



L'ENERGIA CHE TI ASCOLTA.

Enel - the long term experience from Smart Metering Implementation

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Infrastructure and Network Division

Spindleruv Mlyn, 19th April 2012

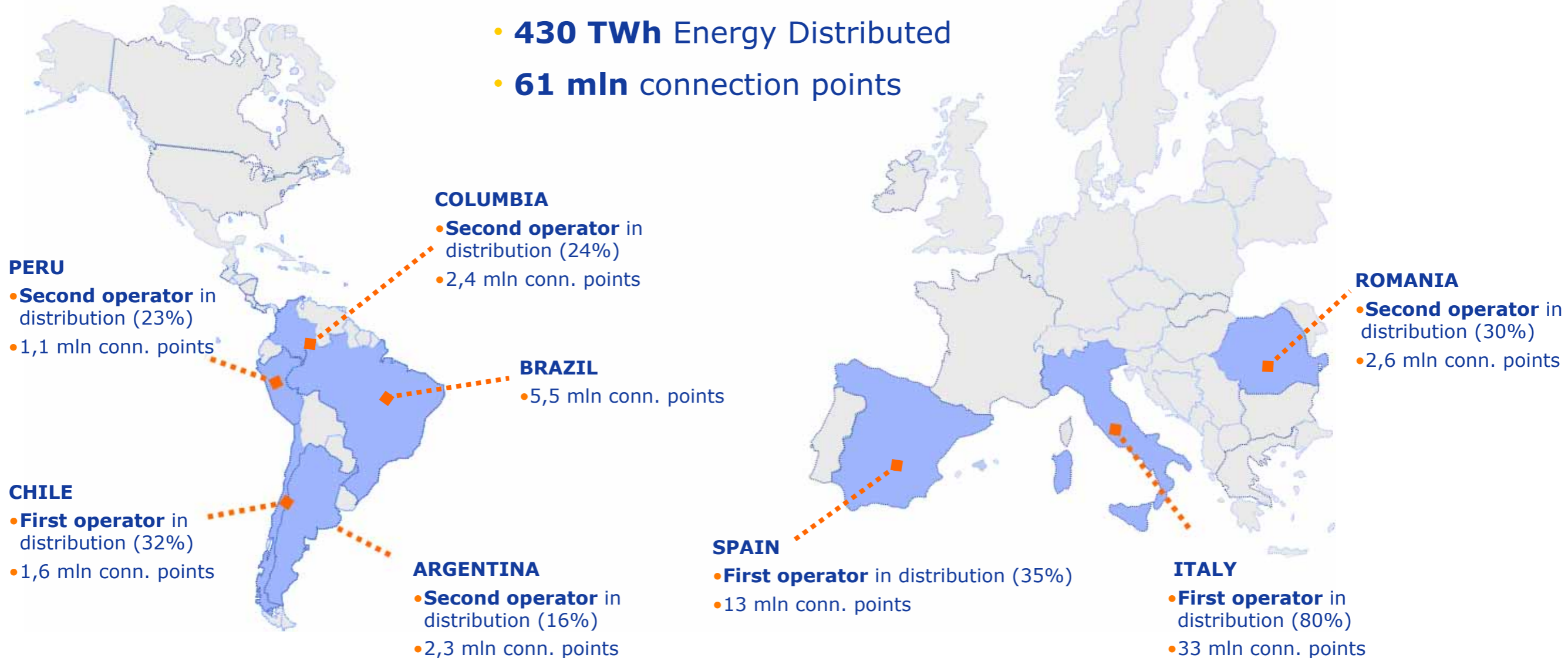
Agenda

- **The Roadmap of Enel Excellency in Smart Metering**
- Roll out and Project Organization
- Operating Network in The Age of Smart Metering

Enel Networks

Areas of presence in Energy Distribution as of 2011 year-end

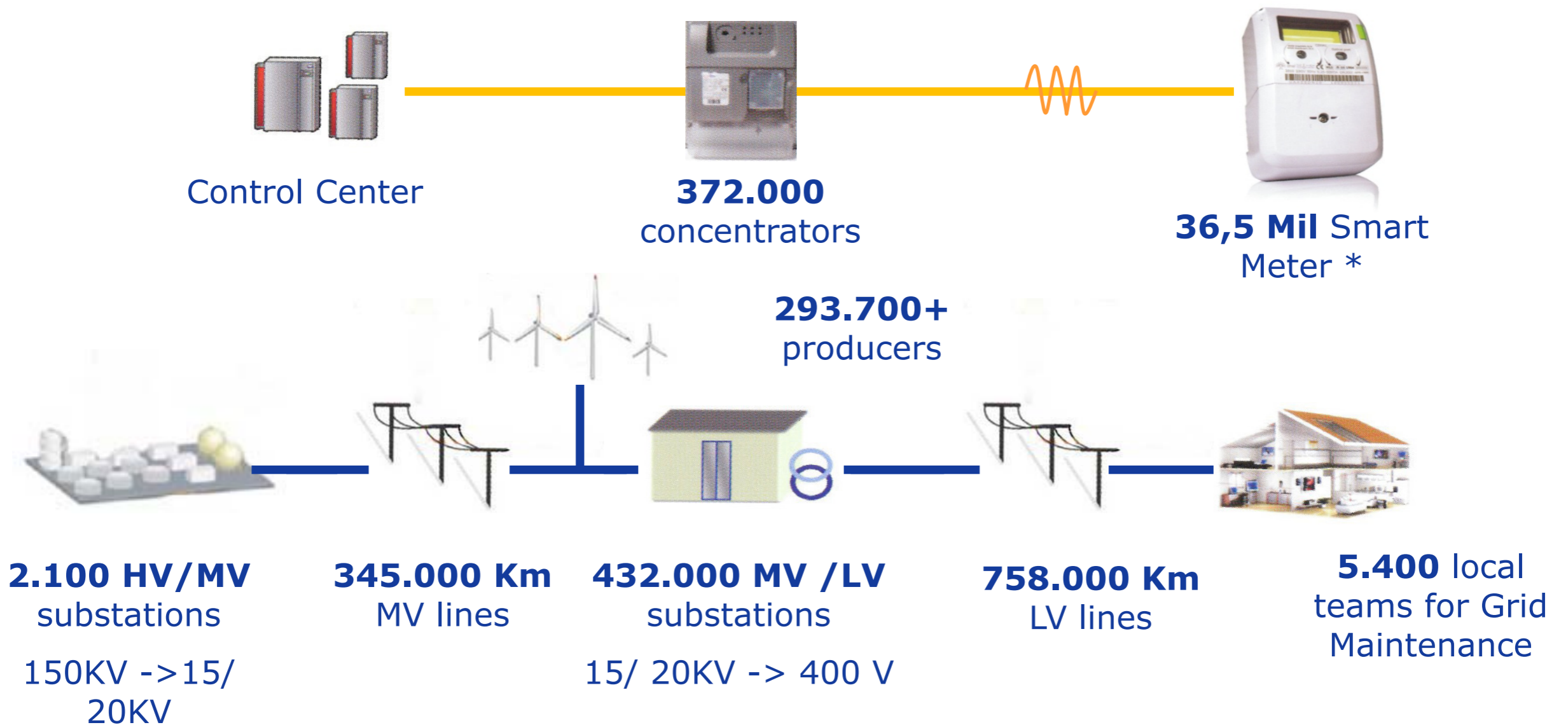
- **1,81 mln km** lines
- **430 TWh** Energy Distributed
- **61 mln** connection points



A global energy player with a leading position in strategic markets

Enel Distribuzione (Italy) 2010 key facts

Technical



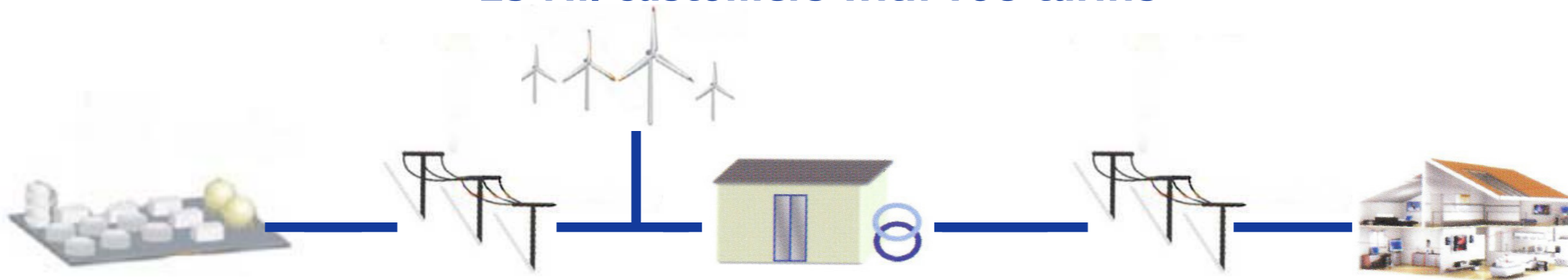
* including Enel supplier Smart Meter to other italian DSOs

Enel Distribuzione smart actions before 2012

Technical



Nearly 100% of customers equipped with **Smart Meter**
25 Mil customers with ToU tariffs



1 AMM National Control Center +28 MV Grid Regional Dispatch Centers

Real time measurement of distributed generation, Load shedding and, load balancing Capacity

109.000 substations remotely controlled* and managed

70% of MV lines are automated for 80% of customers

~700 advanced Electric vehicles charging public stations

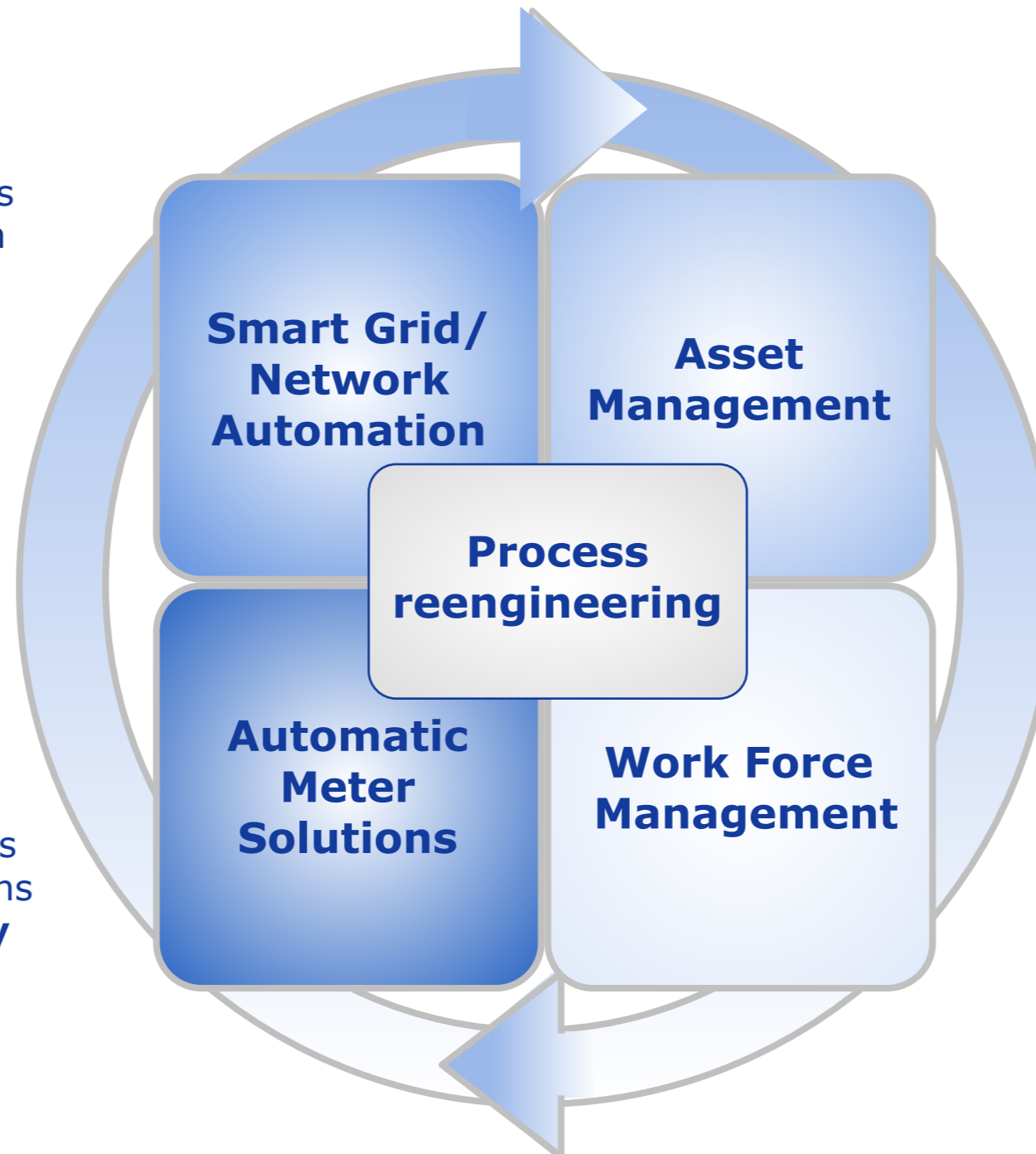
*including systems already installed and in progress to be installed

Enel Network Management and Innovation

Heading towards efficiency, the Enel experience as DSO world reference

- > **2.100 HV/MV** substations remotely controlled (**100%**)
- > **109.000 MV/LV** substations remotely controlled (more than 25%)
- Improved Neutral Grounding System
- **Automatic fault clearing procedures on 80% of customers**

- **39+ mln meters**
- **Other 11,5 mln new generation meters** being deployed in Spain
- 340 Mln/ year remote readings
- 15 mln/ year remote operations
- **97,4% operations correctly performed (2010)**



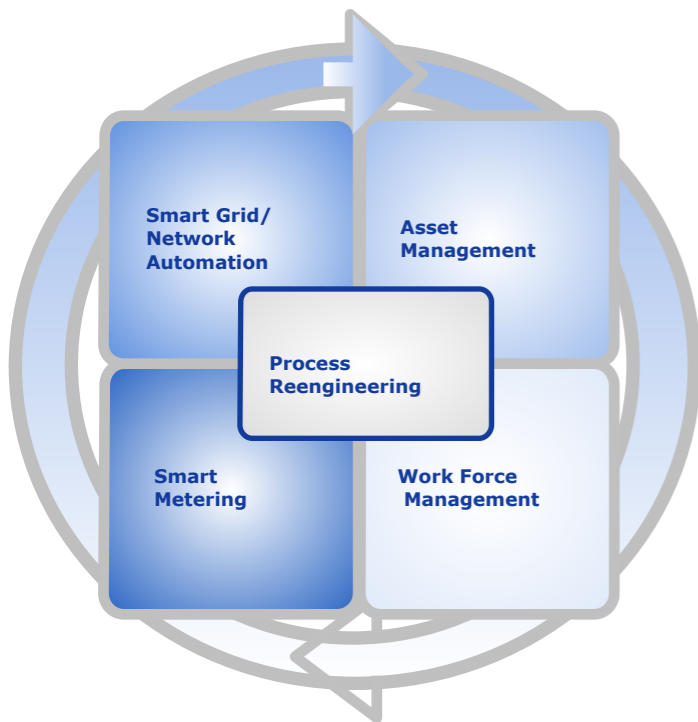
- **Satellite mapping of network assets**
- Database of network events (power outage notification, fault detection)
- **Optimization of network investments based on a risk analysis**
- Optimization of network maintenance

- **5.400 Enel teams** connected via GPRS with GPS localization
- ENEL cartographic on board
- **Mobile applications for all Field Operations**

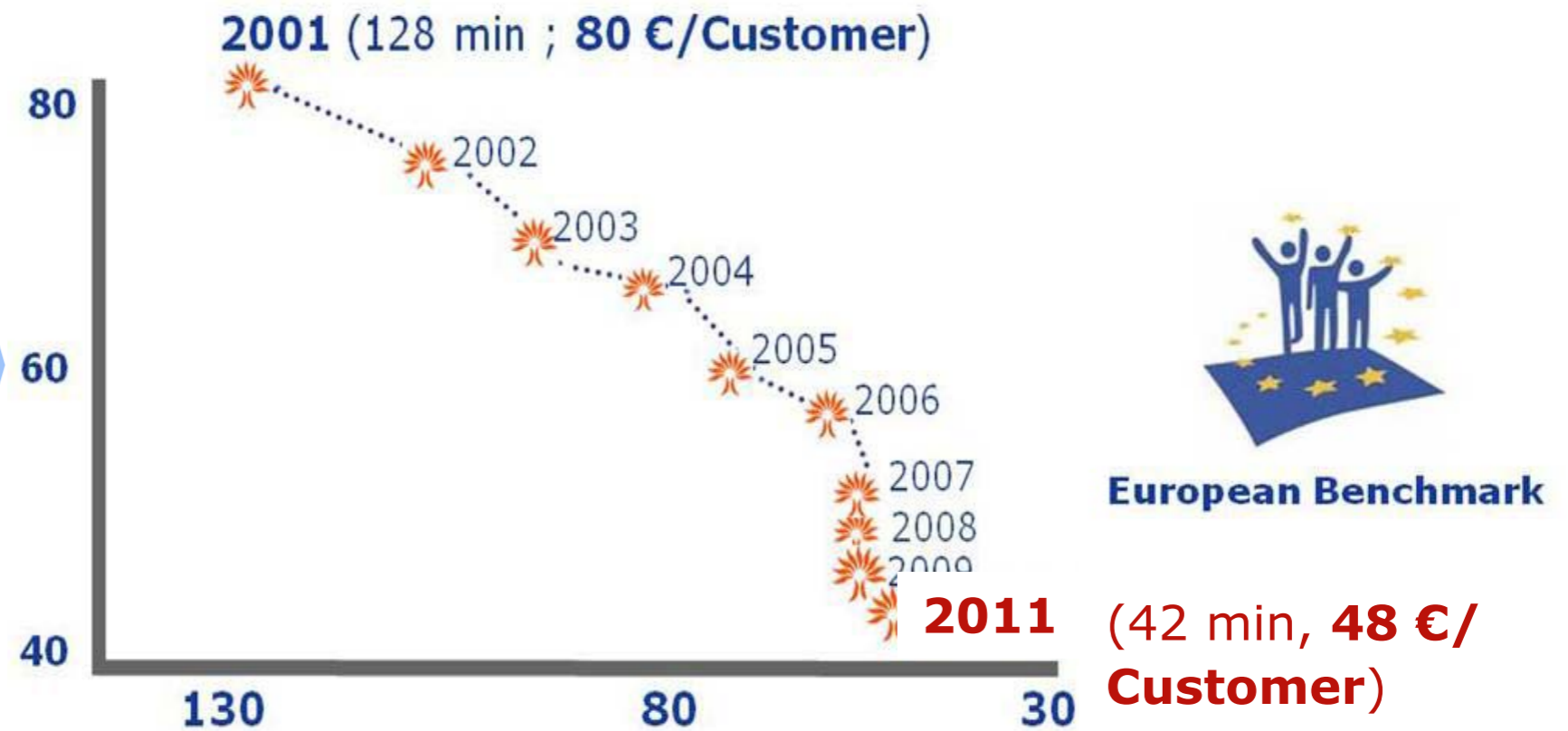
Smart Meter and process optimization are the cornerstone to deliver value to stakeholders and partners

Enel Operational Excellence: the Italian case

A 10 year path towards becoming the European benchmark



Opex cash cost per Customer (€/customer)



Quality of service (minutes interruption/year)

Opex reduction: - 40 %
Quality of service: +68 %

Enel Smart Meter Experience

The forerunner of smart grids

- Low Complexity
- High Complexity

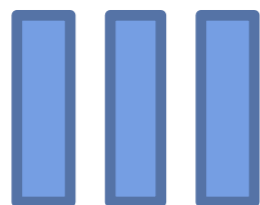


- Business Case + Meter Reverse engineering + Change Mngmt
- Prototyping and industrialization
- PLC fine tuning
- Strategies, Planning and partners selection

- Customer relationship
- Project and Procurement management
- New Organization (and benefits) progressively in place

- AMM System fine tuning with core Systems
- Regulatory final resolution

- New Generation of Smart Meter
- Demand Side Management
- Renewable sources integration
- EV charging infrastructure



Network upgrade and modernization

Energy Efficiency



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Smart Metering Deployment

Key Elements of Italian AMM Project

Scope of Project



85 % of Electricity Distribution market in Italy

127 Geographical operating units

Devices



31 Mln LV Meters in 5 years

358.000 LV concentrators (LV-C)

8.000 palm-PC
Used during massive replacement of meters

Resources



Telegestore[®] Project Team: **250** resources

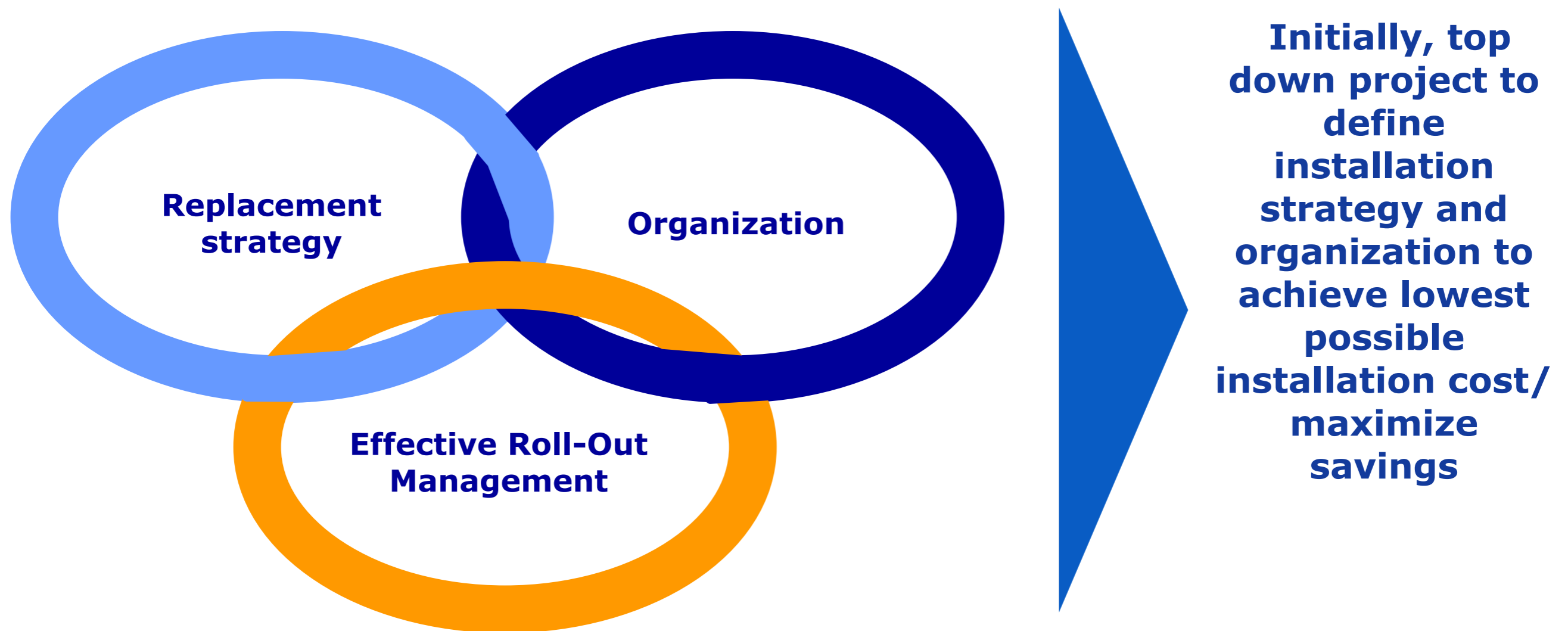
120 ICT Project technicians

More than **3500** third-party installers

Enel roll-out a massive project requiring a strong and dedicated effort

Strategy and Organization

Behind the massive deployment of smart meters



Strategy and Organization

Behind the massive deployment of smart meters

Replacement strategy

- **100% of customers**
- **Ramp-up of 1 year + 4 years of replacement campaign**
- **Parallel / country-wide installation**
- **Strong National and Local communication campaign** to engage Customers and Key Stakeholders

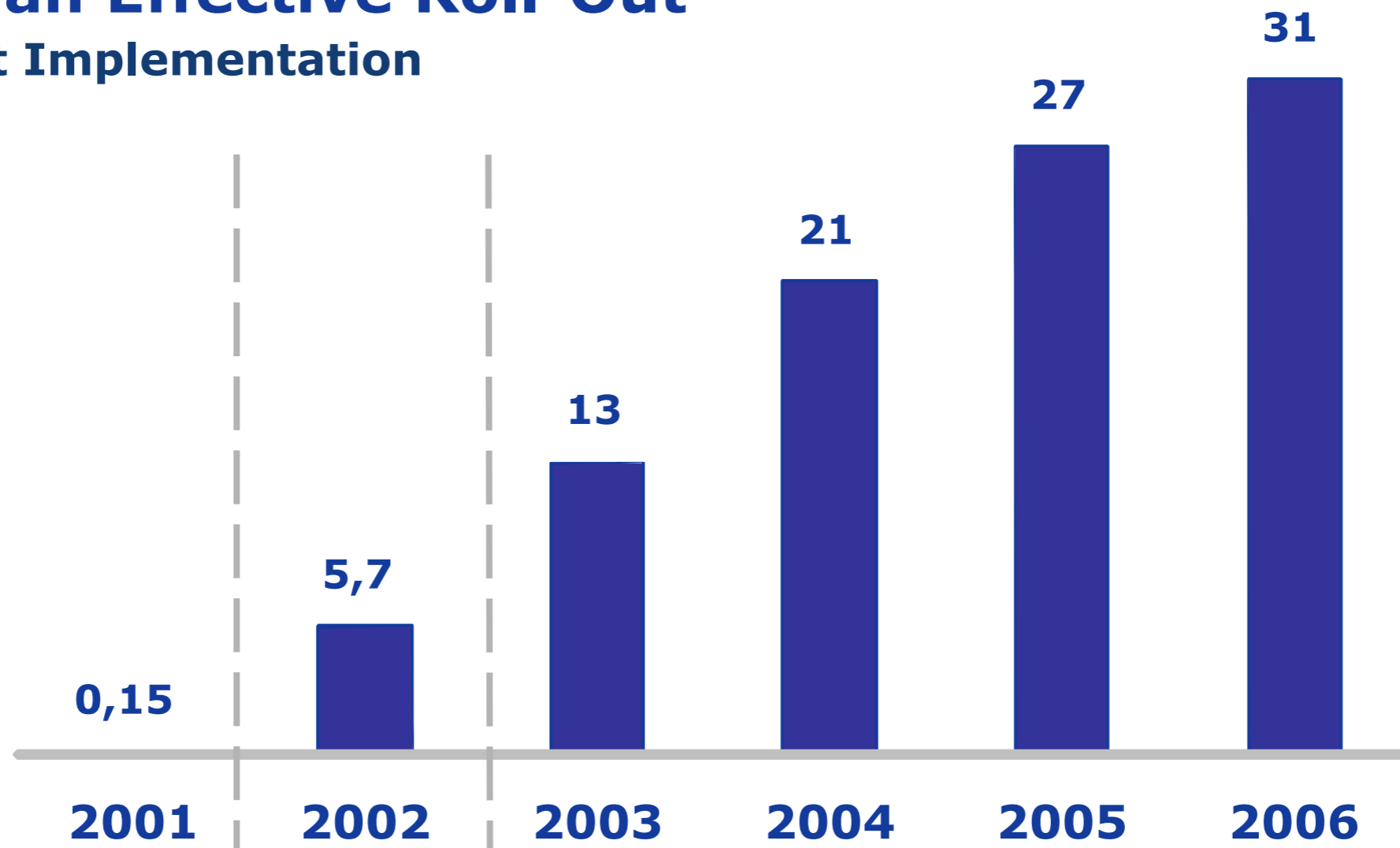
Organization

- **Focused, dedicated organization**
- **700 parallel / uniform installation regional lots to**
 - » **Anticipate saving**
 - » **Achieve quickly only one organizational model/ avoid unnecessary duplication of organizations/ costs**
- **Each regional unit divided in sub-teams** (Concentrators, SM < 15 KW, SM > 15 KW) **to optimize interaction with customers/ manage critical path of deployment**
- **Effective management of third party subcontractors:**
 - » **Code-of-conduct + certification** of local installators
 - » **Training** of personnel involved in the replacement campaign and in the new processes (12,000 people)
- **Key logistics units support** to manage supplies and contractors
- **Toll-free/Contact Center** to provide assistance and detect/improve solution

Initially, top down project to define installation strategy and organization to achieve lowest possible installation cost/ maximize savings

Managing an Effective Roll-Out

Massive/ Fast Implementation



Pilot Project to test technology and organization/ process

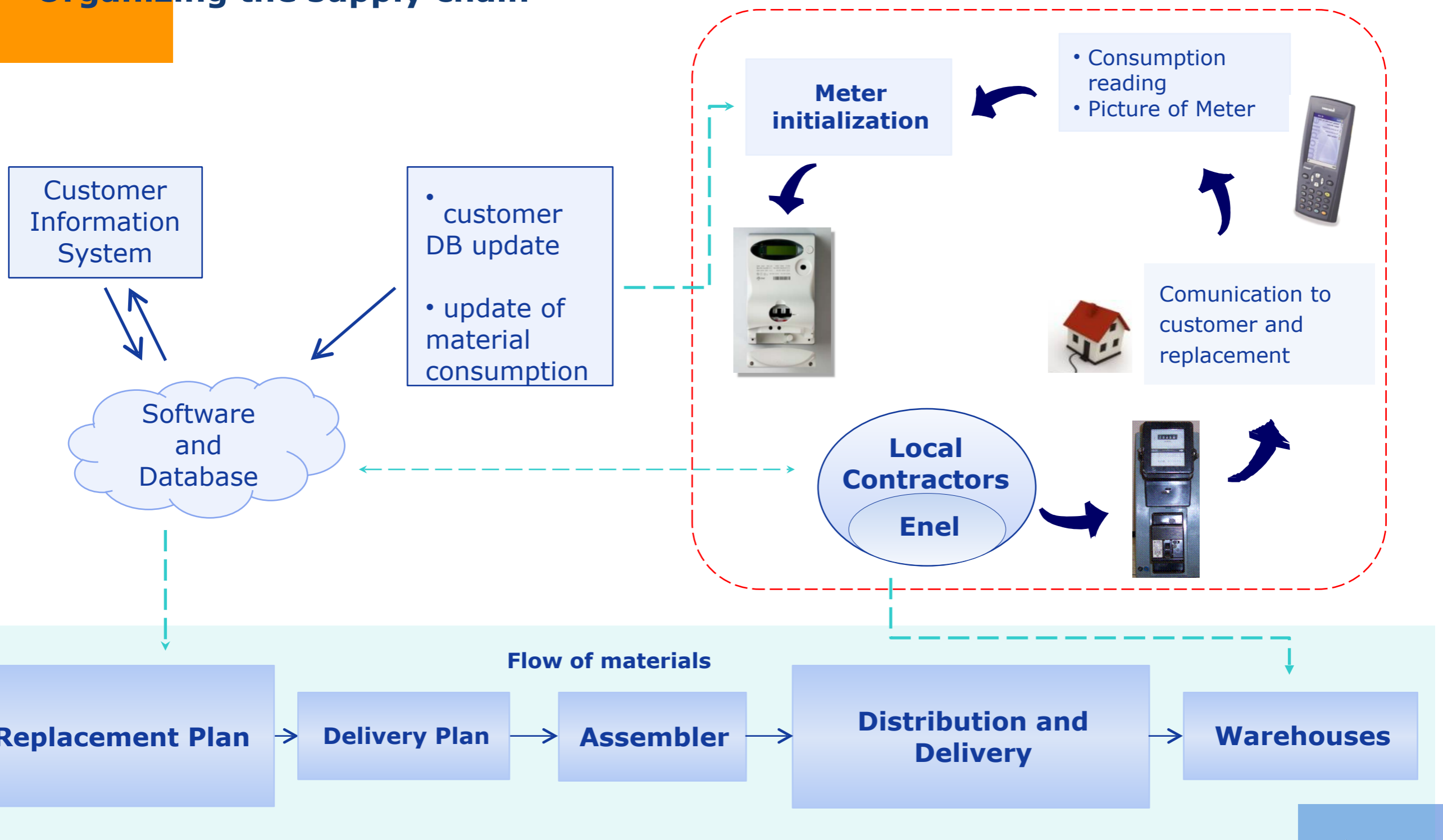
Ramp-up

Massive campaign replacement, near 100% of Customer base

5 years to install 31 Mn Smart Meters in order to be able to balance risks and benefits

Managing an Effective Roll-Out

Organizing the supply chain

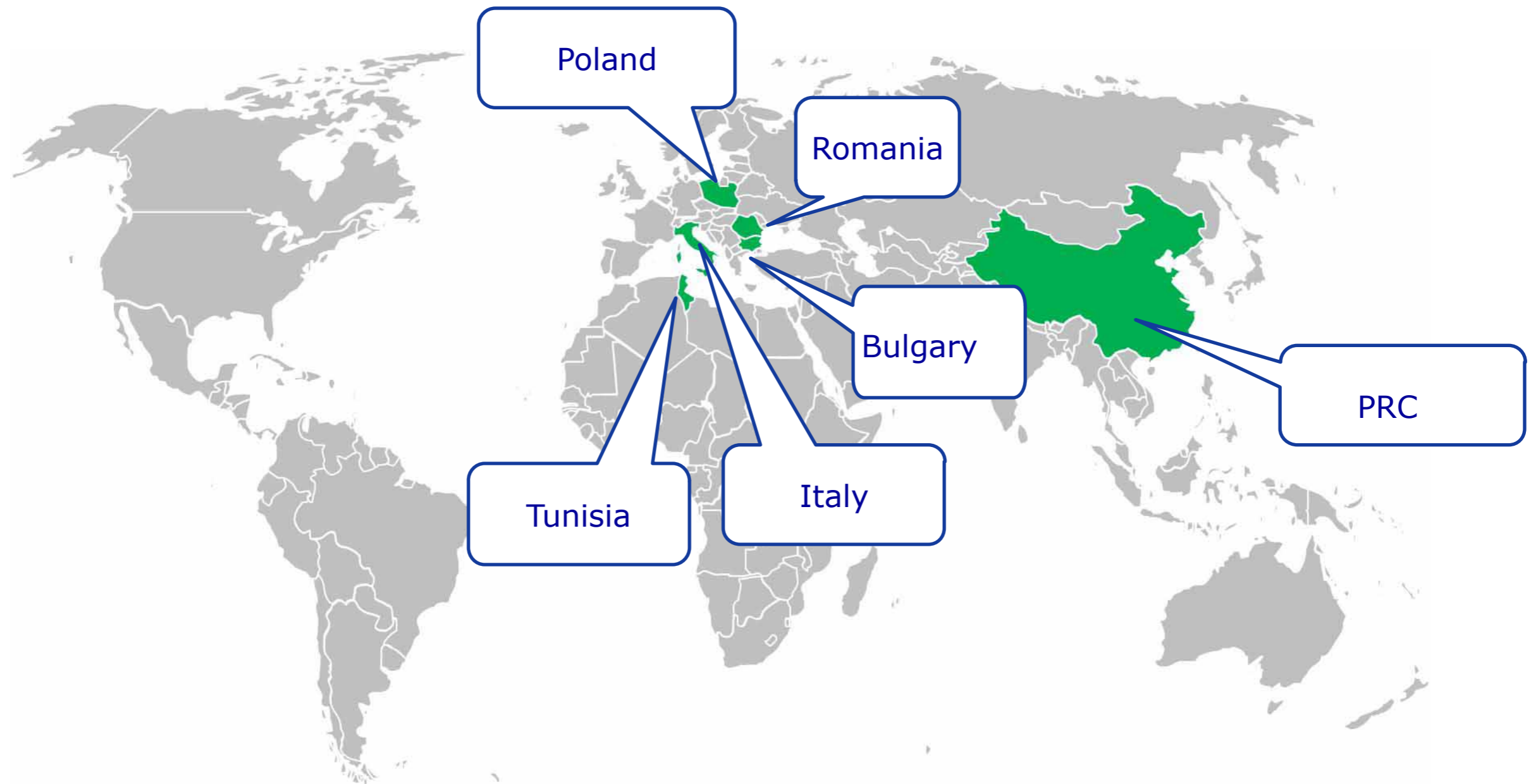


Integrated supply chain



International Manufacturing Strategy

Strong controls on manufacturers - 2011



Local OEM production is permanently under on-site supervision by ENEL to ensure flexible/ world-class quality of products



Enel new Automatic Meter new generation solution



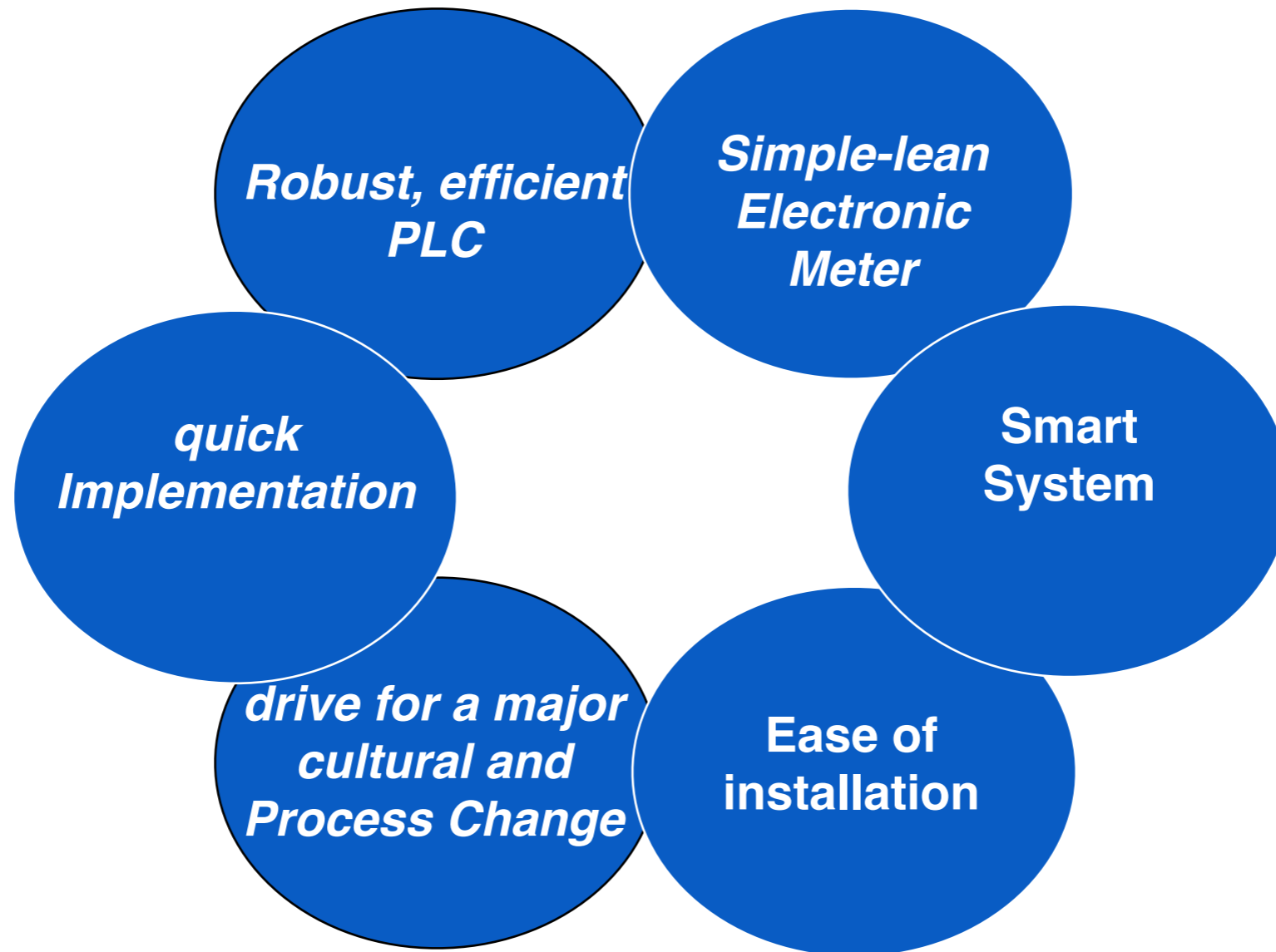
Enel has designed a **new generation Smart Meter solution, with open architecture, as evolution of Telegestore**

The new solution includes the **latest technologies** in terms of components and functionalities, **ready for advanced smart grid development**

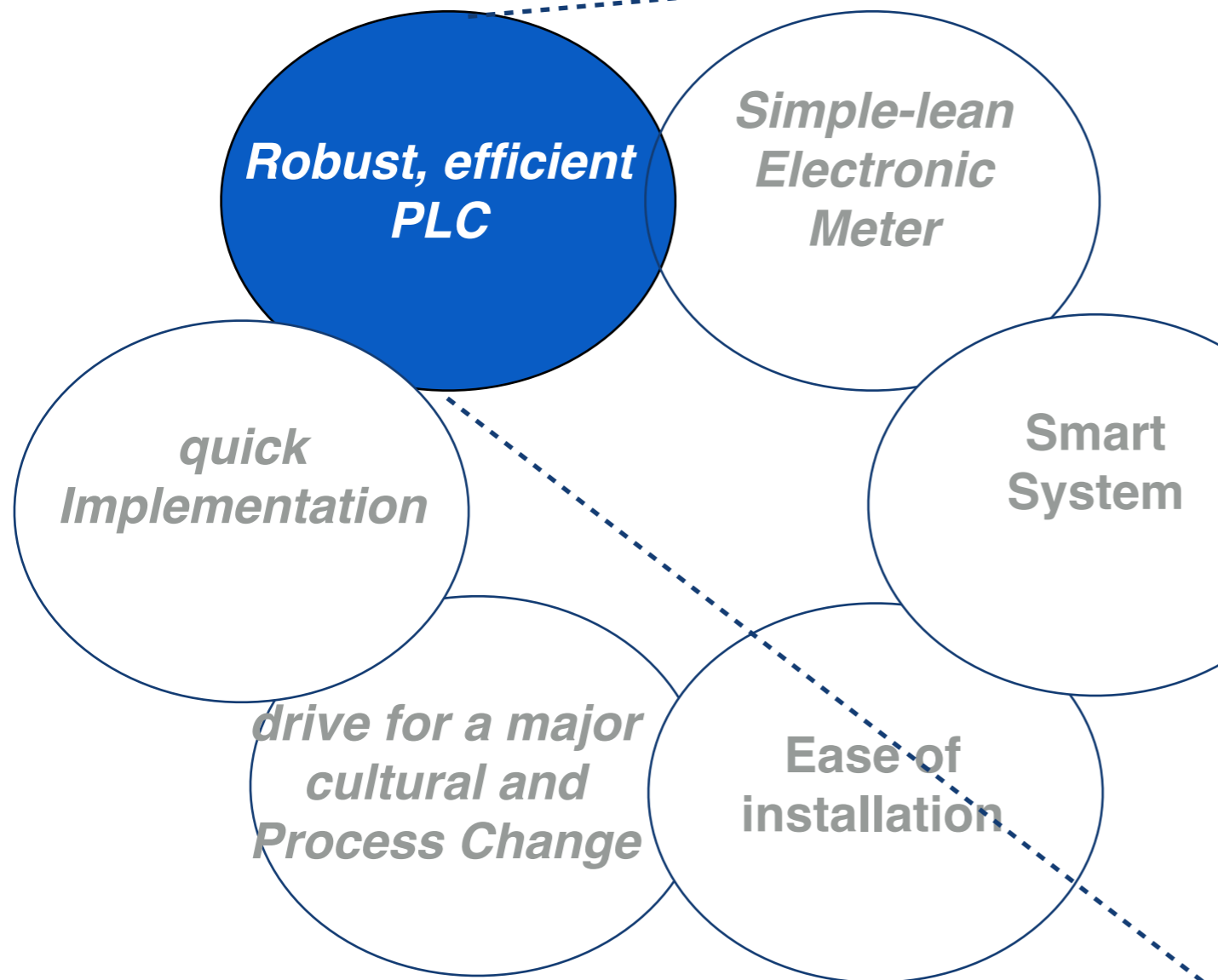
... maintaining **Telegestore robustness, reliability and cost effectiveness**

The solution (meter, concentrator, AMM system modules) is being **deployed in Spain, a Project of more than 13 Mln meters by 2016**

Creating a Smart Metering success story, in sum

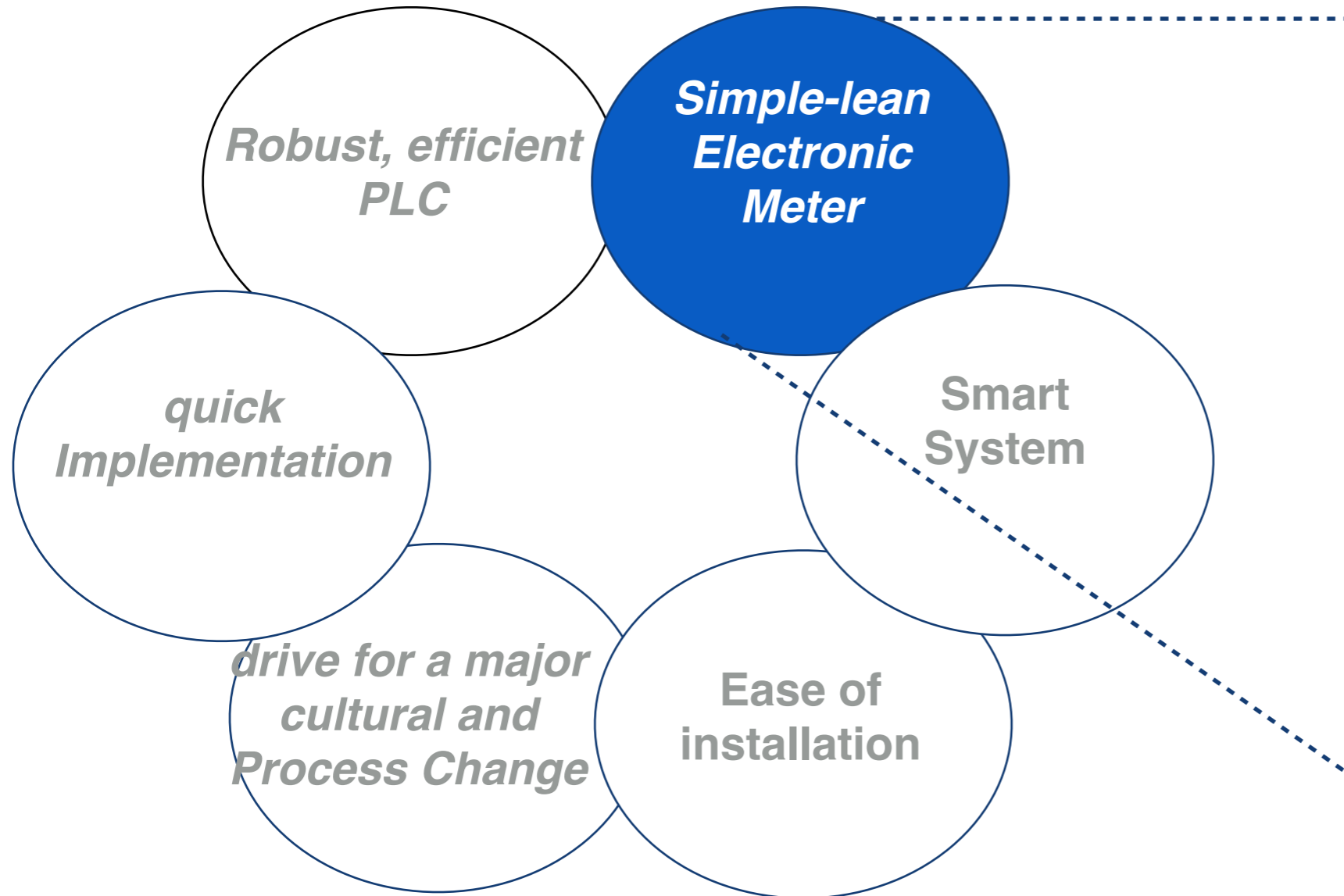


Creating a Smart Metering success story, in sum



- **An extensive field experience** is **key** to **optimize PLC** communication for Smart Metering.
- **Powerline communication performance:**
 - cannot be measured only by available bandwidth, but preferably in terms of reaching and success rate, end-to-end, in real field situations,
 - depends on **overall layers of communication, retry policies and data model.**
- **Encrypted end-to-end**
- **open technology** contributing to **evolution and enhancement** of Smart Metering solution

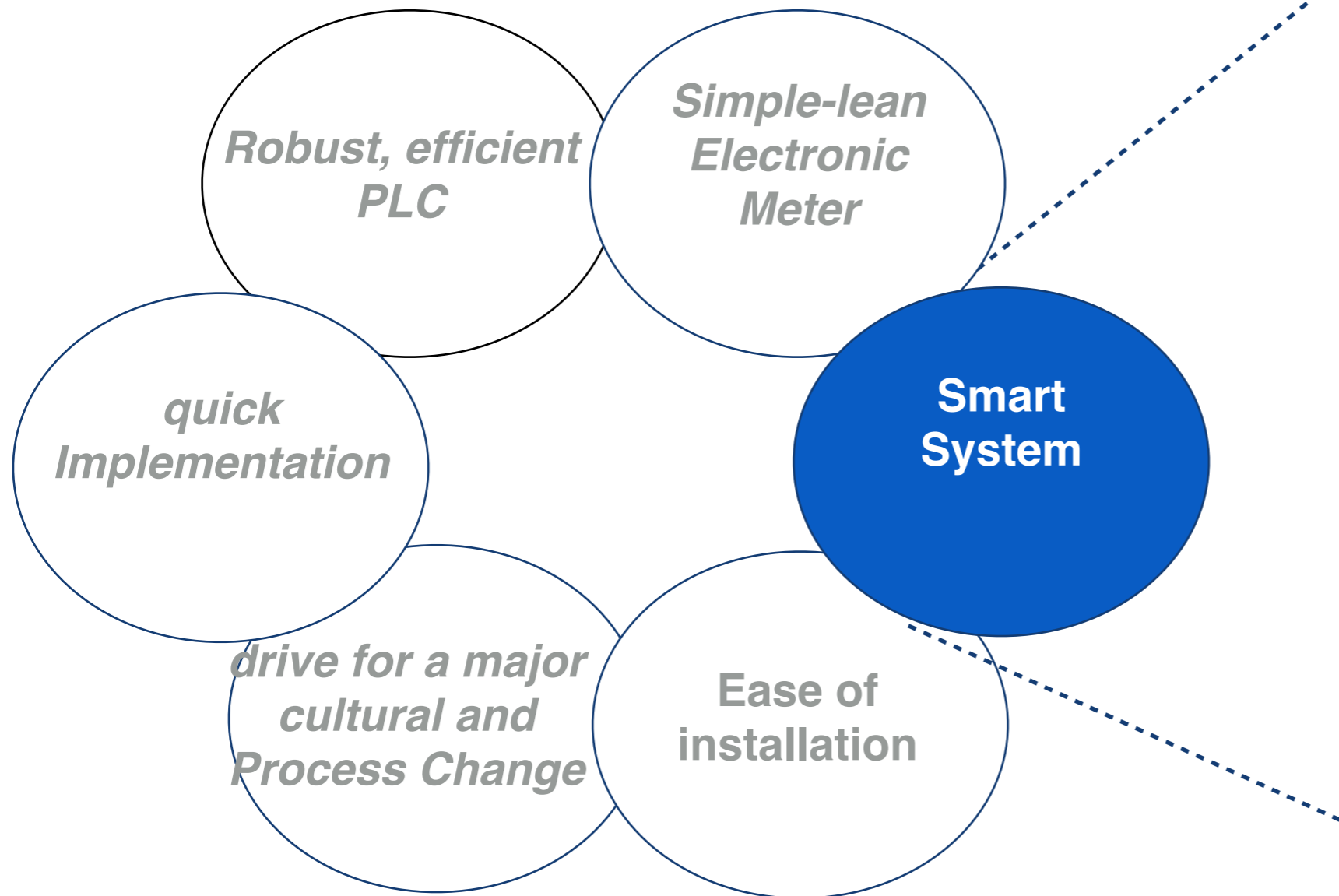
Creating a Smart Metering success story, in sum



- **Robust, field proven solution is necessary** to avoid unnecessary risks,
 - **simple solution/ build**
 - relay,
 - GPRS modem only in concentrators
 - PLC modem, interface,
 - repeater functionality...
 - lean build (high integration of electronic components/ SMT,...)
- Focus on reducing Cost per Meter**

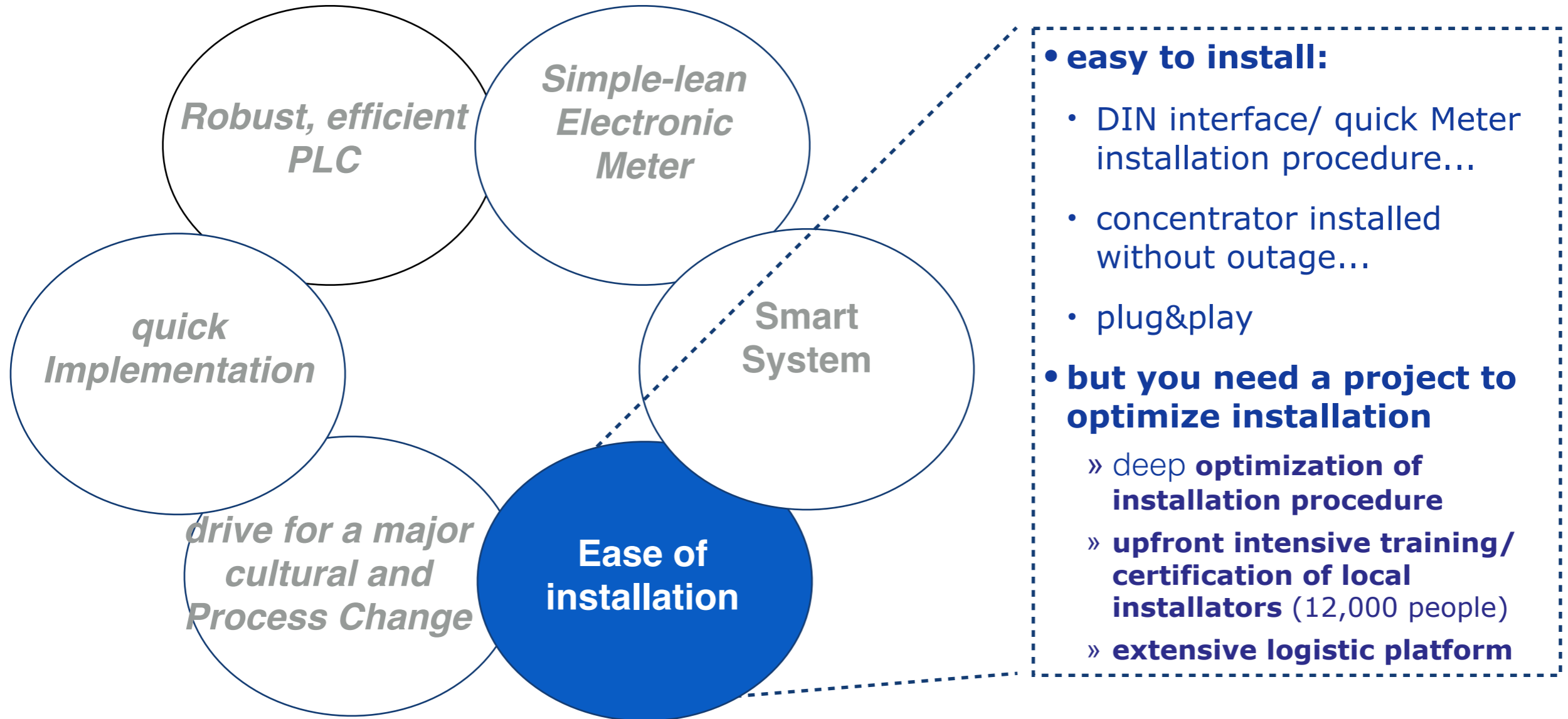


Creating a Smart Metering success story, in sum

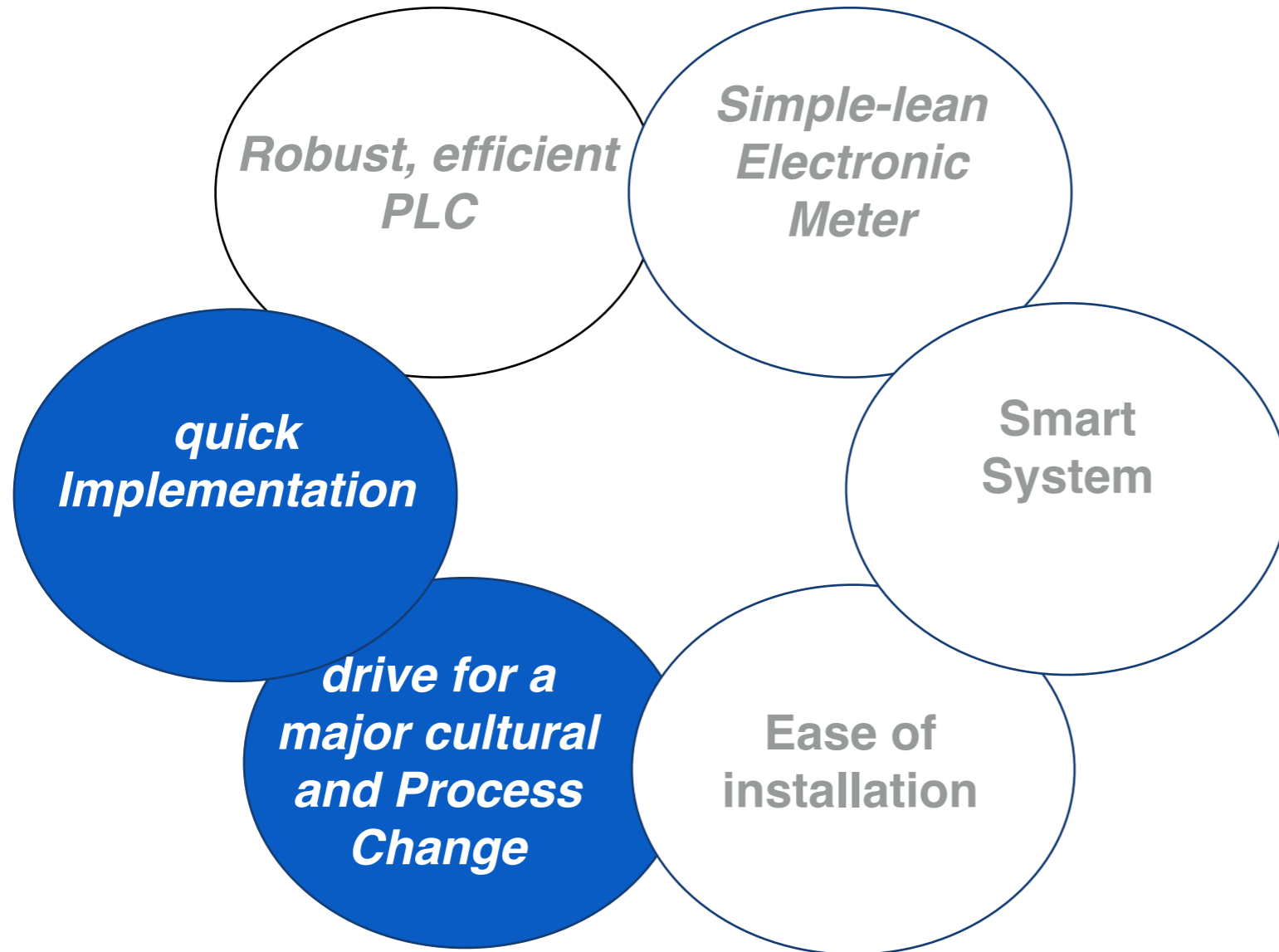


- **full automation**
 - **field activities** - contract, switching, bad payers, load limiting
 - **Field Communication management** self-discovering, adaptation to grid
 - **Meter/ AMM administration** - commissioning, FWupgrade, Meter/ concentrators reconfiguration,
 - **Problem Manager:** eg: automatic action to correct the faults
- **Integration with grid** (investment optimization, Quality control...)

Creating a Smart Metering success story, in sum



Creating a Smart Metering success story, in sum



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- **Operating Network in The Age of Smart Metering**

Benefits

According to distinct points of view

For customers and other electrical system operators

- Invoices on updated consumption
- Remote, near real time meter operations
- Load limiting for bad payers
- Tailored tariffs
- Pre payment
- Support to market development

For the electric power system

- Demand side management
- Energy efficiency and co2 reduction
- Greater competition

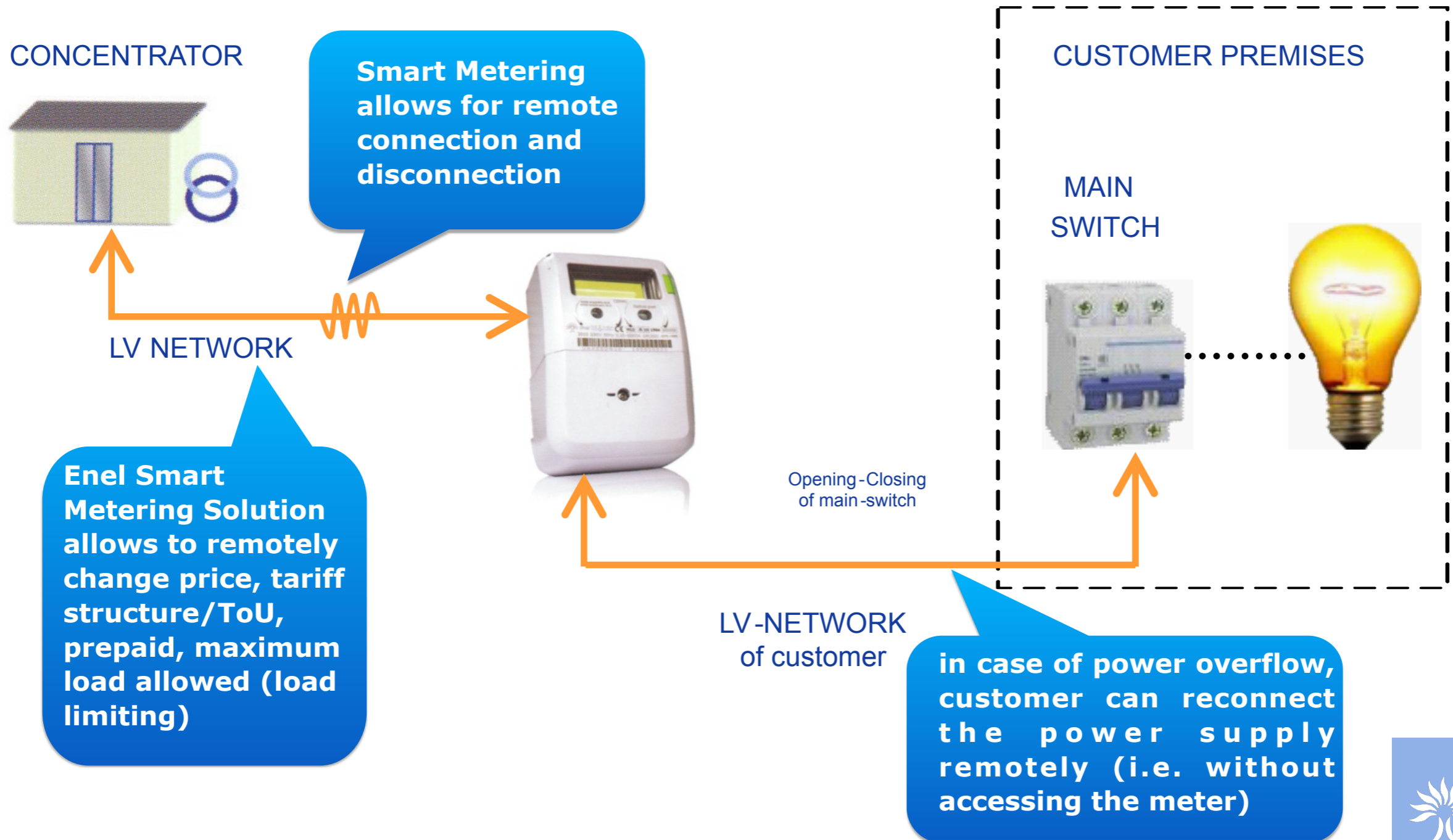
For DSO

- Excellence in commercial quality
- Operating cost savings
- improved fraud detection
- Improving network Planning and management
- Leadership in innovation/ smart grid enabled

How could we have ever lived without Smart Meters?

Contract Operation in The Age of Smart Metering

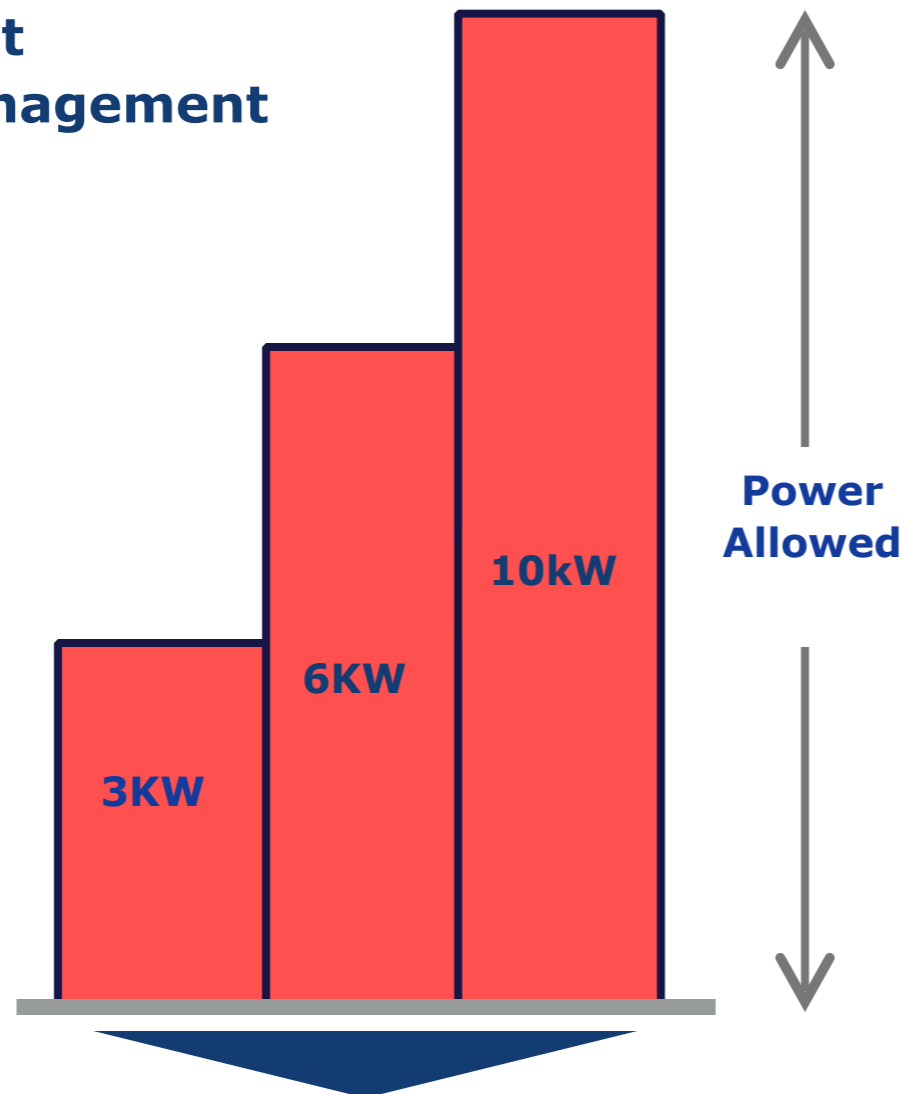
Remote device management



Network operation in the Age of Smart Metering

Load Limiting

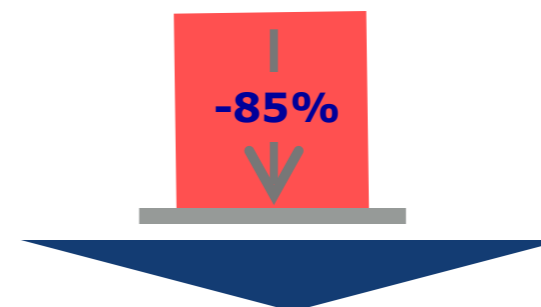
Contractual load limit management



Programmable / flexible load limiting:

- **Flexible contractual power limit changes** from remote(*), key to for load flow/ peak management
- **"Smart" load shedding**

Bad Payers management



load curtailment instead of outright cut-offs; i.e.:

- Power limitation **ensures minimum social supply** contract value (usually 10% of contractual load, programmable value)
- Remote Power restoration soon after payment

* The Meter can simulate the behaviour of a traditional switch in disconnection of power higher than maximum contractual load

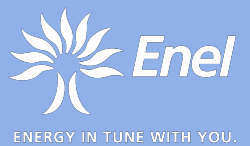
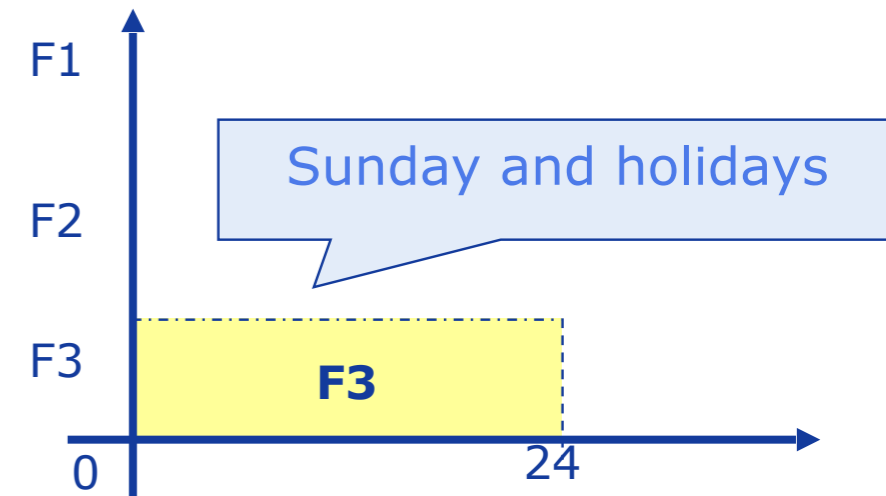
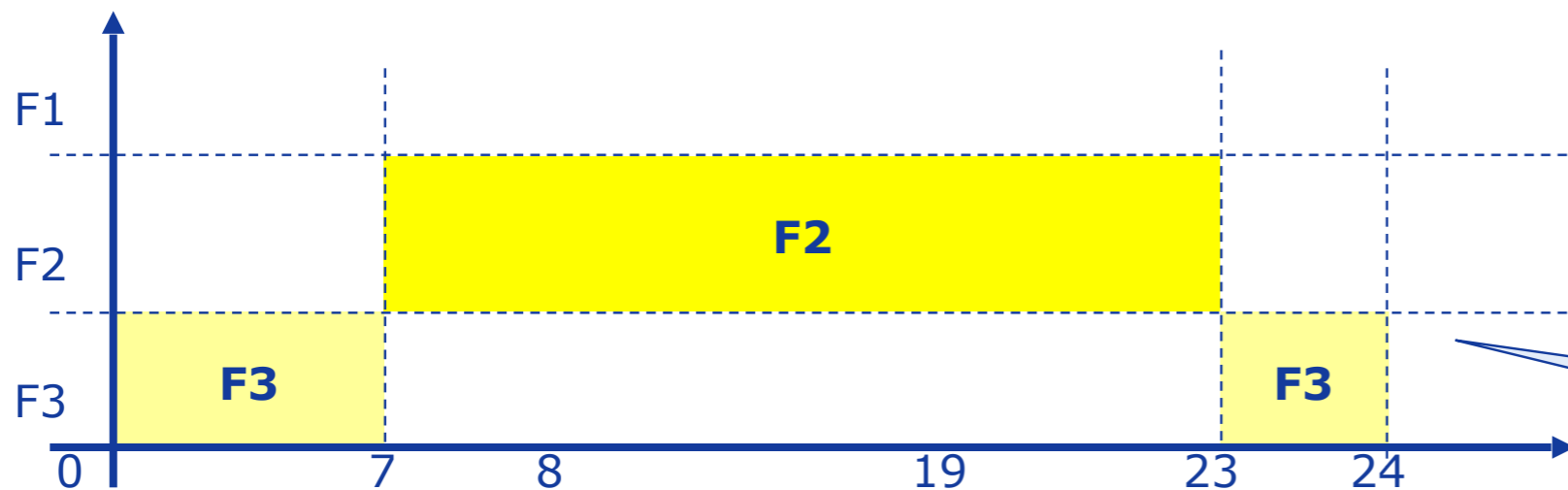
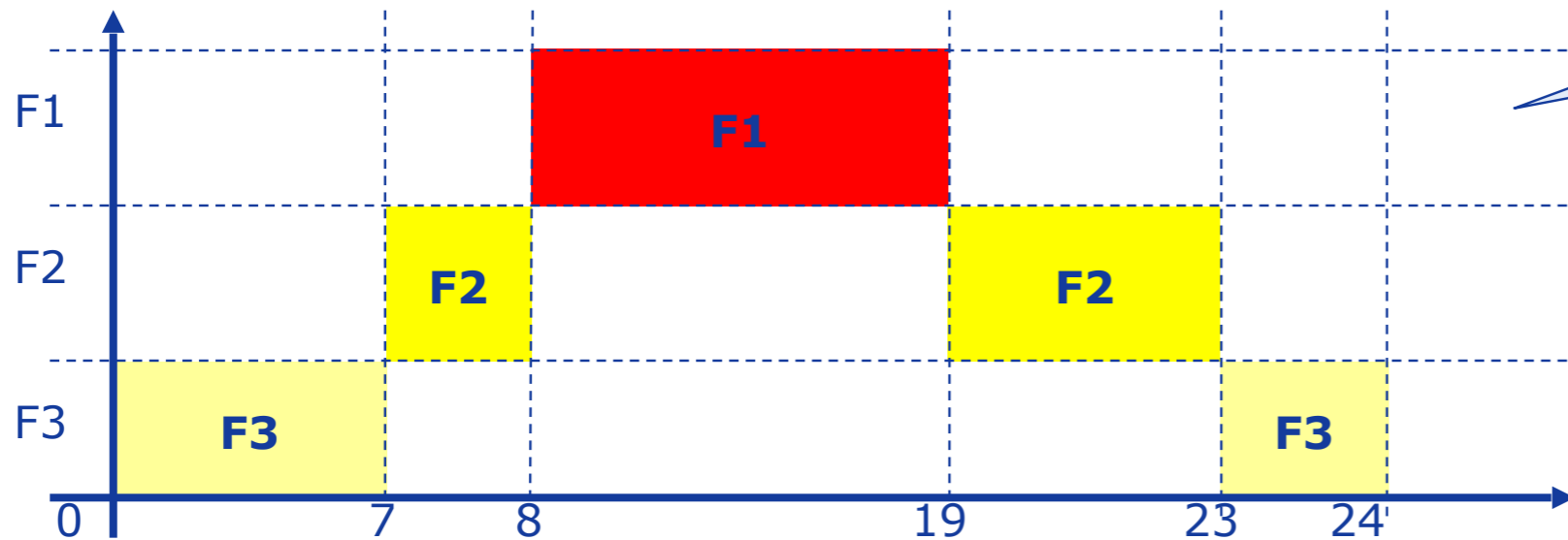


Supporting energy saving

Day/night different tarif

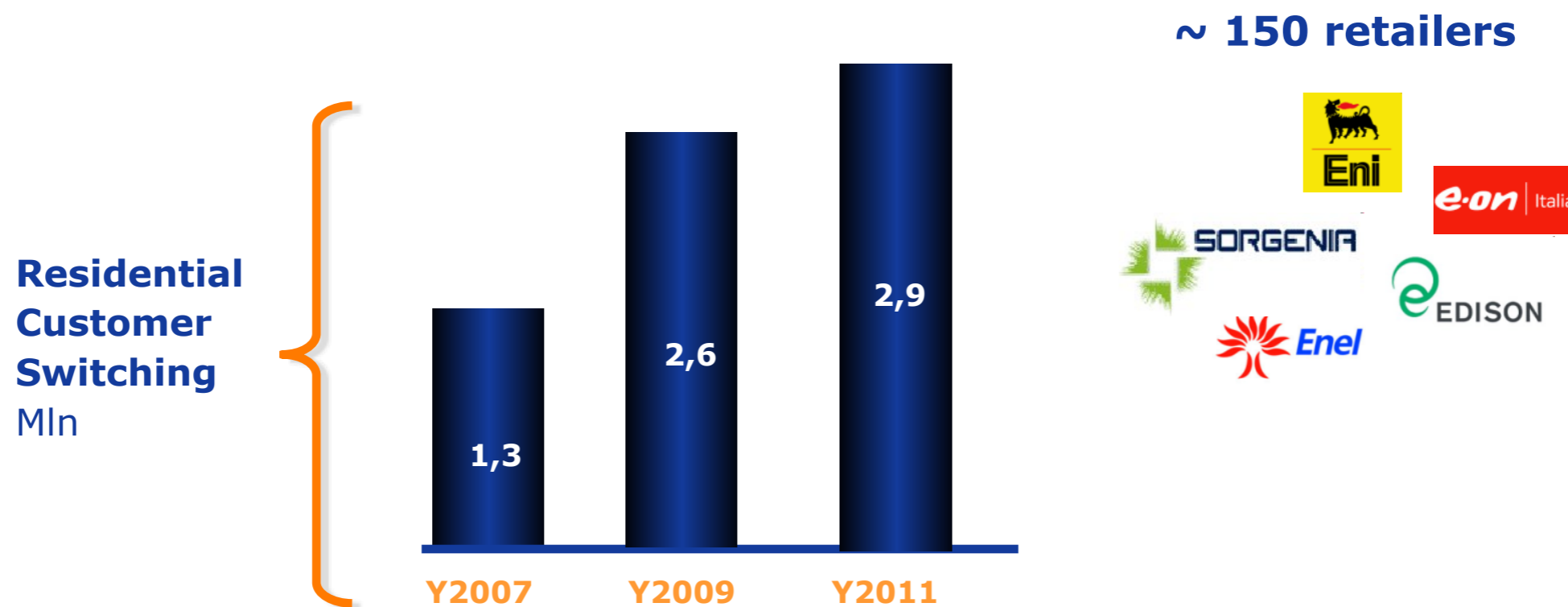
Del. 156/07

DICOs modified configurations for all electronic meters to separately collect energy values for F1, F2 e F3 .



Supporting energy market development

Switching



Smart Metering ensure quick and smooth switching

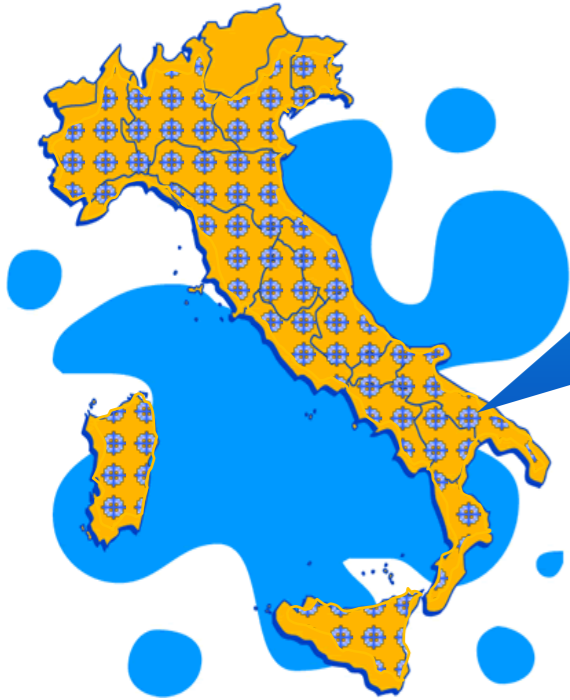


Excellence in commercial quality

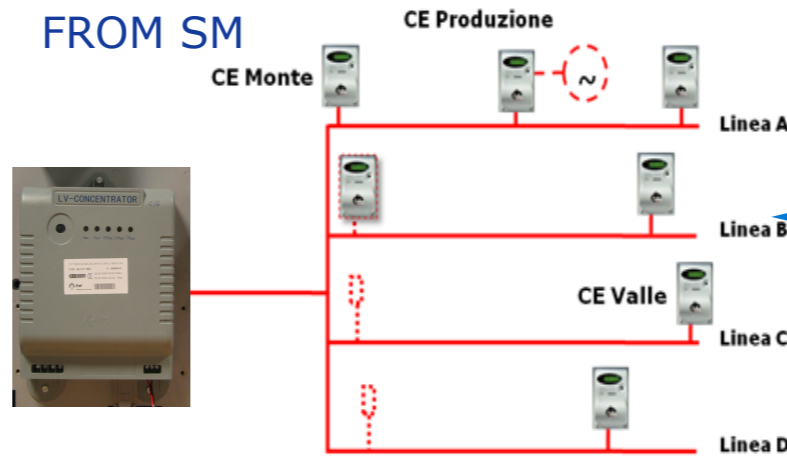
LV quality monitoring at Smart Meter

Covering all Enel network

- Detection of pivots nodes selected on the basis of distance from TR and from distributed generation
- About 3 M selected SM are red for LV quality informations in about 2-3 weeks



LV DATA READING FROM SM



All details to address problems with the right priority

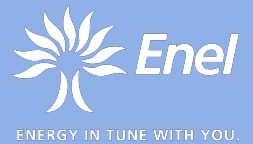
DATA TRANSMISSION FROM CONCENTRATORS TO CENTRAL SERVERS



ELABORATION OF METERING DATA

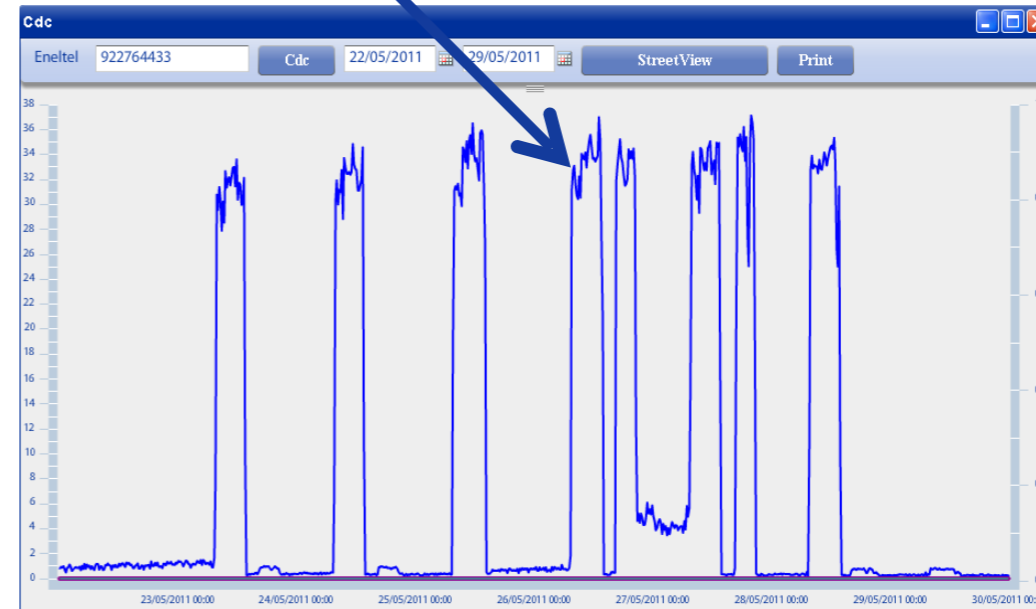
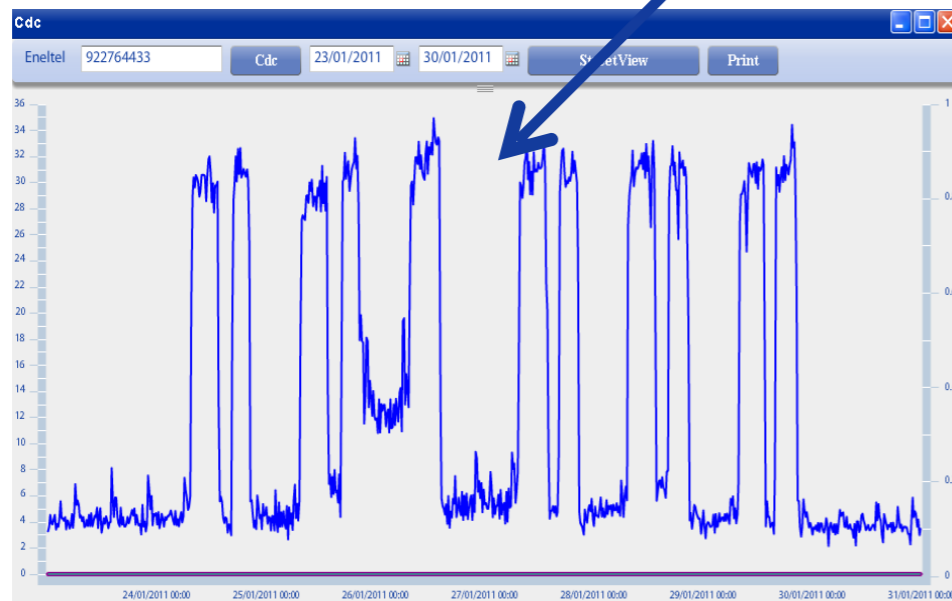


Num. Rpt	Data Inizio Campagna	Data Fine Campagna	DTR	N° Totale Trasformatori	N° Trasformatori Accusati	N° Trasformatori Puntati	N° Trasformatori Puntati Standard per Area	N° Trasformatori Puntati Standard per Area	N° Totale Trasformatori con Produzione distribuita	N° Trasformatori con Produzione distribuita Accusati	N° Trasformatori con Produzione distribuita Puntati	N° Trasformatori con Produzione distribuita Puntati Standard per Area	N° Trasformatori con Produzione distribuita Puntati Standard per Area	N° Trasformatori con Produzione distribuita Puntati Standard per Area	N° Trasformatori con Produzione distribuita Puntati Standard per Area	
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Riepilogo				40.465	37.296	31.268	220	559	114	9	10.736	9.472	9.472	144	58	75

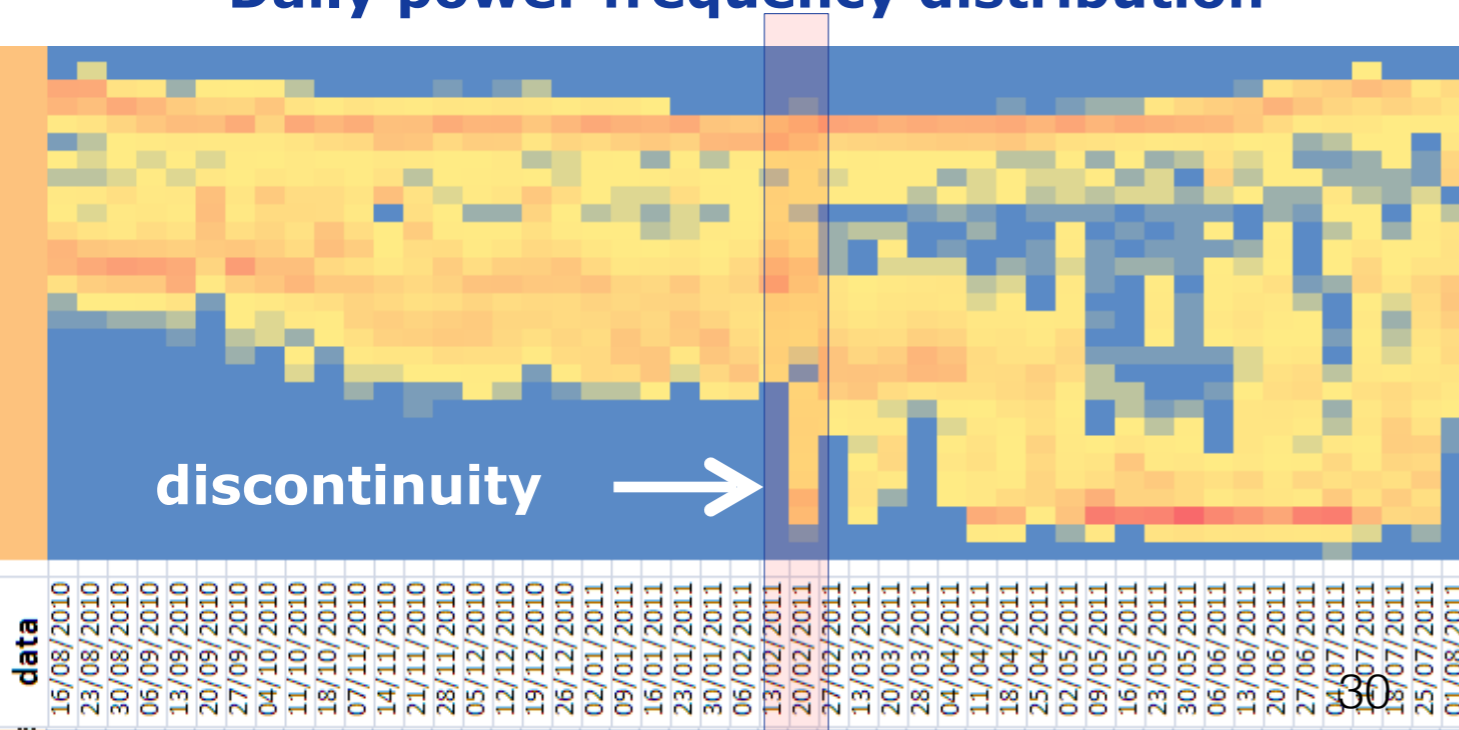


Improved Frauds detection tools

Load profiles in two different weeks (avg. power in 15 min)



Daily power frequency distribution



Enel Smart Metering solution has

- not only robust antitampering
- but also advanced Mathematical and statistical modeling

to detect remotely **suspicious consumption behaviours**

Advanced network planning and management thanks to Smart Metering - *New* STAmi (ST Advanced Metering Interface) application

STAmi it's the application developed by Enel to leverage its massive implementation of Smart Meter, collecting and comparing data from AMM and SCADA:

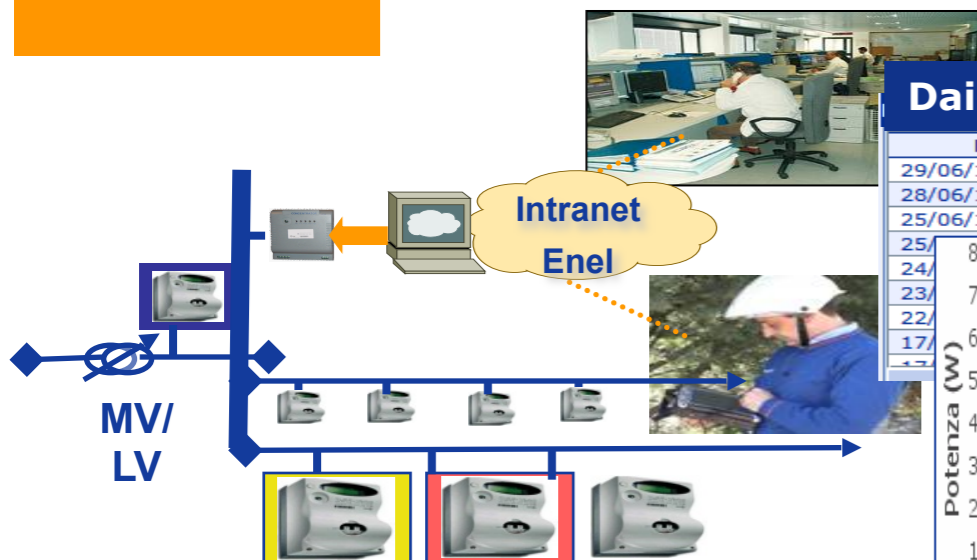
- Quality of Tension
- Interruptions
- daily Consumption
- daily Load Curve
- Field equipment list and status
- K COEFF.

Data are collected from:

- clients Smart Meter
- Concentrators
- Grid Meters for load balance

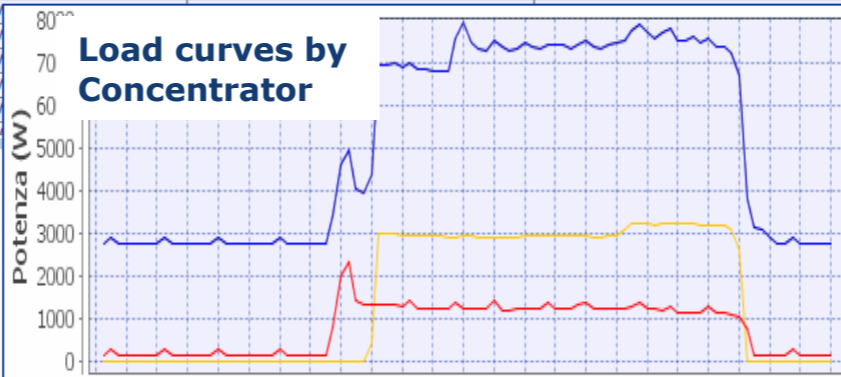


Key Activities supported by STAmi



Daily Consumption by Concentrator

Data	Energia Attiva (kWh)	Energia Reattiva [kvarh]
29/06/10 10.17.23	0,556	0,755
28/06/10 23.59.59	4,771	2,351
25/06/10 11.28.14	0,872	0,655



Grid Control
Fraud Verifications

Quality of Service reporting



INTERRUPTIONS					
Da	A	Progressivo interruzioni	Istante Insorgenza	Durata Interruzione	Fase Interessata
04/02/10					
04/02/10					
04/02/10					
04/02/10					

QUALITY of TENSION										
Periodo		Tensione Istantanea			Fase 1		Fase 2		Fase 3	
Da	A	Fase 1 (V)	Fase 2 (V)	Fase 3 (V)	Vmin (V)	Vmax (V)	N°Camp. OK	N°Camp. KO	Vmi... Vm...	N°Camp. OK
12/04/10 0.00	18/04/10 23.59.59	-	-	-	214	241	1008	0	-	-

Load Utilization - K COEFF. (%)	
Istante	Valore (Percentuale ...)
27/07/10 12.12.33	100.0

INTERRUPTIONS

Periodo		Dati			
Da	A	Progressivo interruzioni	Istante Insorgenza	Durata Interruzione	Fase Interessata
04/02/10					
04/02/10					
04/02/10					

QUALITY of TENSION

Periodo		Tensione Istantanea			Fase 1		Fase 2		Fase 3	
Da	A	Fase 1 (V)	Fase 2 (V)	Fase 3 (V)	Vmin (V)	Vmax (V)	N°Camp. OK	N°Camp. KO	Vmi... Vm...	N°Camp. OK
12/04/10 0.00	18/04/10 23.59.59	-	-	-	214	241	1008	0	-	-

Fault prevention/
Analysis

Network Planning / load
flow Analysis



Integrating data from Smart Meter to forecast Renewable impact on grid - *New*

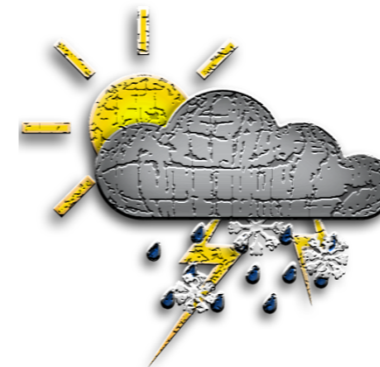
MAGO Application



kW or MW=
n-1 day



~19 GW
~295.000
producers

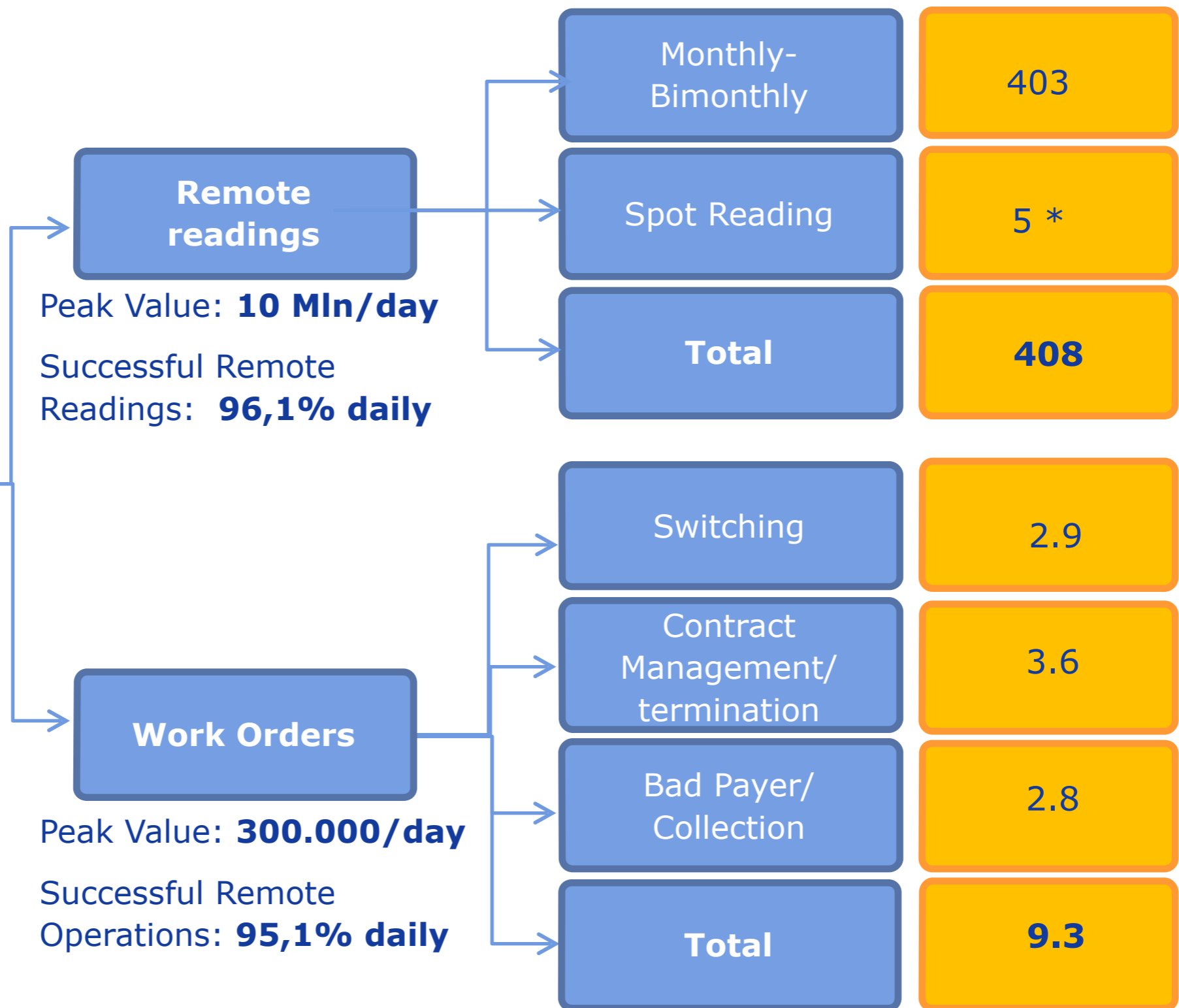


kW or MW=
n day



High Success rate under various grid configuration is the foundation of any large scale Smart Metering project

Enel Smart Metering operation results 2011



* 2010



What AMM does all days (and nights)?

Focus of National Smart Meter Supervision and Support Centre

READINGS

- Registries of LV meters are red monthly
- Load curves for LV meters with $P \geq 55$ kW are red daily

REMOTE OPERATIONS

- Contract management
- Switching from trader to trader
- Bad payer management

AMM ADMINISTRATION

Field equipment

- commissioning
- FW upgrade
- Reconfiguring behaviour
- Automatic clock syncr.tion

LV NET quality monitoring

- Voltage quality monitoring
- Voltage Interruptions at Smart Meter



Problem Manager

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THANK YOU FOR YOUR ATTENTION