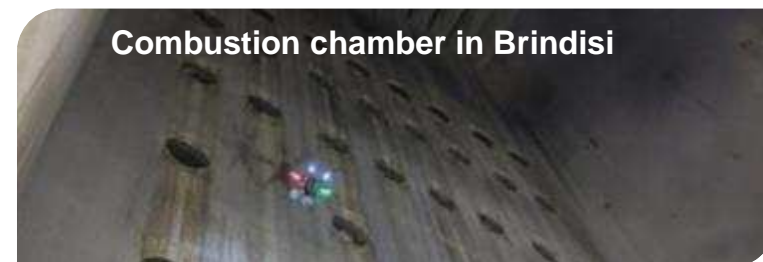
# Inspections in thermal power plants

Boiler inspection remotely managed



Inspection carried out with ENELicopter during a programmed maintenance without scaffolding-  
Time reduction of inspection 10 Days

Combustion chamber in Brindisi



Burners view with drone in Brindisi



Cimney inspection ...



... in Termini Imerese PP



New procedure in TG included drone inspection of cimney before planning of involment of operator at a height

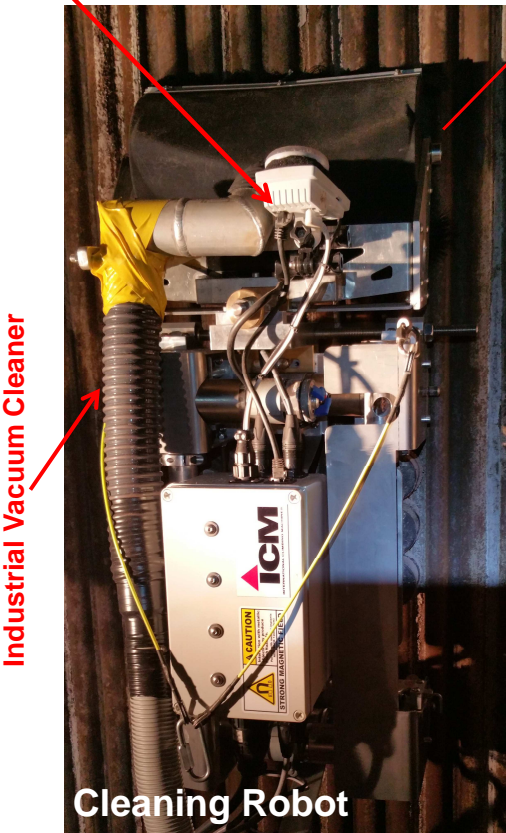
Stacker reclaimers in Brindisi coal de



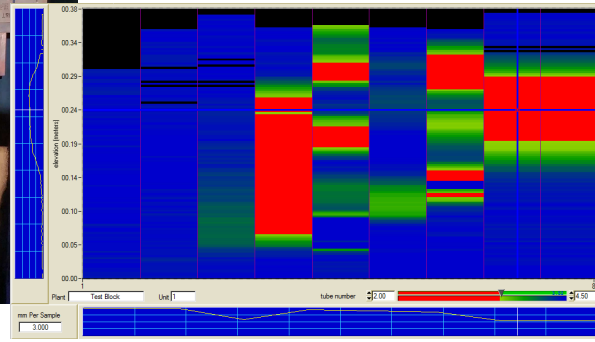
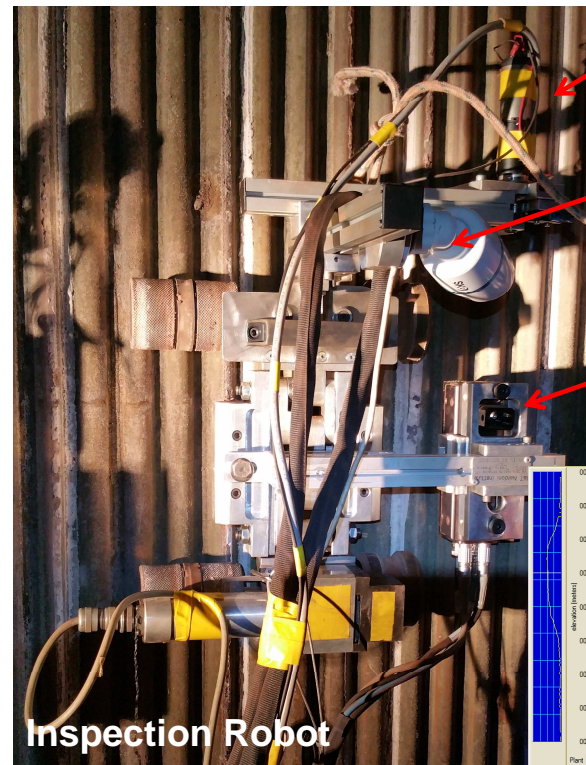
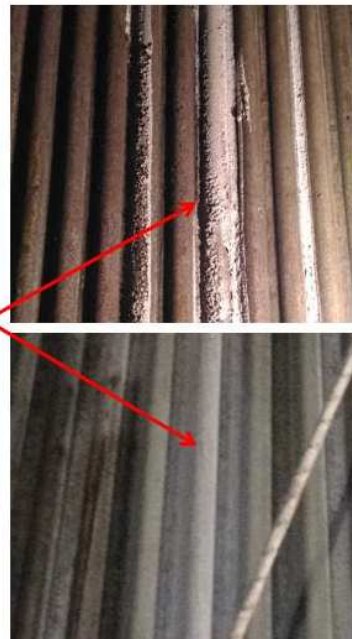
# Climbing robot for boiler wall NDT

Camera

Brushes details



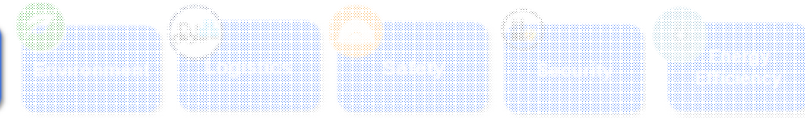
Before & After Cleaning



# Roadmap for new robots

Aerial Robot	Amphibious Robot	Terrestrial Robot
		
Drone Box + Drone	Drone Box + Drone	UGV

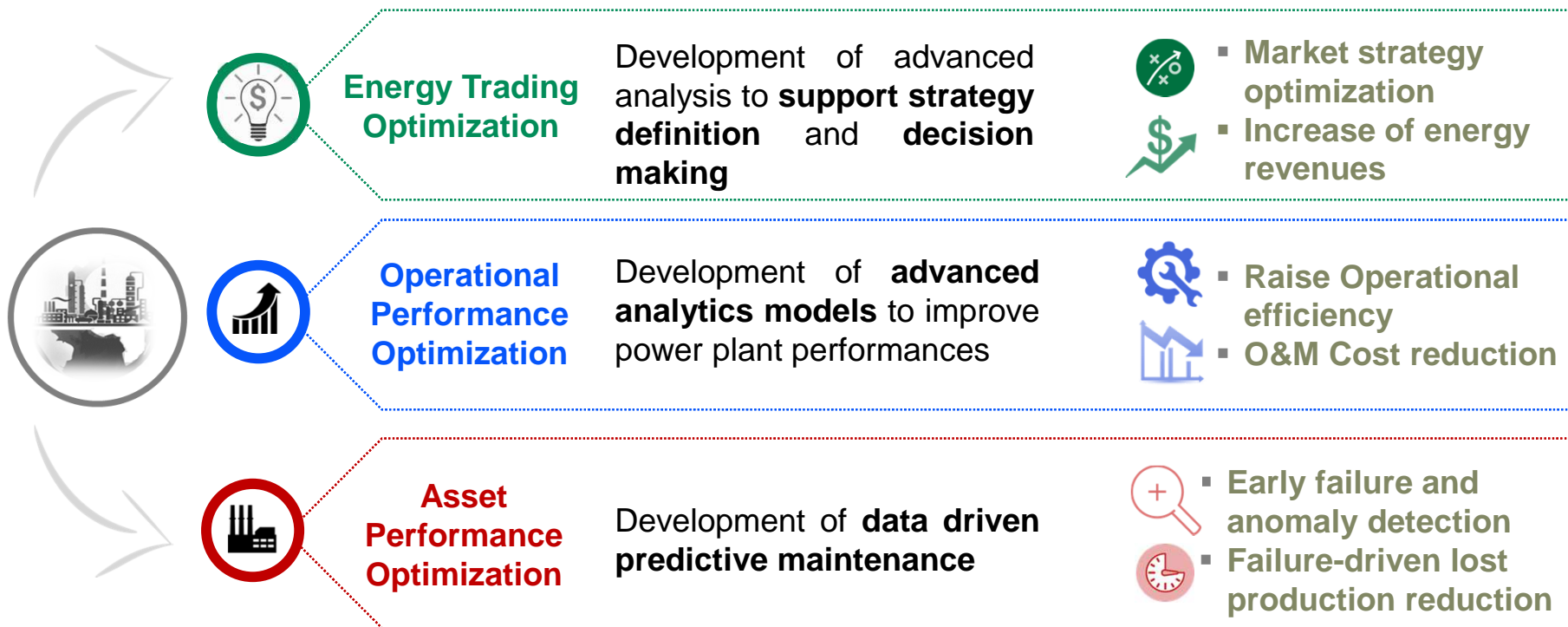
- ❑ **Ground control unit with recharging system**
- ❑ **Real-time mission management**
- ❑ Integrated mission display and payload data retrieval
- ❑ Way-point navigation
- ❑ Mission planning on electronic maps
- ❑ Fully integrated in the IoT platform



# Exploit Big Data technology to improve performance



© Copyright Enel Produzione SpA, Roma - All rights reserved



La Casella Monitoring Room - Single point for Asset Performance TGx fleet analysis



# Augmented reality

## Remote Assistance

**Portable / wearable systems** that allow to:

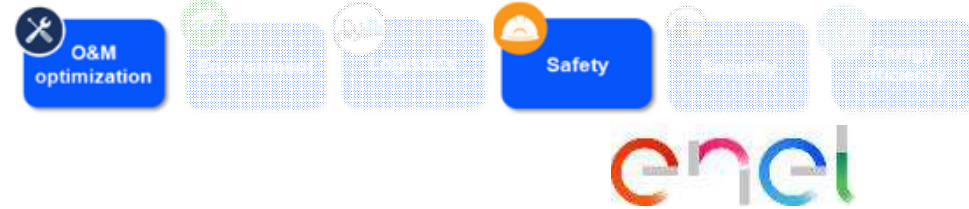
- ❑ **Local staff support by remotely located expert staff**
- ❑ **Retrieve/display the documents and instructions**
- ❑ Ability to provide audio, text, warning information, step by step procedures, in real time overlapped to the real plant assets
- ❑ Hand free Interaction with devices through voice/gesture



**Actual Solution**  
*Sant'Anna-VRMedia*



**Commercial Solutions  
(smart glasses) evaluation**  
*Epson, Sony, Fujitsu, LG*



## 3D Plant Image

- ❑ 3D modeling of each plant main component in order to allow to view, search and locate all the elements
- ❑ Associate with each component the most important information (from the “technical” data to the online data collected from plant data historian system)

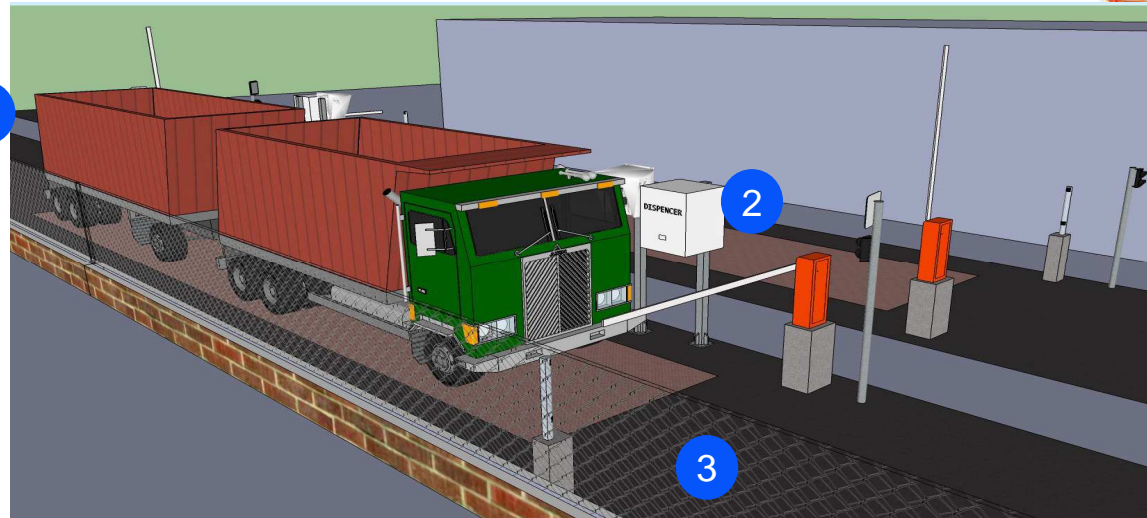


**3D laser scanning**

# Logistics – Material tracking



1



1 Vehicle identification with RFID tag

2 Information storage  
Interaction with driver with terminal panel  
Supply of tracking tag



**Kg**  
Weight



**Touch panel**

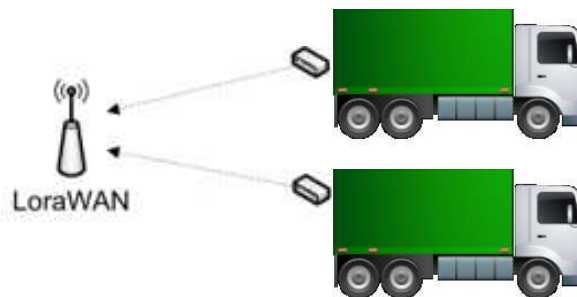


**Document scan**

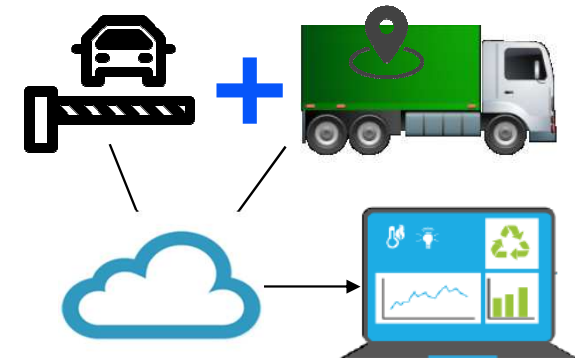


**Pictures**

3 Trucks tracking within the plant perimeter



4 Information collection in the IoT platform for visualization and analytics



# Safety management

## FEATURES

### Worker localization (indoor/outdoor)

- **Geo-fencing applications** for detecting in confined or not authorized areas
- Check on real time of the **PPEs use**
- **Man Down detection**
- **SOS/panic button**
- Notification of **non healthy areas**
- **Automatic alarm/alert** message

### Wearable vital sensing fabric for:

- **Monitoring of heart rate, ECG, EMG and accelerometer**
- **Mental and physical status:** stress level, posture, etc.
- **Diagnostic alarm generation** for remote monitoring applications

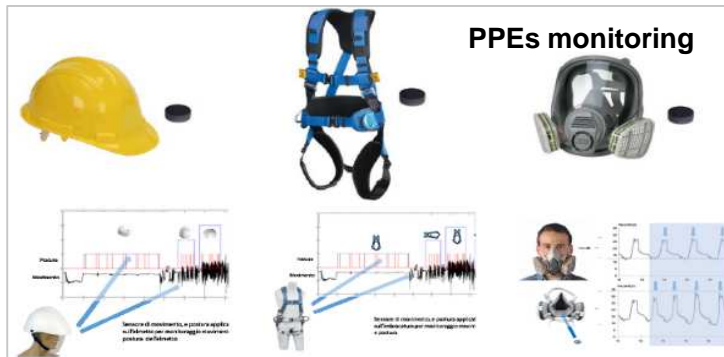
### Indoor/Outdoor Localization

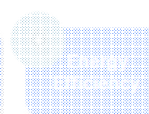
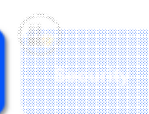


### Vital parameters monitoring



### PPEs monitoring





# Virtual reality - Safety and O&M training

Exclusive **fully-immersive and innovative training experience**, improving the effectiveness of the training and enabling the trainee to perceive the consequences of not complying with safety methods and procedures.



Electrical works

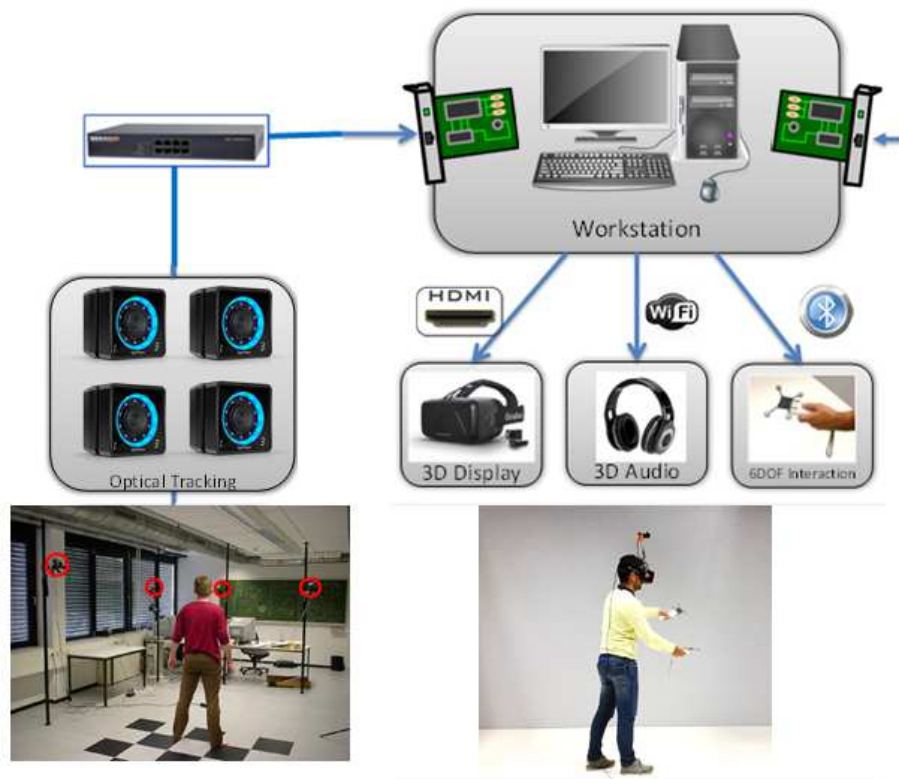


Valve packing



VR condenser

## Developed scenarios



## System components



# Thank you



**[nicola.rossi@enel.com](mailto:nicola.rossi@enel.com)**