Analytics to support revenue protection activities

SARPA Convention

Knysna - July 11, 2014

Ilario Tito – Africa and Middle East

International Business Development

Enel Distribuzione

Contents

Enel group key figures

Systems and tools to support revenue protection

- Introduction - Advanced metering infrastructure (AMI)
- Distribution Management System (DMS) – technical losses
- ST AMI – non technical losses
- Use of AMI analytics in other utilities in Europe

SHAPE, a new business analytics platform

Executive summary

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Enel today

Presence in
40 countries

Net capacity
98,900 MW

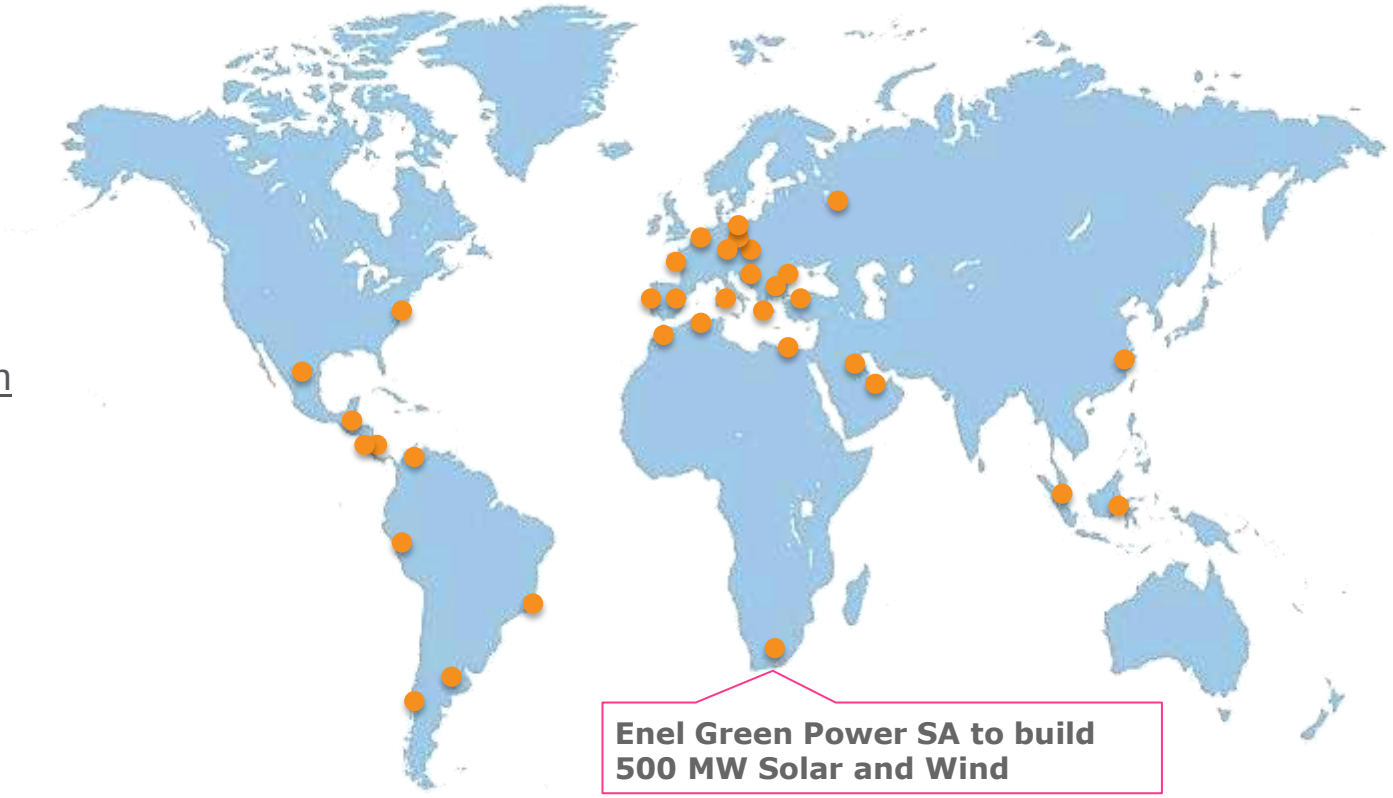
Net generation
286.1 TWh

Gross Operating Margin
17 bln €

Customers
61 million

Employees
71,400

Capex 2014-18
28.6 bln €



Stock exchange

Enel is listed on the Milan stock exchange (~1.3 mln shareholders). 14 companies of the Group are listed on Milano, Madrid, Mosca, New York stock exchanges and in other Latin American countries

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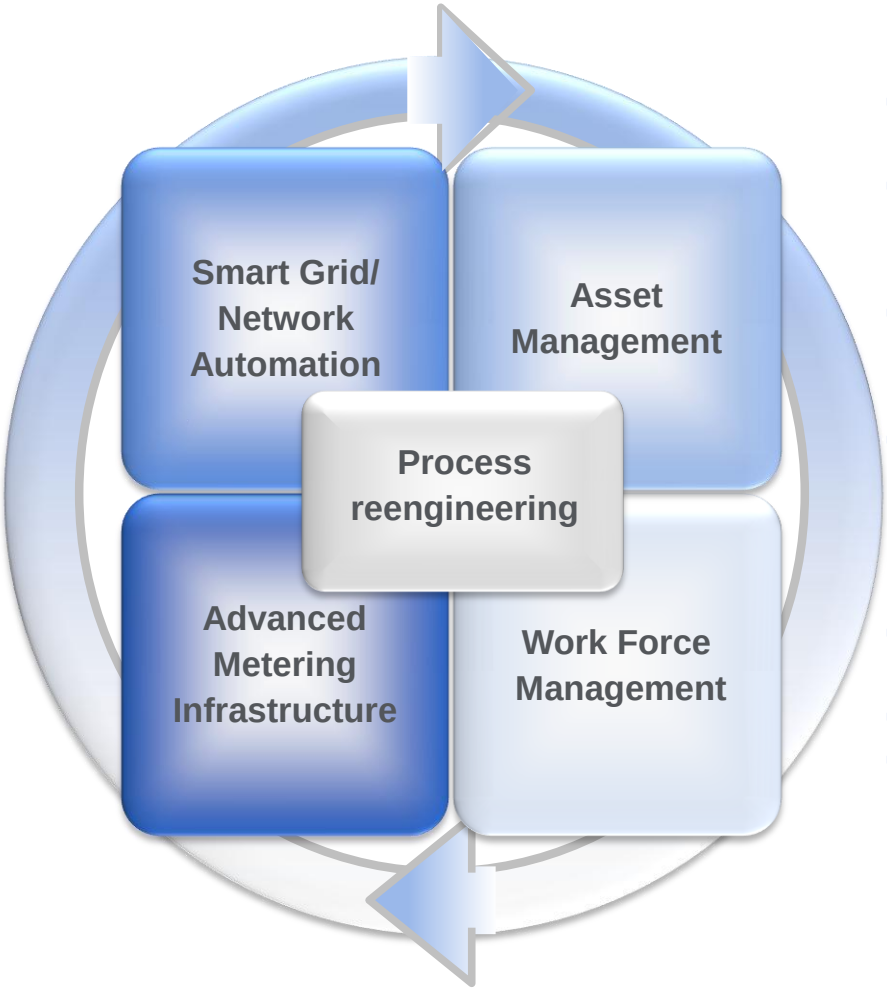
ENEL Distribuzione Technology Map
Facing increasing complexity and uncertainty

- > **2.000 HV/MV** substations remotely controlled (**100%**)
- > **115.000 MV/LV** substations remotely controlled (more than 25%)
- Improved Neutral Grounding System
- **Automatic fault clearing procedures on 70% of MV Lines**



- **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

- **39+ Mln meters in Italy and in Europe** (5 Mln for other DSOs)
- **13 Mln new generation meters in Spain**
- 422 Mln/year remote readings
- 9,1 Mln/year remote operations

- **> 5.200** Enel **teams** connected via GPRS with GPS localization
- ENEL cartographic on board
- **Mobile applications for all Field Operations**

Clear innovation and technology roadmap, strong focus on internal change

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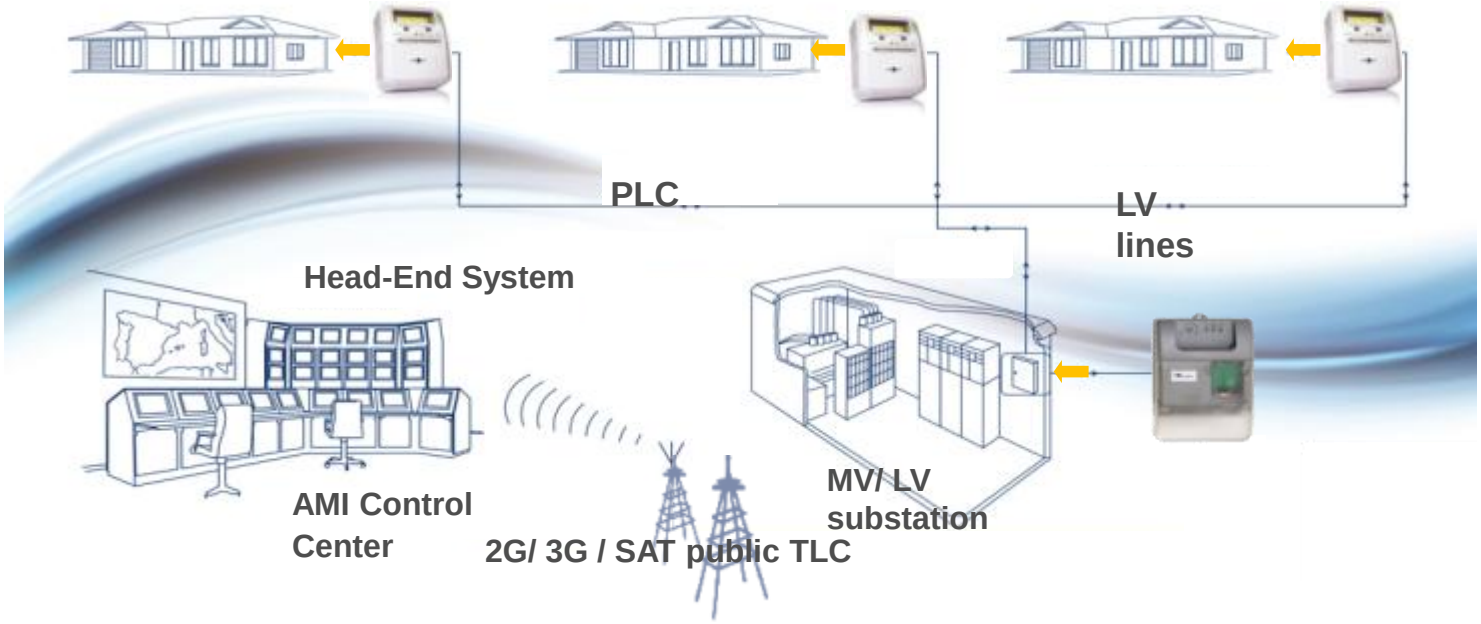
Advanced Metering Infrastructure
The architecture

Advanced Metering Infrastructure (AMI) is composed by an head-end system (HES) of smart meters and other devices, also providing pre-payment and load management functionalites.

Meters are usually installed in boxes outside the customers' houses.

According to our experience the cost effective solution to reach the smart meters (last mile) is the existing electric network (PLC) and the GSM/GPRS to cover the long distance with the central system. It's also easily extendable to other different types of meters (gas, water) and other protocols wireless (UMTS, Wi-Max, LTE).



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Advanced Metering Infrastructure
Operations and Data

Installations of Low Voltage connections

READINGS

Peak up to 9M/day

OPERATIONS

Peak up to of 300.000 /day

Successful remote operations 95,4%*
(-0,5% vs. 2012)

**Yearly Data*

	Final 2012	Final 2013
Electronic Meters	34,7 M	34,3 M
Concentrators installed in MV/LV substations	375 K	374 K
Monthly based	413 M	422 M
*Successful remote readings 96,7%** *(+ 0,3% vs. 2012)*		
Load profile	46,5 M	55 M
*Successful remote readings 99%**		
Switching	3 M	1,7 M
Contract management	4 M	3,4 M
Bad payers management	3,6 M	4 M
Total	10,6 M	9,1 M

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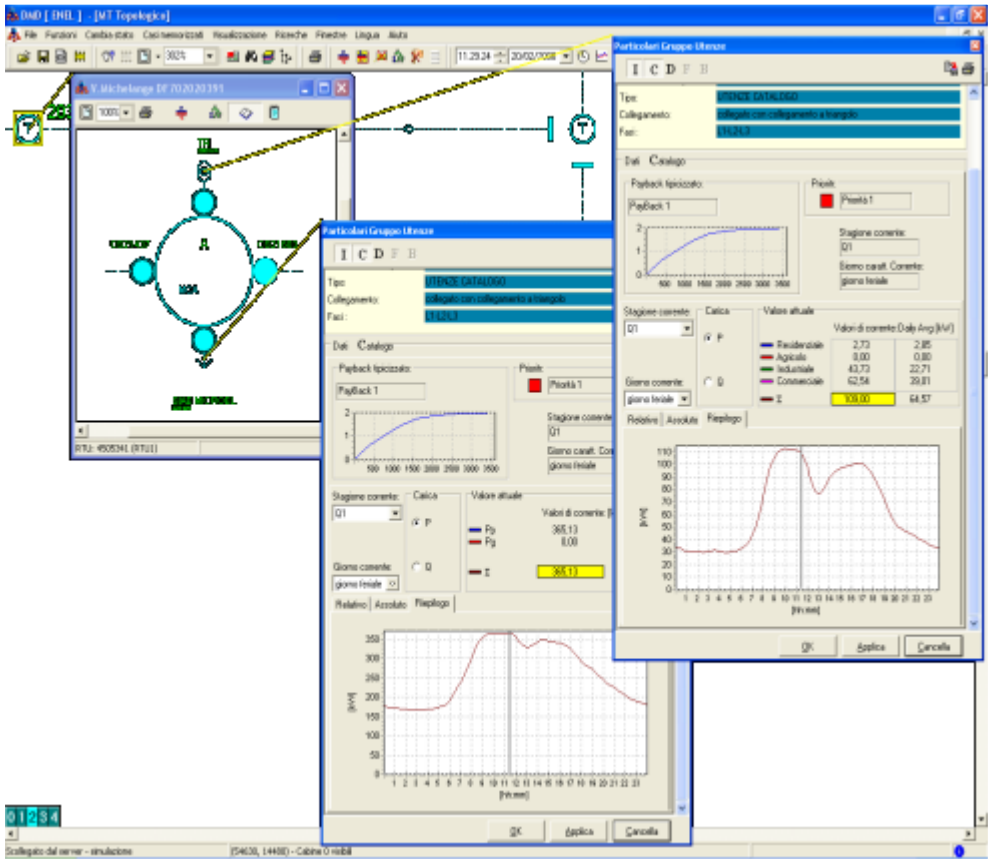
Distribution Management System

Functionalities and advantages of Optimal Switching



DMS main functionalities are topology analyzer, load flow, state estimation, optimal feeder reconfiguration, voltage control, short circuit calculation.

Taking into account only the optimal feeder reconfiguration function, it is possible to minimize the technical losses, reconfiguring the network during the year from season to season. The function identifies a list of network reconfiguration maneuvers alongside the expected losses reduction.

The losses reduction on the involved MV feeders was about 4%.

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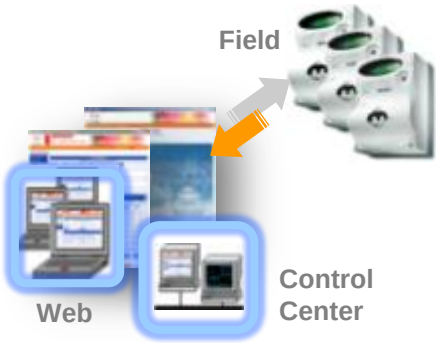
STAMI: ST Advanced Metering Interface

Web Tool to extract value from advanced metering infrastructure

STAMI: dedicated **Web Interface** to collect (on demand and **real time**) specific high quality **data stored in smart meters** for network management purposes.



Direct access to data stored in Smart Meters:

- Voltage Quality
- Voltage Outages
- Monthly consumption
- Load Profile
- Power threshold
- Daily consumption

Main applications:

- Customer Service
- Network Operations
- Electricity Regulation Compliance
- Energy Balance and fraud detection

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Main features: Energy Balance

Energy Balance

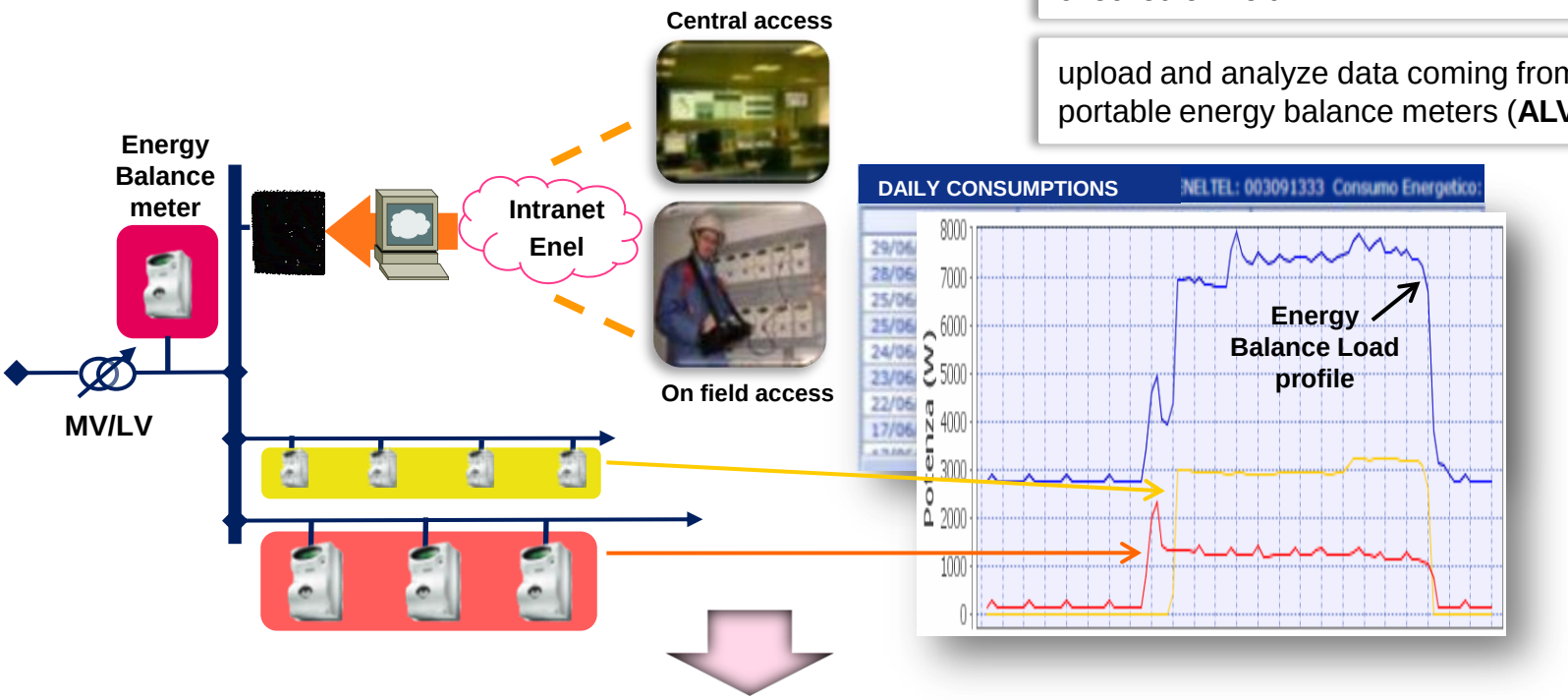
Effectively localize energy fraud & theft

Acquisition of **load profile** and **daily consumptions** to support fraud detection

detailed analysis on the LV network, providing support to the crews

identify precisely the customers to be checked on field

upload and analyze data coming from portable energy balance meters (**ALVIN**)



Combined approach: analytics and reporting

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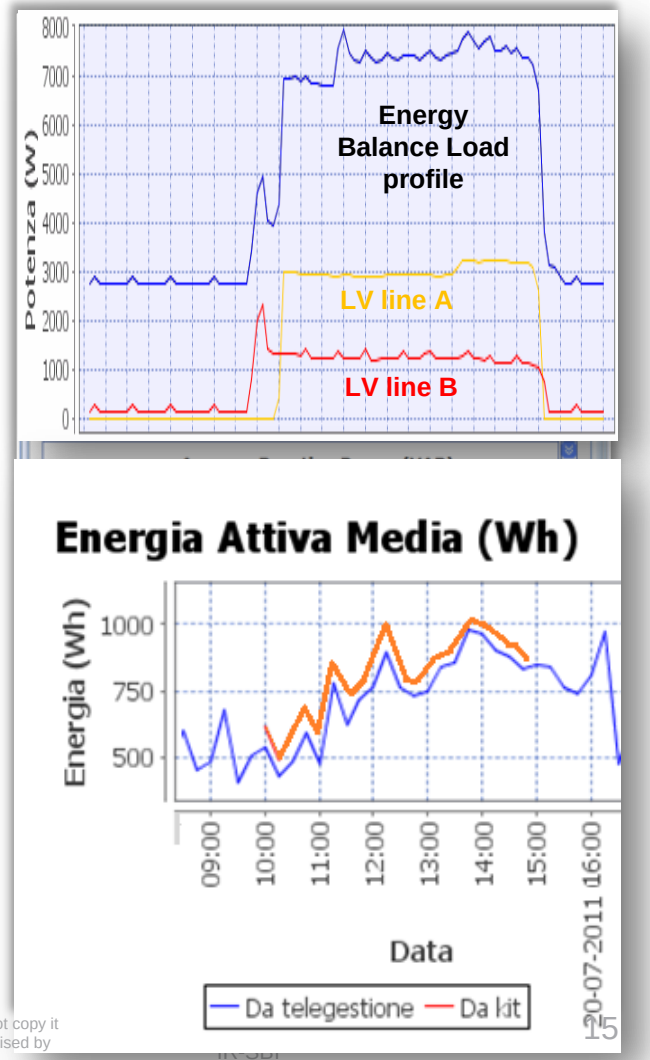
Focus on Energy Balance
Energy Balance: Load profile

Combined Load Profile graphs

- The system allows to draw and **compare in the same graph** different Load curves.
- STAMI shows the LV **topology** of the network.
- Load Profile are available for a **single Smart Meter or a whole MT/LV Transformer**.
- It is possible draw the Load profile of each **LV line** fed by the Transformer, to create the aggregate curve of any **customized group of meters**

That allows to compare the sum of the consumption of the meters connected to the TR, in a unique curve, or grouped in LV lines, with the load profile of the **energy balance meter**.

For a more accurate search of the fraud, STAMI allows to upload and display the average active energy profile recorded by a **portable** energy balance meter (**ALVIN**) and to compare It to the meter aggregate energy curve.



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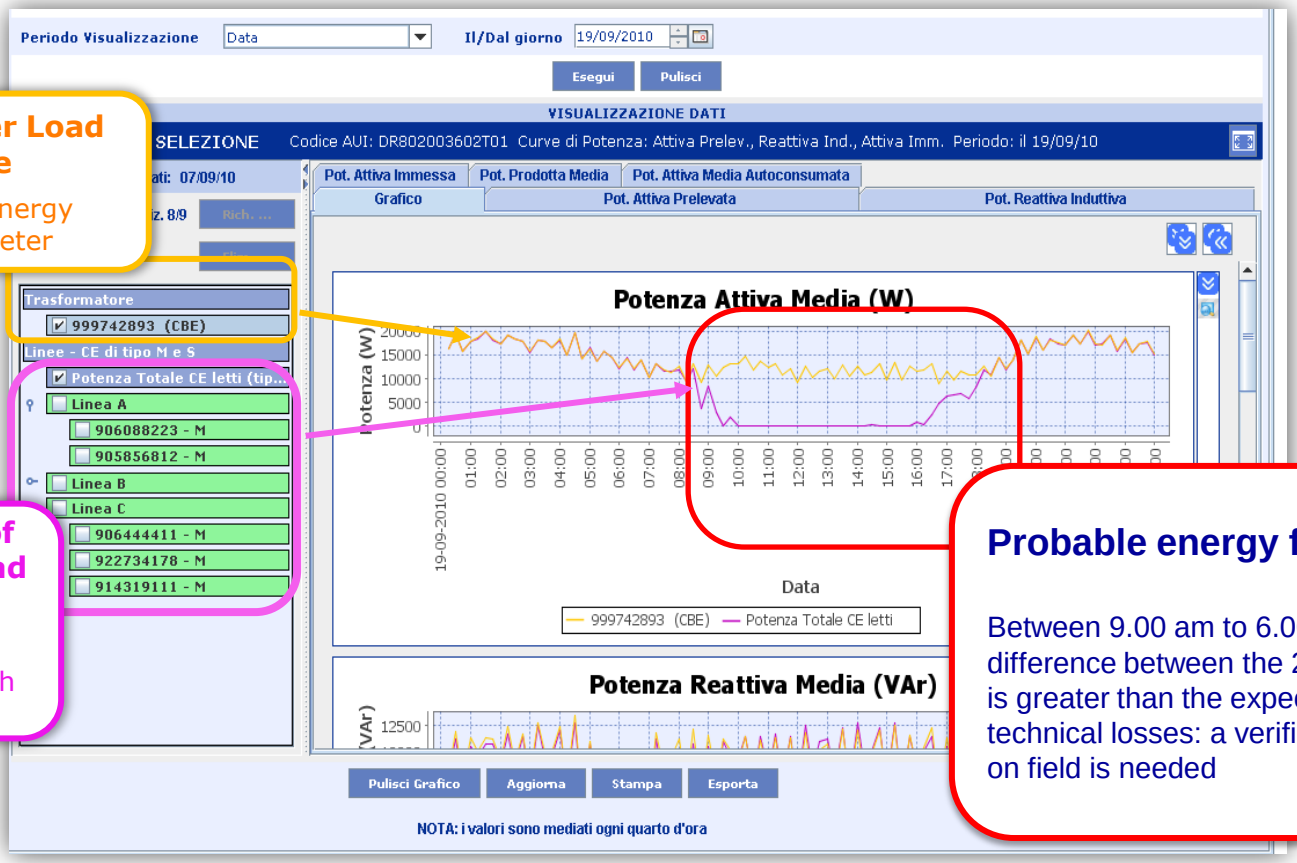
Focus on Energy Balance

Load Profile comparison



Transformer Load Profile

Measured Energy Balance Meter

Aggregation of customers' Load Profiles

Sum of Energy measured by each Smart Meter

Probable energy fraud

Between 9.00 am to 6.00 pm the difference between the 2 curves is greater than the expected technical losses: a verification on field is needed

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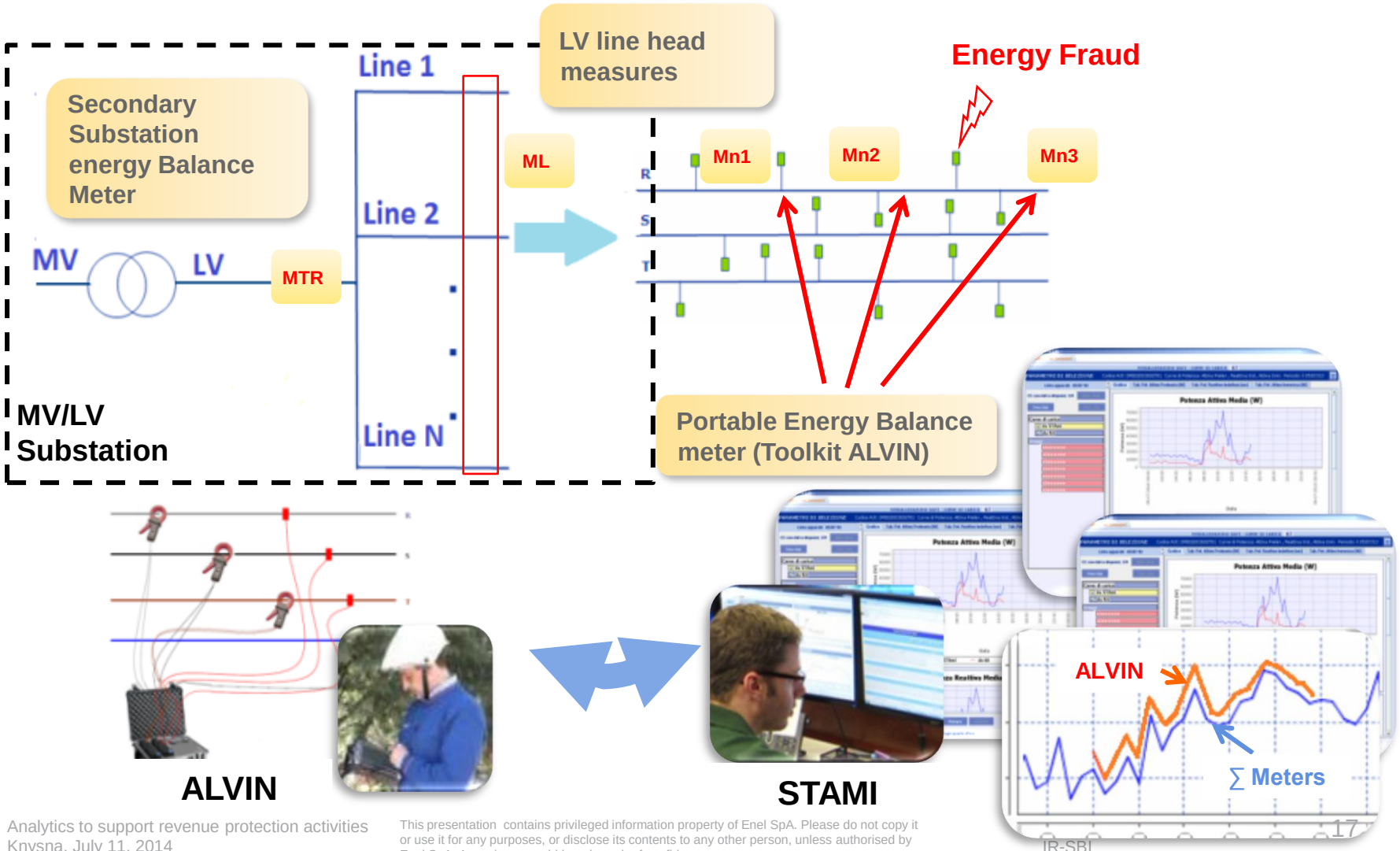
Focus on Energy Balance
Applications of Toolkit Alvin on field



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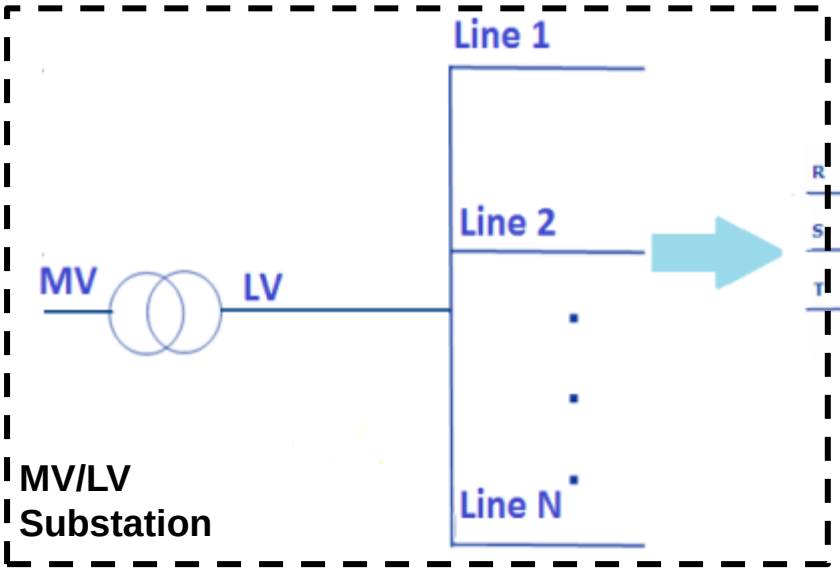

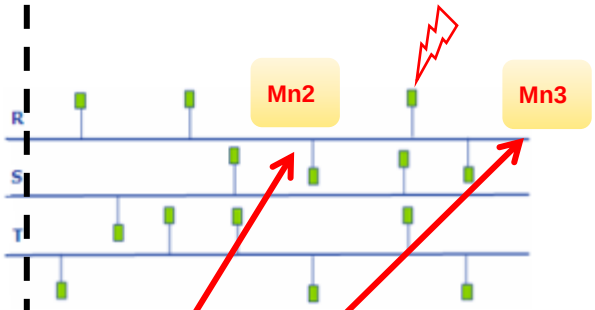

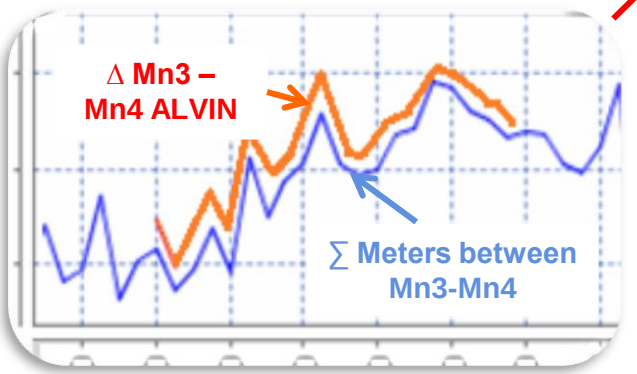

Δ higher than the expected technical losses: audit required

Optimization of fraud detection costs and improvement in its effectiveness

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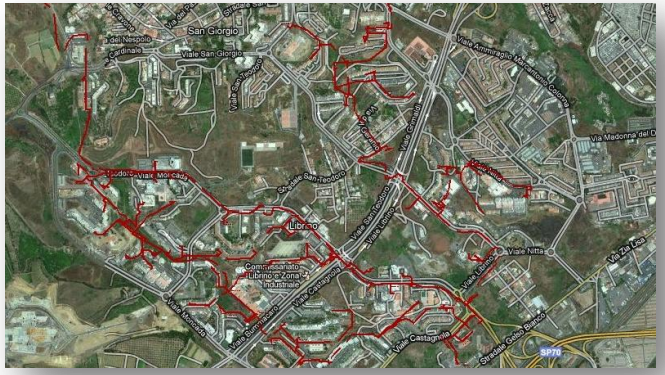
Focus on Energy Balance
Some results

Palermo: Zen 1 e Zen 2 districts

20 subst. MV/LV (10.5 MVA)

3.519 LV customers
114 tampering detected

Catania: Librino District



123 subst. MV/LV (47.9 MVA)

18.075 LV customers, 509 tampering detected

Key tactics:

- **collaboration with law enforcement in risky areas**
- **always prosecute the fraudulent customer**
- **AMI tools increase the effectiveness**
- **Audits are always necessary**

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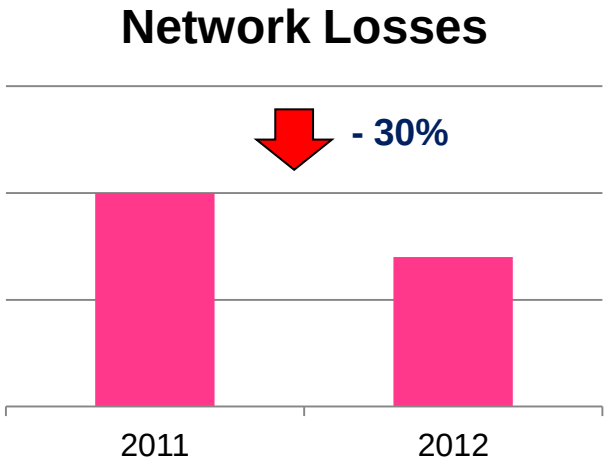
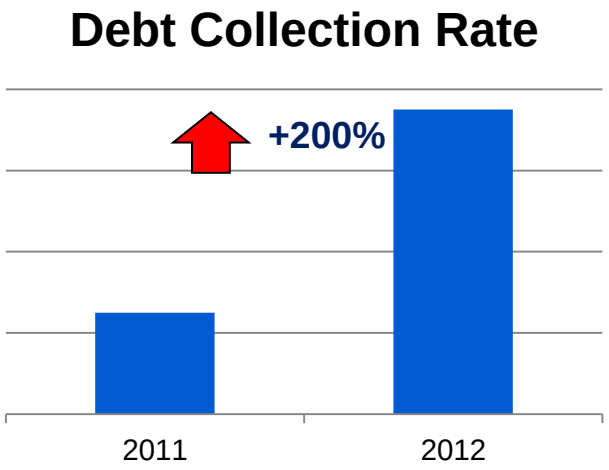
Focus on other European countries

EPCG experience in Montenegrin republic

EPCG is the energy company in Montenegro, distributing electricity to over **600.000 people through 360.000 meters.**
Major challenges in 2009:
•**losses were 23%**
•**collection rate less than 90%**
EPCG started implementing an **AMI solution in 2011**. **ENEL supplied** the smart meters and data concentrators.
In **2012** more than **70.000 meters** were in operation and first measures of the project KPIs indicate that results are very encouraging.
Ghost customers, incorrect meter constants and CT maintenance, pending starts, new meters related issues are tackled by AMI implementation.





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The SHAPE Project

Description and Main Features

Shape is the Enel **Web Business Analytics Platform** for advanced analysis of load patterns collected from Enel's smart meters by the AMM "Telegestore".

Main Features

- Load patterns Basic Statistics Analysis and coverage
- Energy Flows Analysis
- Load-based Customer Segmentation & Classification
- Load Prediction
- Non-Technical Losses & fraud support detection

Enel

Smart Meter

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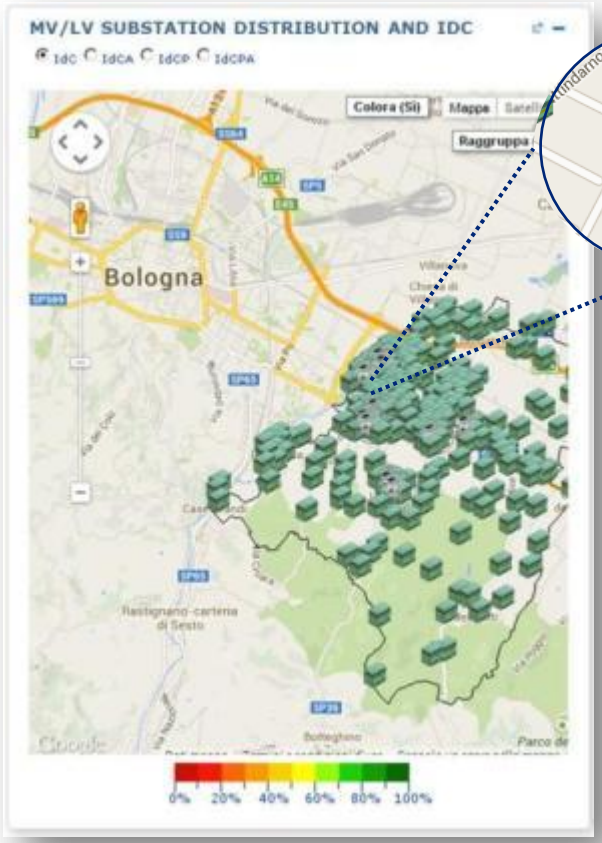
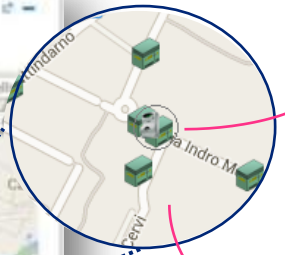
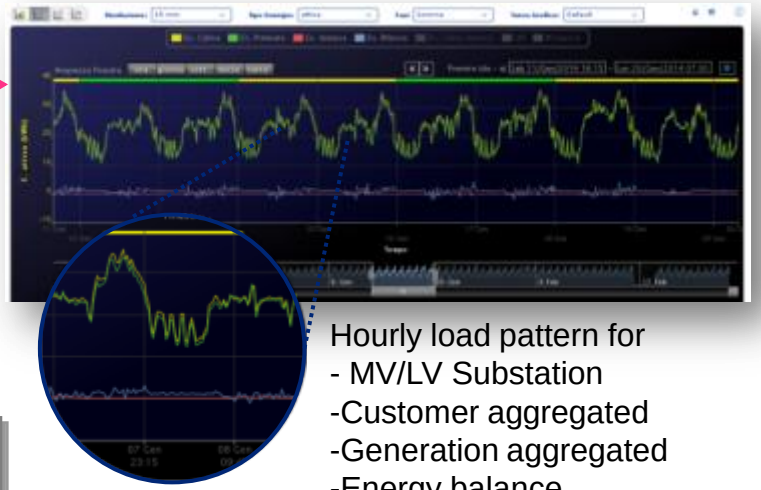
The SHAPE Project

Energy Flows and Customer Segmentation

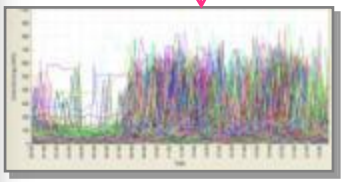




MV/LV Subst. Energy flows analysis

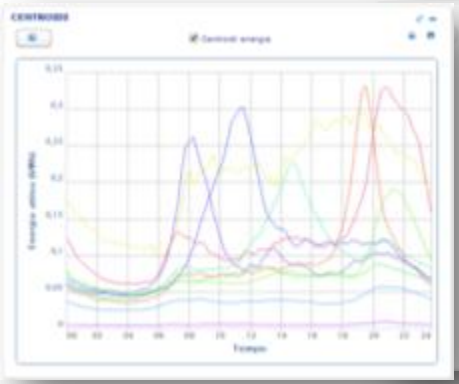


Hourly load pattern for
- MV/LV Substation
-Customer aggregated
-Generation aggregated
-Energy balance



Clustering

Customer segmentation



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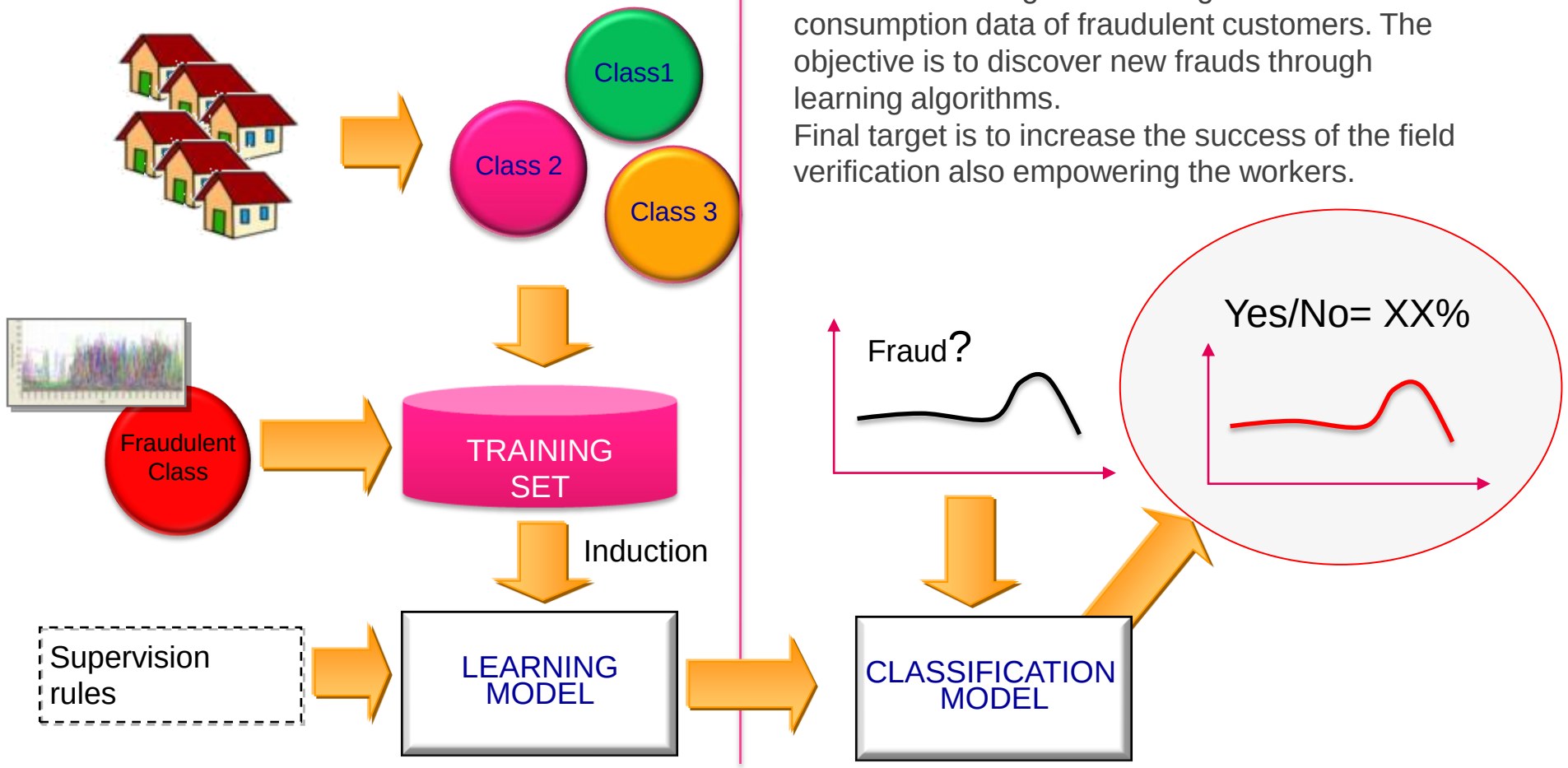
The SHAPE Project
Frauds identification

Macrocategory



Load consumption patterns divided by class are fed to the learning model alongside the load consumption data of fraudulent customers. The objective is to discover new frauds through learning algorithms.
Final target is to increase the success of the field verification also empowering the workers.

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Executive Summary

Final remarks from Enel experience:

•AMI implementation is the starting item of innovation in electricity distribution

•Data from AMI must be properly gathered, prefer robustness to real-time

•Data must be properly presented to the users: both employees and workers should be empowered and made aware of the ongoing change

•Prepare simple reports available to the field technicians to enable them to support every decision with solid case

•In a “distributed factory”, reliable analytics make the difference between success and failure

•Continuously improve and innovate to better serve the community

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