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Enel and the Smart Grids experience

Towards a Low Carbon Society

Outline

- Introduction on Smart Grids
- Enel and its "*first generation*" of Smart Grid
- Focus on Enel's *TELEGESTORE* project
- The European SET Plan and the EEGI
- A brief overview on Enel's pilot projects
- Conclusions

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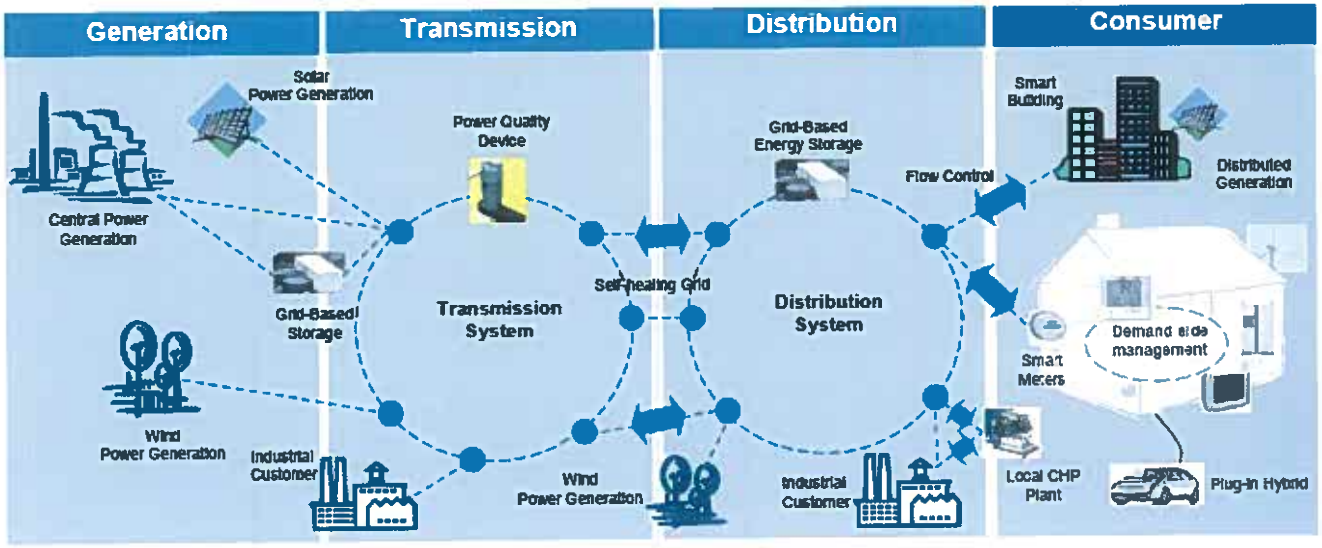
Introduction on Smart Grids
Definition

The Smart Grid European Technology Platforms (comprising European stakeholders, including the research community) defines a Smart Grid as:

"an electricity network that can intelligently integrate the actions of all users connected to it – generators, consumers, and those that do both, in order to efficiently deliver sustainable, economic and secure electricity supply"



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Introduction on Smart Grids

Drivers for change

The **drivers** to change the current Electricity Networks in Europe are both external to the network, like **preparing for low carbon future**, as well as internal, like the need for **replacement of an aging infrastructure.**

One of the main external drivers is the **"EU Energy and Climate Package"** which set out for **2020 and beyond**:

- **20 % reduction for GHG emissions**
- **20 % of renewable energy sources**
- **20 % reduction in primary energy usage**

In parallel the **"Third Energy Package"** pushes the **Member States,** the **Regulators** and the **Network Operators** to deploy **smart meters or smart grids** and, more generally, to launch **innovation programs with appropriate remuneration schemes for Electricity Networks**.

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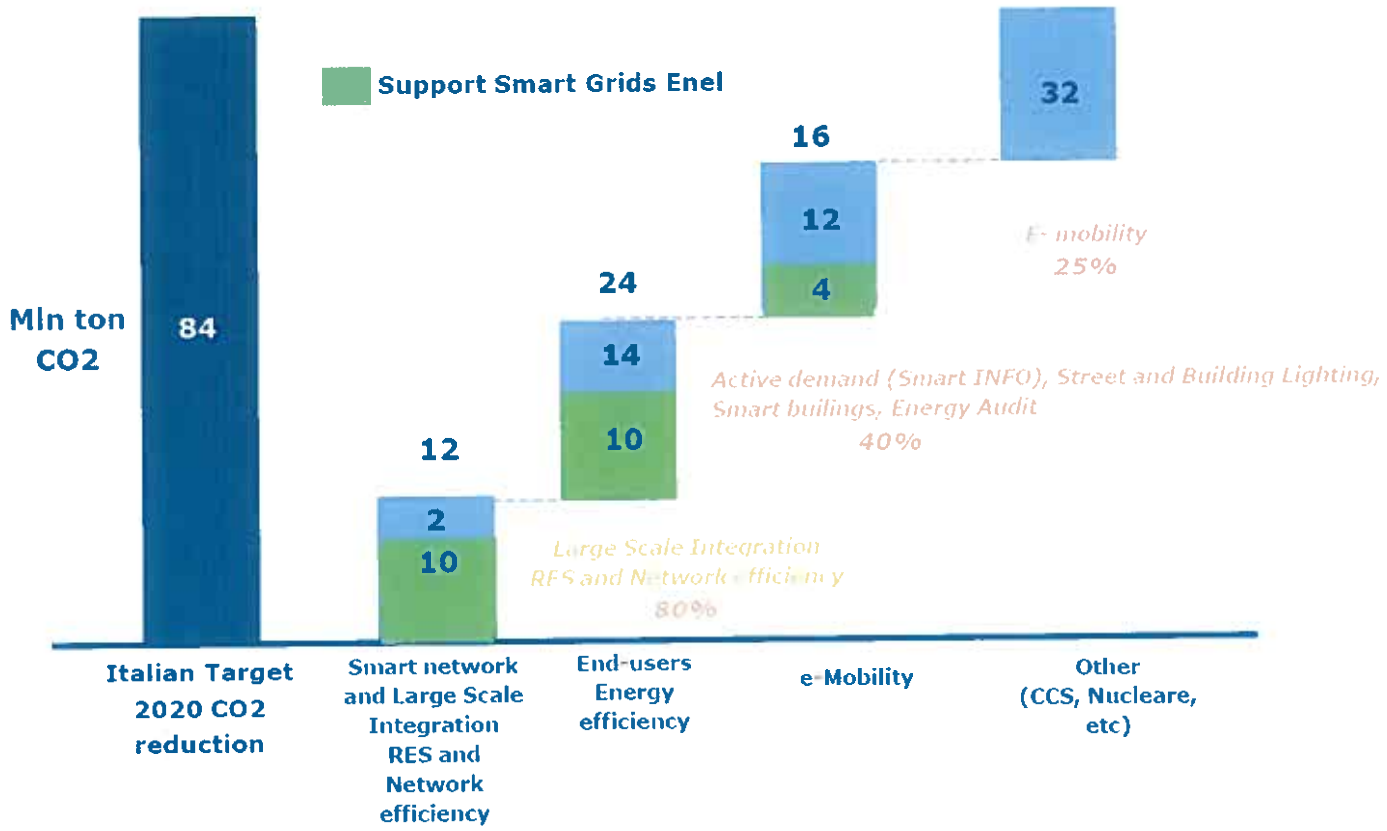
Introduction on Smart Grids

Smart Grids support in CO_2 reduction



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Introduction on Smart Grids
Vision

By 2020 the electricity networks in Europe should:

1. **Actively integrate efficient new generation and consumption models:**
   - Integrate new intermittent renewable resources at the different voltage levels
   - Enable and integrate active demand from end users
   - Enable and integrate new electricity uses, in particular recharging infrastructure for electric vehicles and increasing electric heating (heat pumps)
   - Support and enable energy efficiency by end users.
   - Enable new business opportunities and innovations for market players
2. **Coordinated planning and operation of the whole Electricity Network**
   - Coordinate planning and operation for the pan European transmission network through ENTSO-E with dedicated solutions developed in the EEGI program
   - Coordinate planning and operation between transmission and distribution networks with dedicated solutions developed in the EEGI program
3. **Study and propose new market rules to maximize European welfare**
   - Study and recommend new market rules both at national and European level.

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Enel and its *"first generation"* of Smart Grid

Enel network is the largest Smart Grid in the world

Automatic Meter Management

Telegestore is fully operational on > **32 Mln** Customers

- Leading Technology
- Excellence in operation

Network automation

- HV and MV network remotely operated
- More than **100.000 MV** substations remote controlled
- Automatic fault clearing procedures

Work Force Management

- **5.200** vehicles equipped
- Logistic support to Enel crews
- ENEL cartographic available on board
- All processes through mobile applications
- Connection from field to the centre for Enel crews

Asset Management

- Cartographic census of network assets
- Database of network events (power outage notification, fault detection ,etc)
- Optimization of network investments based on a risk analysis.

Investment exceeding € 2,5 bn

Dramatic reduction of cash-cost per customer

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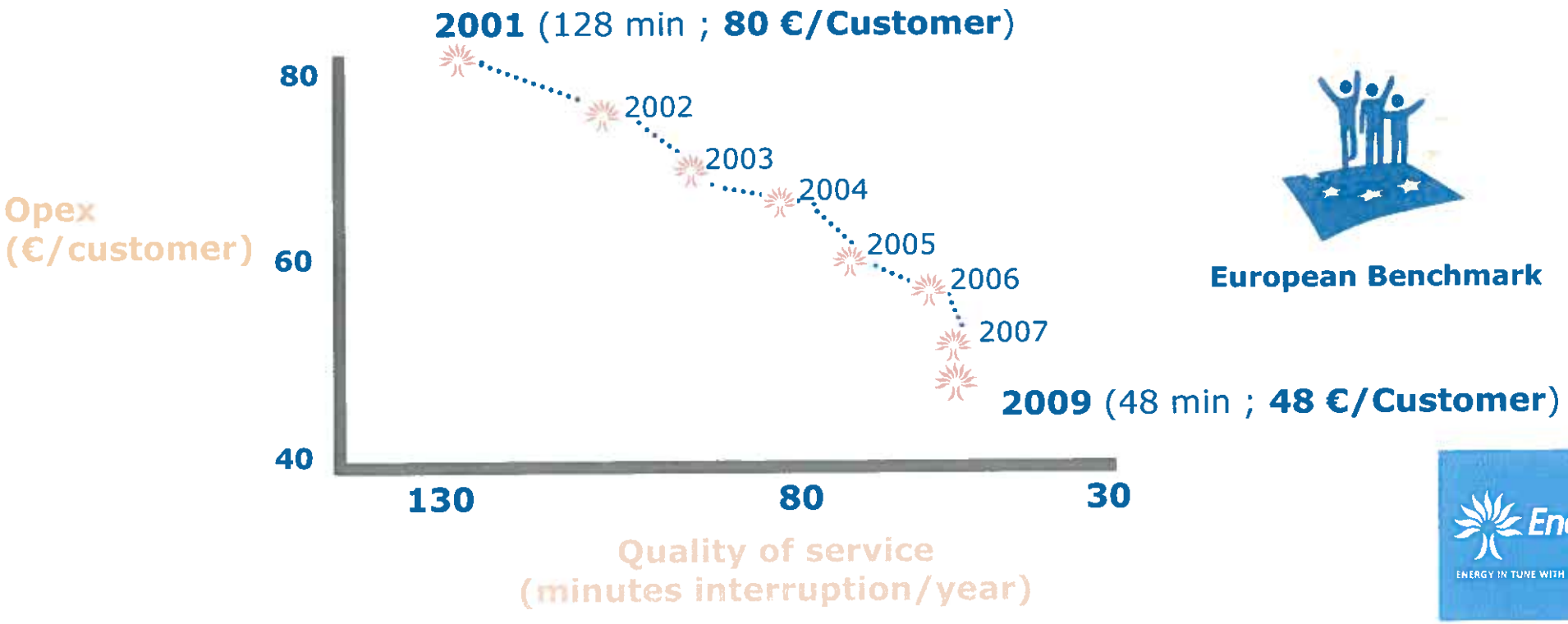
Results achieved

Enel Operational Excellence

- Network remote control and automation
- Automated work force management
- Automated metering management
- Process reengineering
- Investment and network development optimization



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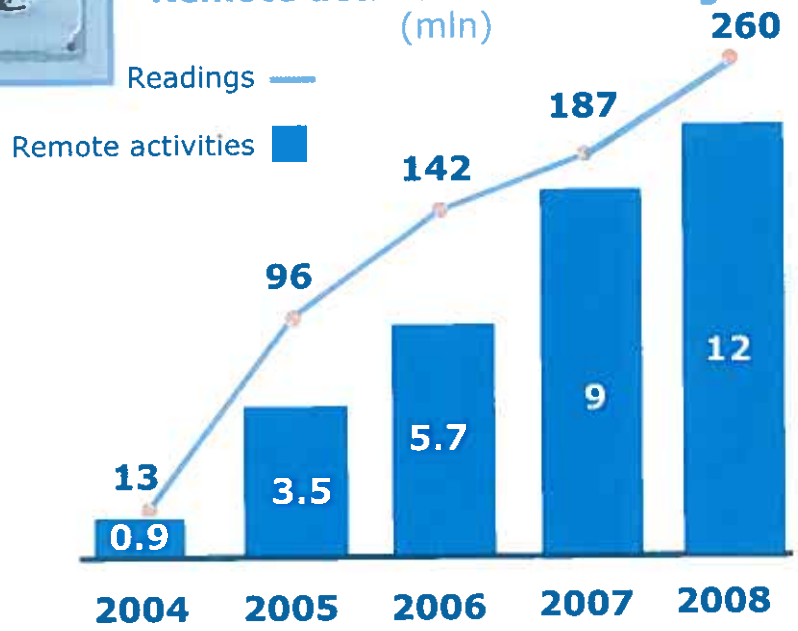
Electronic Meters and Automatic Meter Management

Italian pioneering experience and leadership

Digital meters installed, controlled and read in December 2009: 32 mln

Remote activities and readings
(mln)



13 million Customers in Spain

New Generation based on Italian unique experience

with state of the art functionalities

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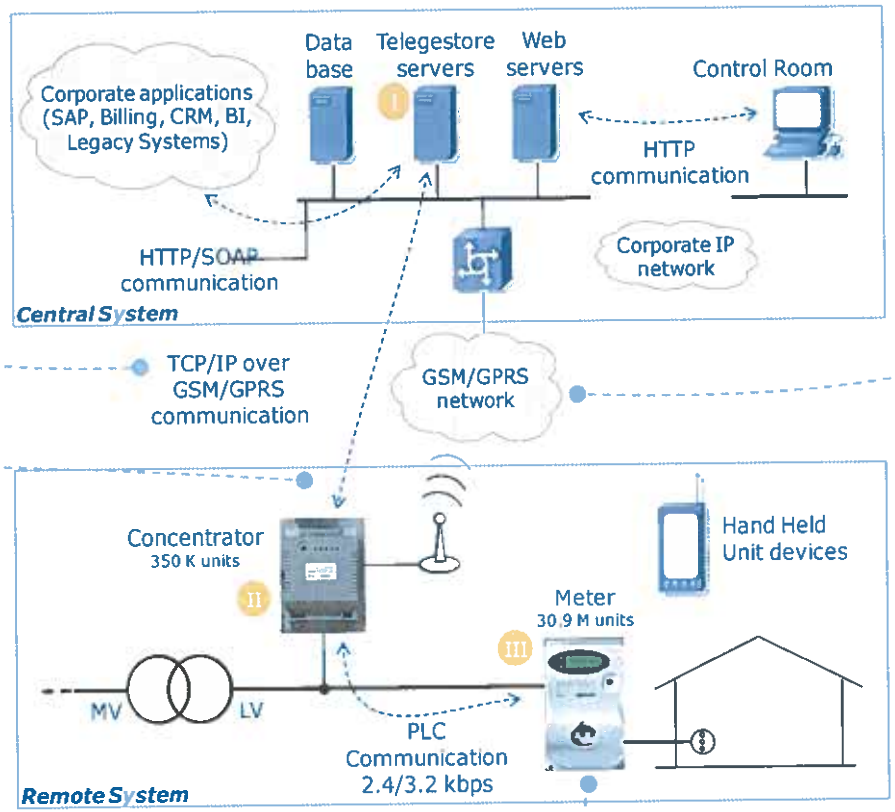
Telegestore: General overview

TCP/IP support is used in communication between concentrator and Electronic Meter Management System (AMM – Main Station)

The Remote Metering System communicates via the public telecommunication network (GSM, PSTN & Satellites) with a LV concentrator installed in every MV Station



The LV concentrator manage the communication in both directions: towards the Remote Metering Central System via Public Telecommunication Network & toward the Electronic Meters via private Distribution Line Carrier Powerline Communication

Integrated (I.e. equipped with breaker) electronic meter , provides metering, contract management and PLC communication functions

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Focus on Enel's *TELEGESTORE* project

Summary

- **Telegestore** is fully operational on > **32 Mln Customers**
  - Leading **Technology**
  - **Excellence** in operation

- **Benefits** are targeting Enel and the Italian Electricity System

- Italian Authority AEEG has published the resolution 292/06: **all Italian** electricity customers will be equipped **with AMMS** (Automatic Meter Management System) by **2011**

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Investment and savings areas

TOTAL INVESTMENTS → 2,100 M€

- R&D COSTS
- PRODUCTION AND INSTALLATION OF ELECTRONIC METERS
- PRODUCTION AND INSTALLATION OF CONCENTRATORS
- IT SYSTEM DEVELOPMENT

Revenue Protection

- Thefts and Failures
- Self Consumption
- Checks on Meters

Purchasing and Logistics

- Purchasing
- Revision
- Warehouses
- Internal Transportation

Saving Areas

500 M€/Y

Customer Service

- Customer Service
- Collection
- Bad Payers
- Invoicing

Field Operations

- Installation and Recovery
- Interventions on Failures
- Replacement
- Activation Deactivation
- Failed Accesses
- Readings

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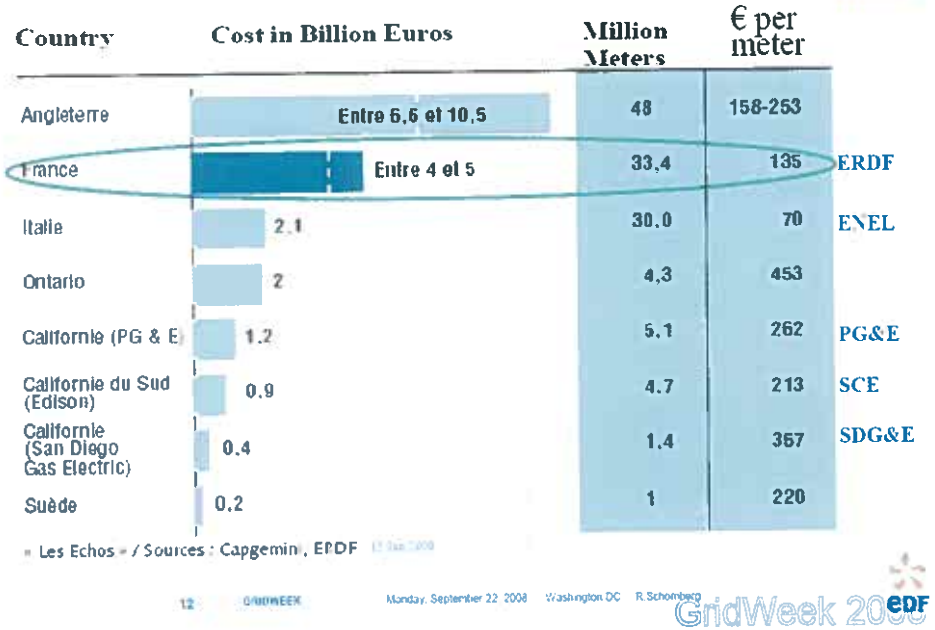
Investment benchmark

International cost challenge



Country sources	Project global cost	Nr. of meters	global cost per point of measurement
Italy (Enel)	2,1 G€	30 million	70 €
United Kingdom (Ofgem) *	5,2 G€	27 million	193 €
Sweden (E.ON)	0,2 G€	1 million	220 €
California (SCE)	1 G€	4,7 million	213 €
California (PG&E)	1,3 G€	5,1 million	262 €
California (SDGE)	0,5 G€	1,4 million	357 €
Canada/Ontario (regulator)	2 G€	4,3 million	453 €

Source: Capgemini Consulting and CRE – AMM for France: the complete case, 3rd Oct '07;

* desk analysis done by the regulator

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Telegestore: a proven solution

Remote management readings and operations

READINGS

600.000/day

*Successful remote readings 99.9%**

	Final '09
Montly-bimontly	204.700.000
Spot readings	5.000.000
Total	209.700.000
Load profile	46.000.000

OPERATIONS

50.000/day

PEAKS of 300.000

*Successful remote operations 98%**

Activations	845.000
Contract management	15.263.000
Contract termination	759.000
Bad payers management	2.958.000
Total	19.825.000

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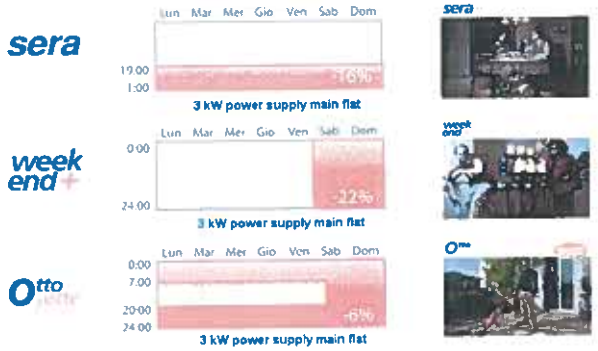
**Yearly Data*

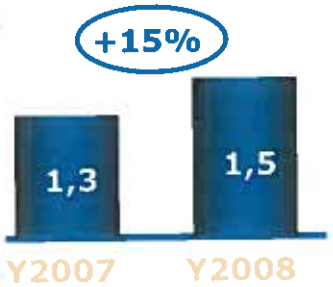
Lessons learnt

Shared benefits

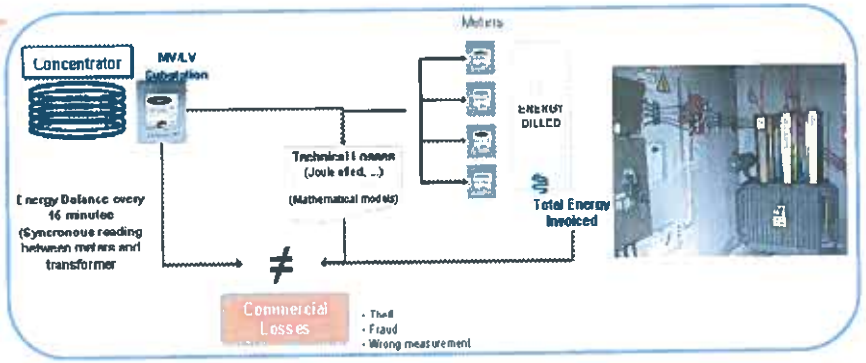
Tailored tariffs



Switching *(ml)*



Energy Balance



Success rate of meter verification from 5% to 60%

Efficient and competitive market

Eni
e·on Italia
SORGENIA
EDISON
Enel

~ 150 retailers

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Benefits

FOR CUSTOMERS and other electrical system operators

- INVOICES ON REAL CONSUMPTION
- REMOTE CONTRACT MANAGEMENT
- TAILORED TARIFFS
- SAVINGS IN BILLING
- PRE PAYMENT
- EASIER FREE MARKET DEVELOPMENT AND MANAGEMENT

FOR THE ELECTRIC POWER SYSTEM

- PEAK SHAVING
- ENERGY EFFICIENCY AND CO2 REDUCTION
- REDUCTION OF COMMERCIAL AND TECHNICAL LOSSES

FOR ENEL

- CUSTOMER SATISFACTION
- EXCELLENCE IN COMMERCIAL AND TECHNICAL QUALITY
- OPERATING COST SAVINGS
- LEADERSHIP IN INNOVATION

due

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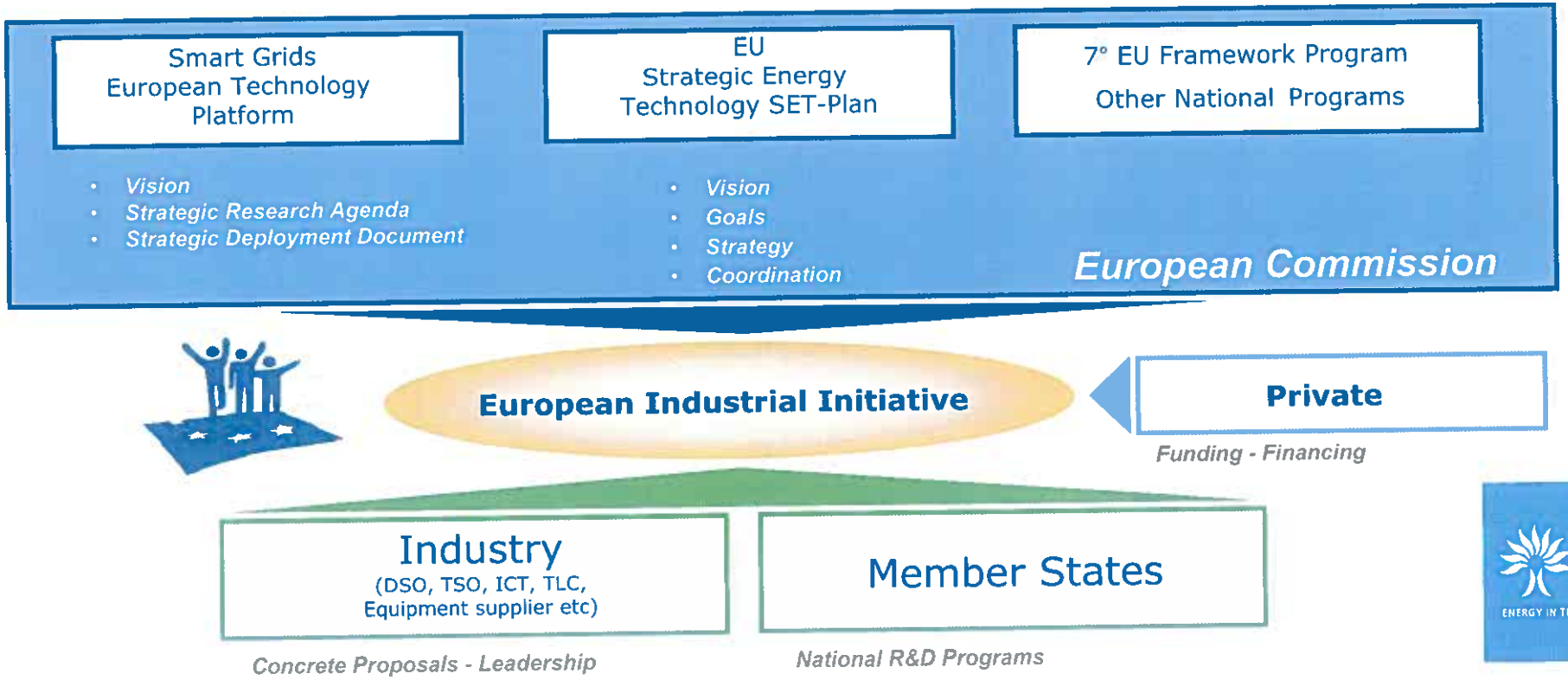
The European SET Plan and the EEGI

Smart Grids represent a key technology to reach the EU 20-20-20 goals

- The EU has set up a **European Strategic Energy Technology Plan (SET-Plan)** to accelerate the development and deployment of cost-effective low carbon technologies to achieve its 20/20/20 goals.

- **Electricity Grids** is one of the seven **Europen Industrial Initiative** proposed by the SET Plan.



The European Electric Grid Initiative (EEGI)

Introduction

The European energy and climate change targets for 2020 and beyond require a major acceleration of the development and deployment of cost-effective low-carbon energy technologies, as proposed in the SET Plan. **A single, stronger and smarter European electricity grid will have a central role to accommodate the resulting massive deployment of renewable and decentralized energy sources**.

The European Electricity Grid Initiative (EEGI) is a 9-year European research, development and demonstration (RD&D) programme initiated by electricity transmission and distribution network operators to accelerate innovation and the development of the electricity networks of the future in Europe, a so-called Smart Grid

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Background

A joint programme initiated by 7 TSOs and 7 DSOs

The European Electricity Grid Initiative (EEGI)

Background

The role of the network operators

- The EEGI focuses on **system-level innovation** and its validation and replication, a natural and legal responsibility of the network operators.
- The **network operators must lead the demonstration activities** to ensure secure operations , since the projects are performed under real operating conditions, and security of the system is the responsibility of the network operators.
- The network operators will ensure that new developments provide a **level playing field** for the competitive activities of market players.
- The network operators, through the interaction with their regulators, aim at **optimising the overall electricity system efficiency**.

Background

Involvement of other main stakeholders in the EEGI program

- **Generating companies and generator manufacturers**, particularly those involved in solar and wind electricity production.
- **Retailers and aggregators** needed to validate the role of network players when involving real time price signals and the so called energy boxes
- **T&D equipment manufacturers and ICT industry** which will be needed to support the integration of technology solutions into the European electricity
- **Consumers** whose present and future needs (smart buildings, smart appliances, electric cars, etc…) and data protection (data privacy etc) will have an impact on how networks can be managed even more efficiently.
- **RTD performers** to support the network operators in developing new solutions prior to their demonstrations in real operations
- **Regulatory bodies** who have an important role in the design phase of large scale demonstrations involving a large number of real customers. Three workshops have been held with the European regulators, in May and October 2009, and March 2010.

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The 12 Functional Projects on distribution networks

SMART GRIDS
Functional level

SMART GRIDS MODEL

Level 5: Smart Customers
Customers aware and actively participating

Level 4: Smart Energy Management
Management of end-use energy efficiency, aggregation, retail

Level 3: Smart Integration
Renewable energy, DG, electric vehicles, electricity storage and aggregation

Level 2: Smart Distribution network
More automated MV distribution networks with self healing capabilities.
Monitored and controlled LV networks
ICT supported processes

Functional projects

Cluster 1: Integration of smart customers

D1. Active Demand Response
D2. Energy Efficiency from integration with Smart Homes

Cluster 2: Integration of smart metering

D3. Metering infrastructure
D4. Smart metering data processing

Cluster 3: Integration of DER and new uses

D5. DSO integration of small DER
D6. System integration of medium DER
D7. Integration of storage in network mgt
D8. Infrastructure to host EV/PHEV

Cluster 4: Smart Distribution Network

D9. Monitoring and control of LV network
D10. Automation and control of MV network
D11. Methods and system support
D12. Integrated communication solutions

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RD&D Roadmap - distribution networks

Smart Grids Functionalities	Project	YEAR											Costs (M€)
		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
Active Demand Response and integration with Smart Homes	D1	ADDRESS			Active Demand Response								190
	D2	BEWARE Smart Homes/Smart Grids			Integration with Smart Homes								120
Smart Metering Infrastructure & Data Processing	D3	OPEN METER Existing Deployment		Smart Metering Infrastructure									150
	D4	Existing Deployment	Smart Metering Data Processing										20
Integration of RES, storage and EV	D5	Active Distribution Network		Integration of small DER									90
	D6	Active Distribution Network	Integration of medium DER										150
	D7	STORAGE TECHNOLOGY			Integration of storage technologies								60
	D8	ELECTRIC VEHICLES		Integration of Electric Vehicles									100
Planning, monitoring and control	D9	Active Distribution Network		Monitoring and control of LV networks									100
	D10	Active Distribution Network	Automation and Control of MV networks										90
	D11		New methods and systems support										80
Integrated communication Infrastructure	D12	Active Distribution Network		Integrated Communications Solution									50
												Total	1.200

EEGI Program budget - summary

- Total program cost estimation is around **€ 2 bn in 9 years (2010 – 2018)**
- The cost estimation of the **priority actions** that need to **start in 2010 - 2012** is around **€ 1 bn**

Roadmap	Priority projects costs (€M) Start 2010-12	Other projects costs (€M) Start 2013-	Total costs (€M)
Transm./distrib. coordination	67	163	230
Transmission networks	108	452	560
Distribution networks	830	370	1200
Total	**1.005**	**985**	**1990**

- The results are beneficial for the whole European energy value chain, requiring a comprehensive funding **that must involve EC, the Member States, the regulators and industry**.

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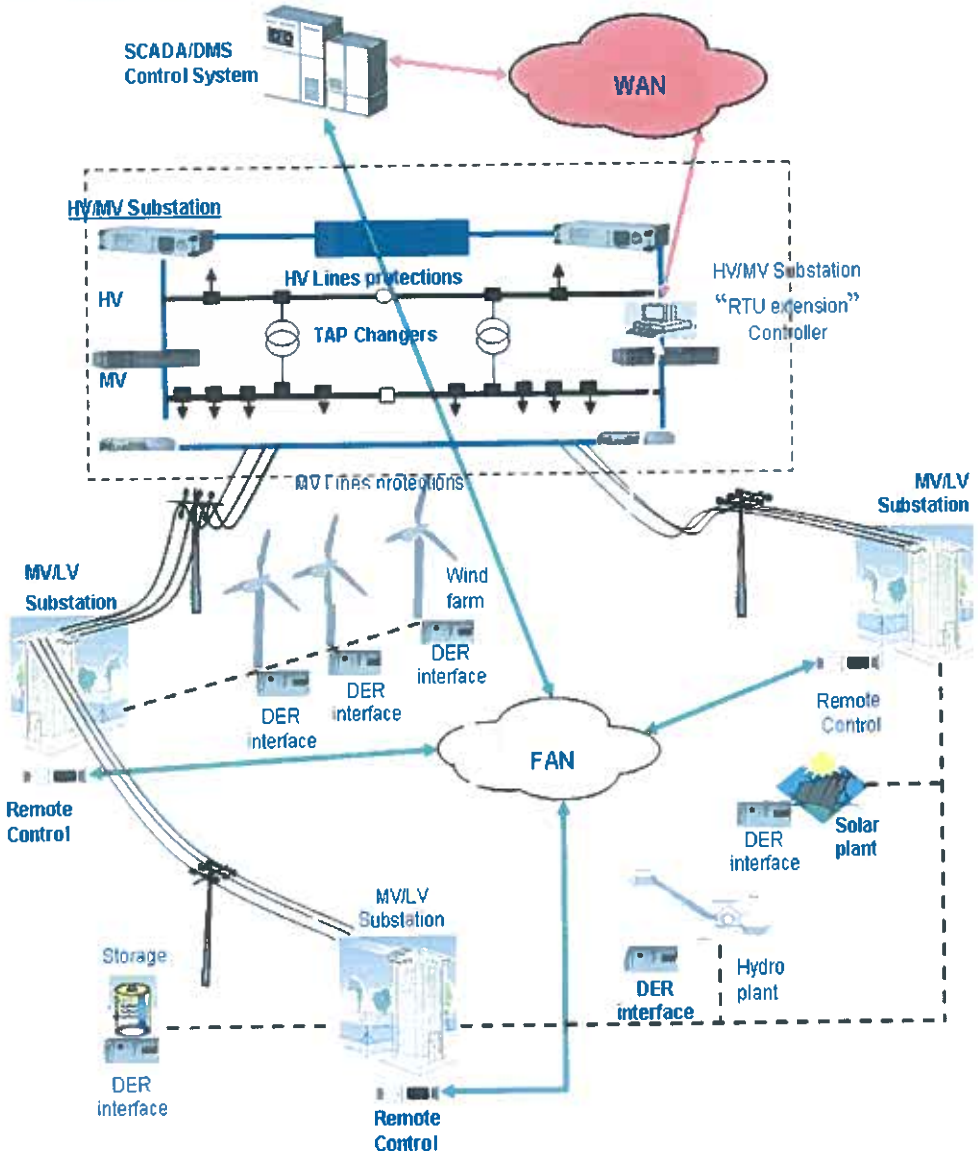
Integration of Distributed Generation on large scale in MV and LV systems



The project involves grid areas with:

- Large influence of wind and solar DG
- Relatively Weak Network
- Sunny and Windy Climate

Development and application of :

- **IP-based** communication architecture
- New actuators (e.g. protections, switches) and new sensors (e.g. fault detectors, outdoor voltage and current sensors), new smart devices (e.g. distributed generator protections)
- **Control Interfaces** for large and medium renewable production units
- Different electricity **storage solutions** in the network
- New **Scada and Network Management** application software
- Tools for enabling DER to provide **ancillary services** for network operations
- Tools for enabling **DER participation** in energy management

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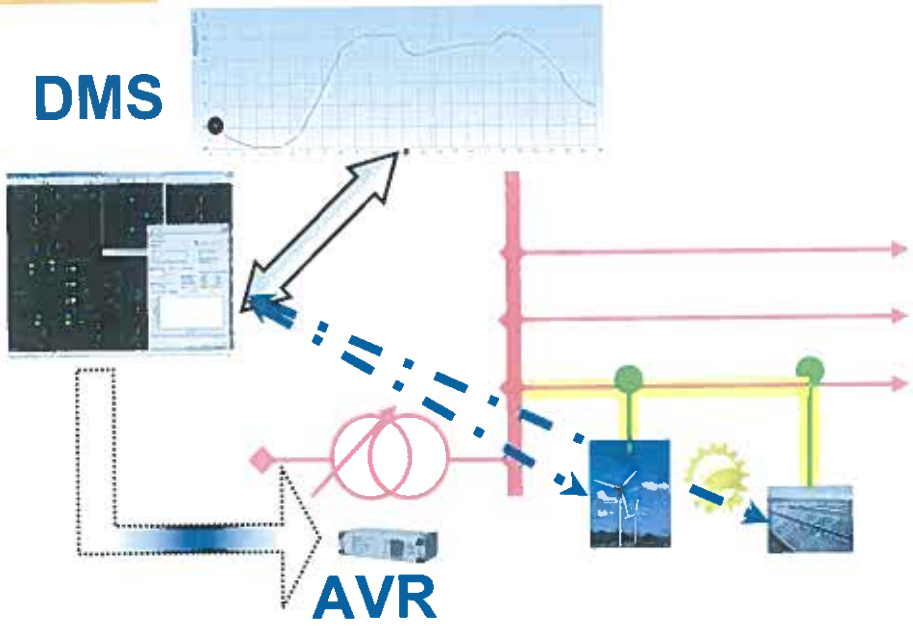
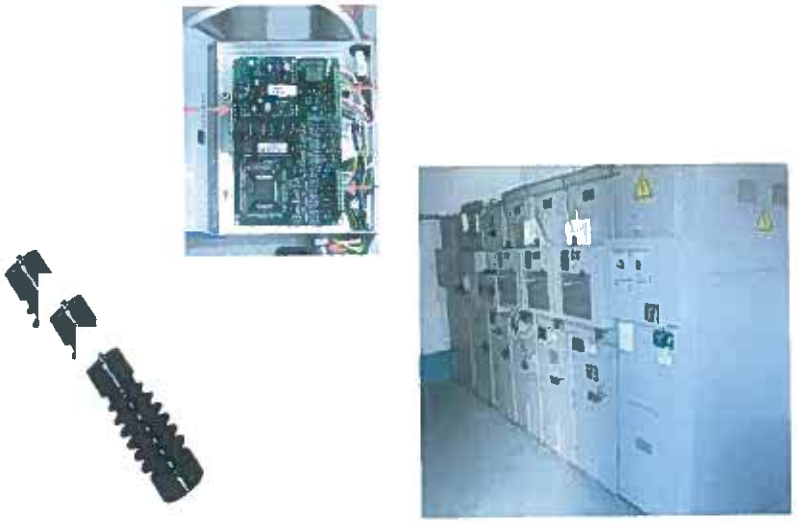
Enhanced Voltage Regulation and MV Producers Dispatching



The input data for DMS are provided by the advanced fault locator called RGDM sensors, installed on the MV network nodes.



The RGDM is composed by two parts:

- n°3 Voltage/Current combined sensors
- Electronic part

The RGDM provides the tools to dispatching and control in remote the producers on the MV network.

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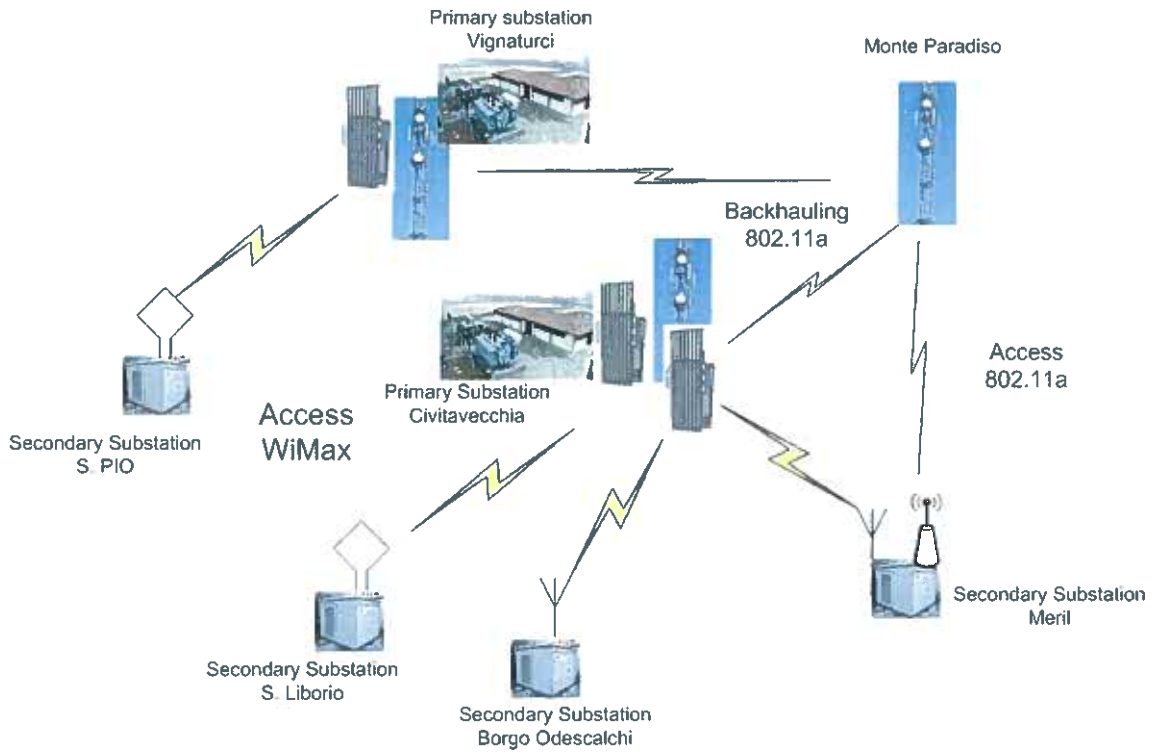
Real time broadband communication

Enabling full control and observability of networks

Innovative IP broadband communication infrastracture to enable all smart grids applications



- ✓ Wireless communication technologies (WiMax, 3G, WiFi)
- ✓ IP network devices and sensors
- ✓ IT Integration with remote control automation and remote meter management system

First pilot in operation

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Electric vehicles recharging infrastructure

Enabling large scale electric mobility

Smart recharging network to overcome functional and technological barriers for large scale Electric Mobility

Car recharge system :

at home

At work

In car parks

- ✓ Enable new advanced services to manage the **billing and recharge process**
- ✓ Innovative technologies in a **standardized framework**
- ✓ Include Smart Grids functionalities such as load management and storage

2010 -2012

Pilot test: 500 recharging points in 3 cities

2012 -2019

Know-how Telegestore

Know-how Enel Sole

New smart recharge infrastructure

Roll out

Smart Info

Enabling new services for customers

Large scale deployment of devices enabling the active participation of the customers in the energy market

- Multi-channel communication
- Pilot in progress in collaboration with Telecom Italia, Indesit e Electrolux.
- Collaboration with Google to develop web applications
- Cost effective solutions thanks to the integration with existing AMM infrastructure

2010 -2012

Design, development and Pilot

Test

2012 -2019

Roll-out

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Conclusions

In order to realize a **low carbon society**, the **Smart Grids** represent a **key technology**: the electricity grid in Europe will be able to integrate up to 35% renewable electricity in a seamless way and operate along the "smart" principle, effectively matching supply and demand by 2020.

Smart Grids deployment is an enormously complex and comprehensive effort and undertaking and **all the stakeholders involved have to play a proactive role in order to reach the end goal**.

With the experience from the current pilots, **ENEL will be able to launch large scale demonstration projects in the framework of the European Electricity Grids Initiative in the next years, preparing for the deployment of the European Smart Grids of the future and playing a key role in this context**.

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