Enel Augmented Reality helmet for remote assistance

EPRI Summit

D.Pestonesi
Enel GG R&D

Madrid, 28 April 2015

Agenda

1 Enel scenario

2 Enel Augmented Reality System

3 Improvement of AR System

4 Questions and Discussion

Enel today
An international energy operator

ENERGY TO LIFE

No.1 electricity company in Italy. Second largest utility in Europe by installed capacity

Presence in:
40 countries

Installed capacity:
99.000 MW

Annual output:
286 TWh

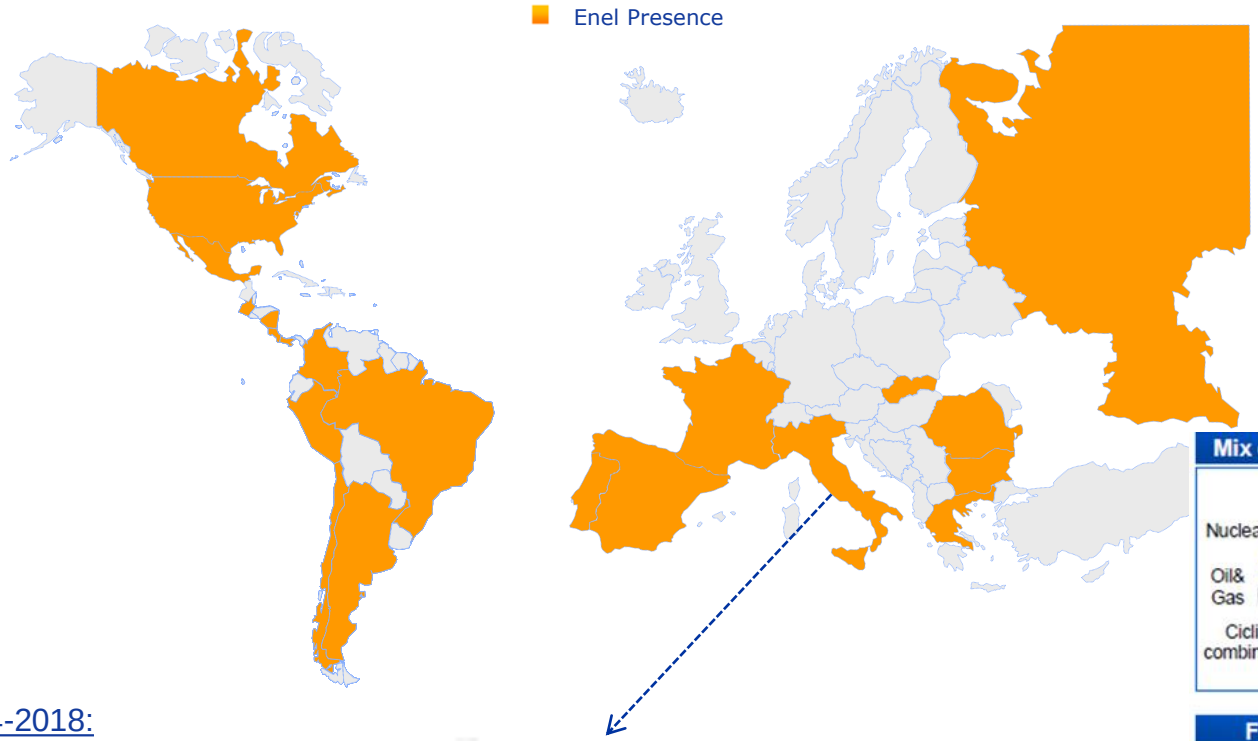
Electri Grid length
1,9 mln Km

EBITDA:
17 Mld €

Customers:
61 million

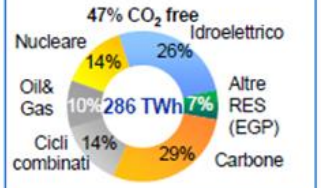
Employees:
70,300

Investment Plan 2014-2018:
€26 Mld€

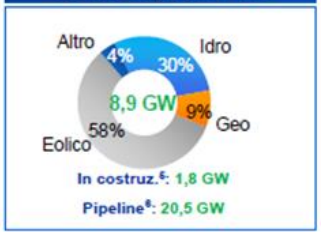


Italia
1° in generazione (27%)
1° in distribuzione (85%)
40 GW (di cui 3 GW)
31 Mln clienti

Mix di produzione Gruppo



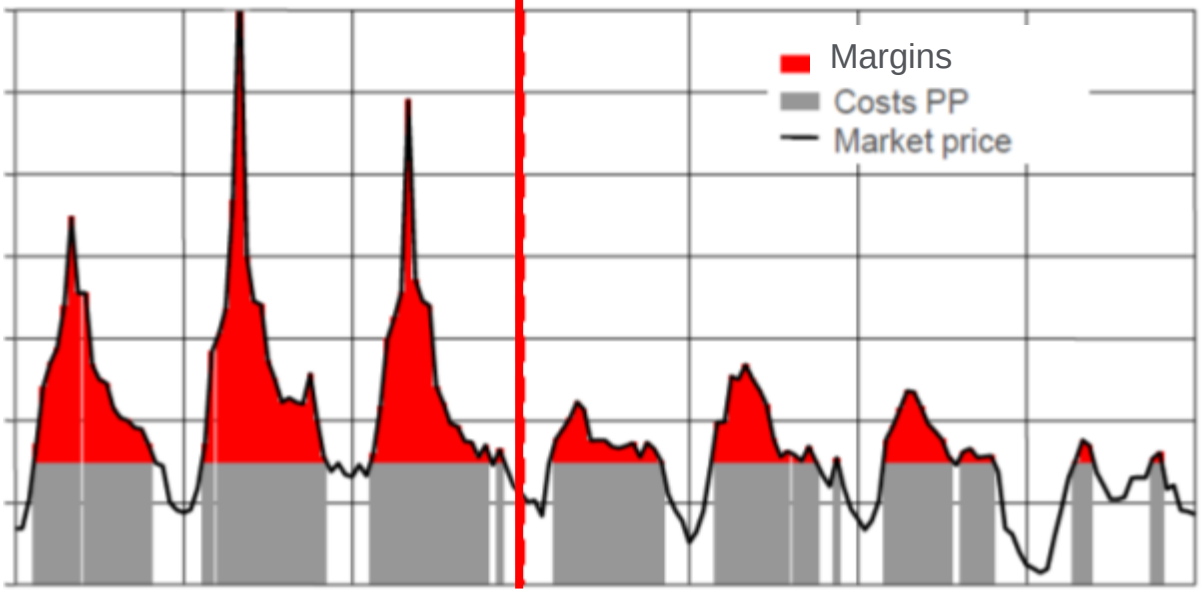
Focus capacità EGP



Data as of 31.12.20113

Electricity price profiles and contribution margins before and after major RES investments

Before major RES investments ⟵ ⟶ **Effect of RES on prices and operation**



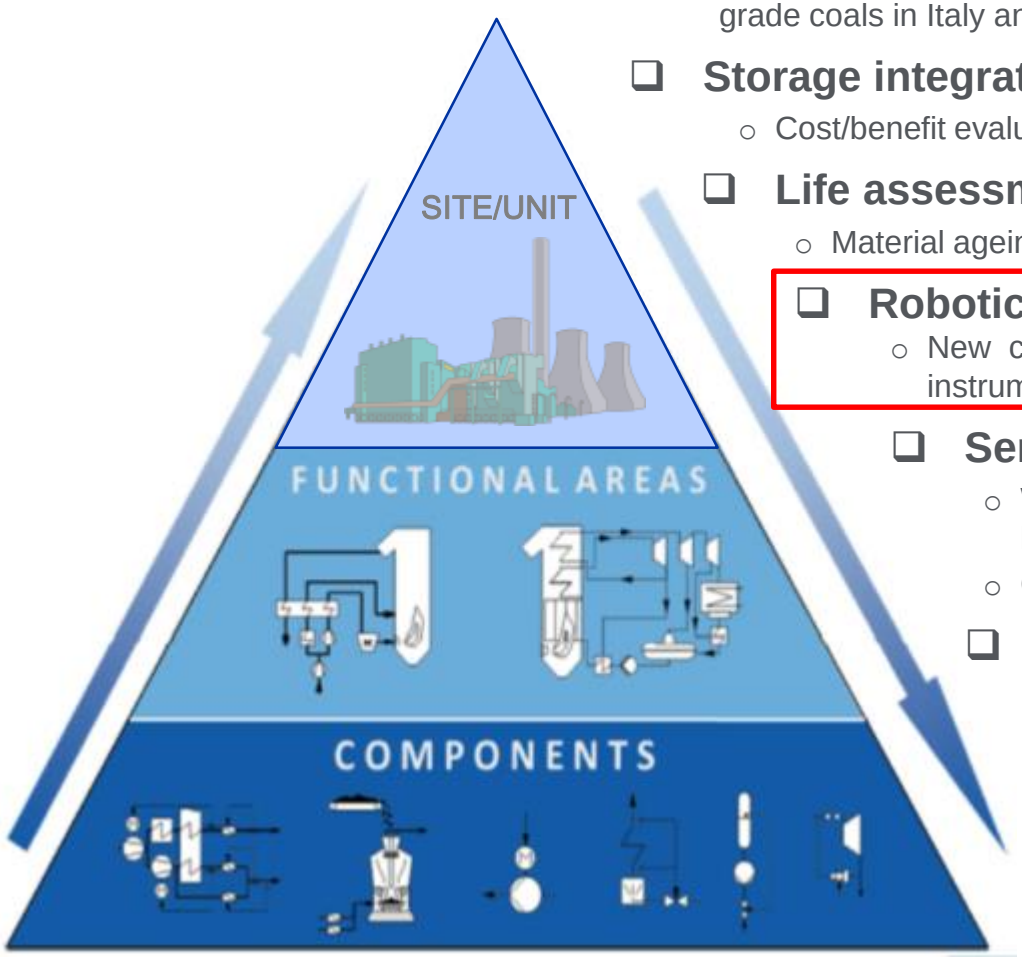
Source: VGB Congress PP 2014, Hamburg, September 2014 Germany

Imperatives for PPs and R&D targets in the new scenario

Money can no longer be earned by conventional power plants unless:

- ❑ **O&M cost are strongly reduced**
- ❑ New/expanded flexibility capability is created to provide services to the electric system
- ❑ Optimal operational efficiency is pursued even in cycling/part load conditions

Main R&D areas



- **Fuel flexibility**
  - Assessment of new, low cost, fuels for different contexts (e.g. petcoke in Spain, low grade coals in Italy and Russia)
- **Storage integration at PPs level**
  - Cost/benefit evaluation of Thermal and Liquid Air Energy Storage
- **Life assessment/management of PP systems**
  - Material ageing modeling (creep & fatigue interaction), new NDTs
- **Robotics and Augmented reality for O&M**
  - New customized technologies (i.e. automatic drones and instrumented helmet) able to support /assist O&M
- **Sensors & Diagnostic for O&M**
  - Wireless sensor networks, on line monitoring tools (e.g. lubricant oil quality, ammonia in fly ash, coal fineness)
  - O&M big data predictive analytics demonstration
- **Advanced automation & control**
  - CRTL that simulate transient behavior, forecast outcomes and optimize plant operation in real time
- **Waste heat recovery technologies**
  - Selection & feasibility
- **New components**
  - Plasma torches for direct coal start-up
  - Combustion system optimization
  - New materials & components design criteria

O&M optimization
The needs

Support the maintenance technician <u>cognitive and operative needs:</u>

- ❑ Bring knowledge and operative capability just close to hand (documentation, data, procedures)
- ❑ Use these capabilities at the right place in the right time.
- ❑ Remote assistance
- ❑ Reduce back Office activities (reporting)

KPIs/Targets

- ❑ System cost < 10k€
- ❑ Reduction of human errors
- ❑ Reduction of inspections time
- ❑ Expertise sharing overcoming geographical barriers

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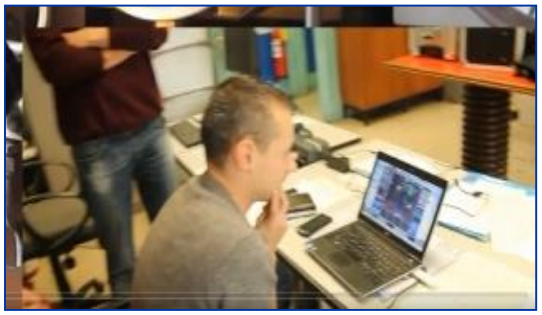
Remote Assistance using Augmented Reality Systems

Technologies of Augmented Reality and Wearable Computing
Technological innovation in the industry:
Equip technicians with portable / wearable systems making it possible to operate in the plant with the ability to communicate easily and effectively with the rest of the staff.

Objectives

- Develop and Test of Mobile Augmented Reality technologies to be integrated into **personal equipments of ENEL personnel during operation, diagnosis, maintenance activities**.

Enel Augmented Reality System
First Release System



This system is a portable system that allows one or more experts to assist the User in remote operations during maintenance activities.

The user equipment includes a:

- headset with microphone,
- mini camcorder and
- an embedded micro display
- cameras built into a flashlight

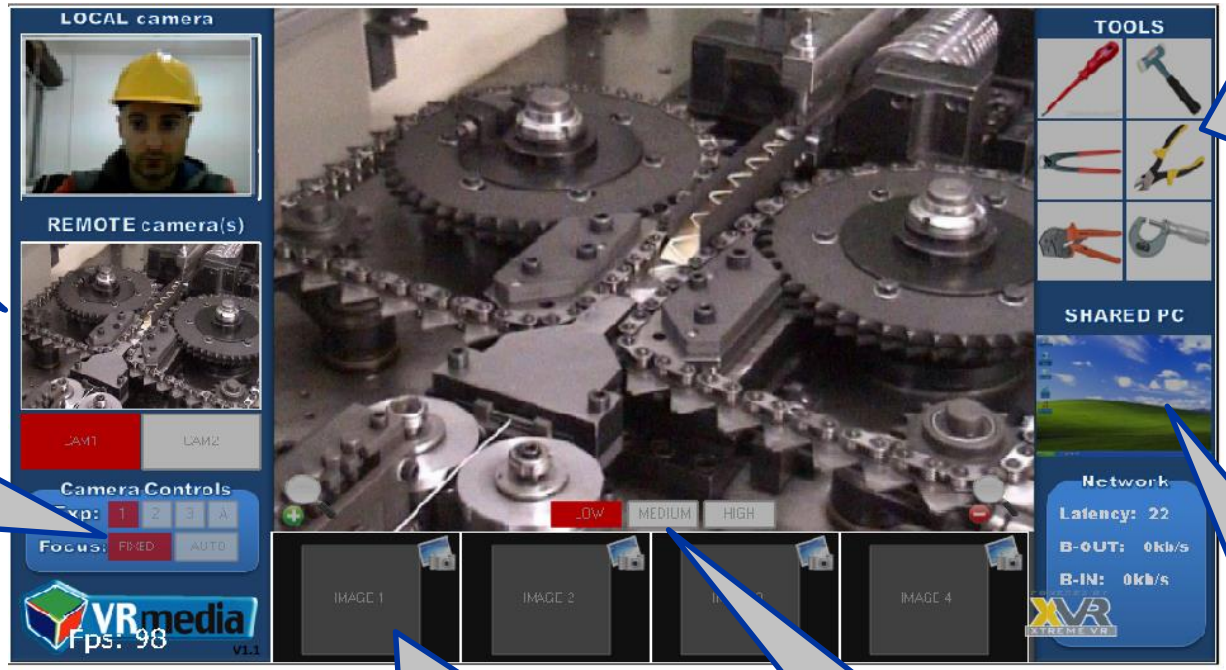
connected via transmission cable to a central reception and transmission of data powered by batteries

Enel Augmented Reality System
The functionalities

Receiving visual and audio information in real time and on-site the User is able to perform complex tasks remotely guided by the expert.

- The developed system allows one or more **expert operator to remotely communicate with and train an operator located in the power plant**.
- **The Expert sees what the operator is seeing** and is able to guide the implementation of activities in a timely manner through precise audio communications, sending clear visual indications.
- **In Field Operator may receive remote support audio / video** through headsets and portable viewer, allowing him **to receive over his field of view different types of information in real time** such as graphic symbols and text and documents generated by the Expert desktop, and images from external cameras.

Enel Augmented Reality System
Remote Expert GUI Controls



Remote camera selection:
CAM1: head camera
CAM2: hand camera

This value controls the shutter speed, and can be manually forced to “1” “2” o “3”. “A” will select auto exposure.

Save up to screenshots from the remote camera and recall them when needed. Click on the camera icon to capture image.

“LOW”, “MED” and “HIGH” will change the quality of the remote image and the bandwidth occupation.

Icons representing common tools. Click on any of these icons and they will be shown in the remote user display.

This button enables sharing the user desktop with the remote user, who will see it on its own display.

Enel Augmented Reality System
O&M Feedback and New System Design

The use of the equipment by the O&M operators during the diagnostic activities on-site in a generation plant, makes possible to identify some limitations on the equipment ergonomics.

- Excessive weight
- Cables not making the operation easier
- Excessive equipment size
- Low quality of images

The analysis resulted with the release of a new version with a brand new technological design.

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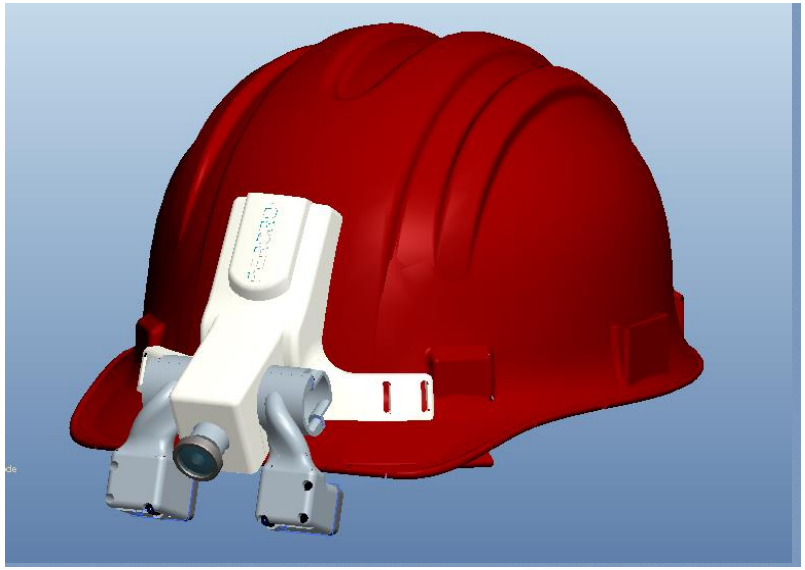
Enel Augmented Reality System
Improvements & Features

High quality images

Significant reduction of weight



Wireless Equipment

Light and Portable

ATEX certification in progress

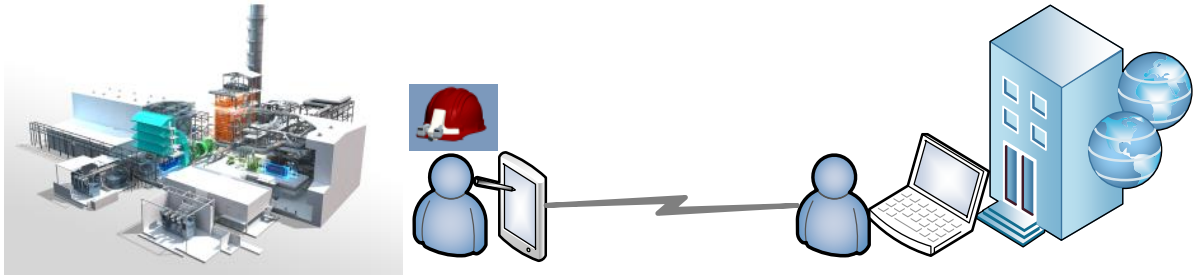
Feature of Expert Application

- Visualization of images coming from selected camera (micro-camera, stethoscope camera)
- Media collection from all video sources
- Sharing desktop with operator on-site
- Visualization of monitoring data on communication quality

Features of Application for User on-site

- Showing on viewer the images coming from cameras
- Showing on viewer the images shared by expert operator remotely placed
- Collection of media data (images and videos)
- Fruition of documents related to a specified plant component

Enel Augmented Reality System
New design



Operator In Field

Expert

Improvement of AR System
First Release vs Improved one (1/2)

2013 - 2014

1. Helmet + Dedicated CPU (2.5 Kg)
2. Total Power: 17Watt
3. OS Centra Unit

2015

1. Helmet 390 gm + Tablet
2. Total Power: 0.9 Watt
3. OS Tablet

Windows 10

Improvement of AR System

First Release vs Improved one (2/2)

2013 - 2014

4. 3 Hours (Dual Battery)
5. VGA+ quality for helmet camera
6. High quality for portable camera

2015

+

4. 5 Hours (Single Battery)
5. Full HD quality for helmet camera
6. High quality for portable wireless camera

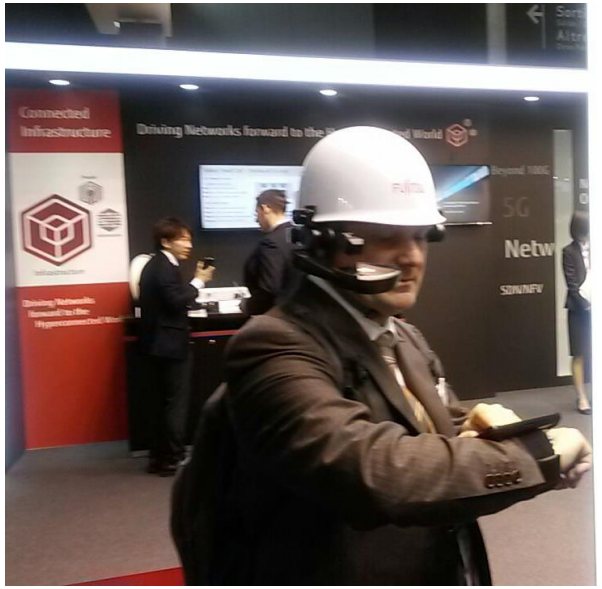
Improvement of AR System
Future development

- **Assessment of industrial advanced solutions and integration**

- **Retrieve and use of documentation by utility workers** while operating in the field via wearable computers.
- **Ability to provide audio, text, numerical and color coded warning information** to the workers using augmented reality in real time

Smart Glasses

Gesture control armband



The idea of a Virtual Control Room

ENERGIA ALLA TUA VITA

AR System

The smart interface for the technician

ERP

DMS

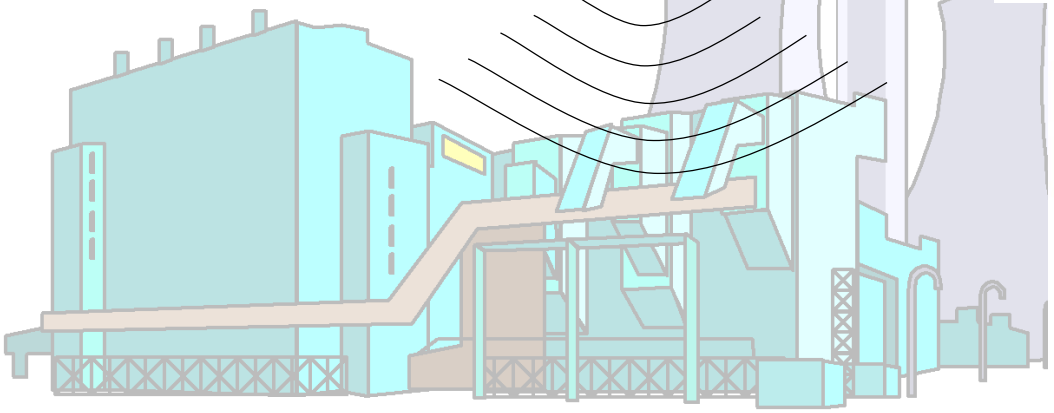
DCS

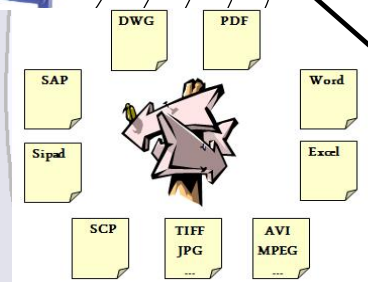
LAN Ethernet

IEEE 802.3

Wireless LAN

IEEE 802.11b





Information:
- **complete**
- **updated**
- **close to hand**

Questions and Discussion