i - EM

intelligence in Energy Management

Improving the efficiency of self-consumption in home using forecasting production data

Eng. Ciro Lanzetta, Head of Technology Unit, i-EM

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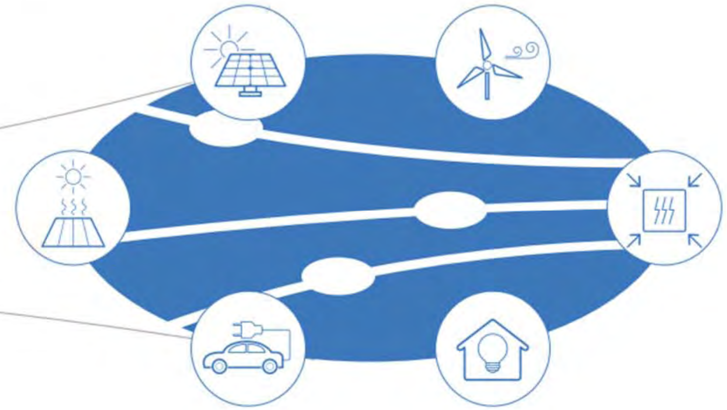
Energy@home

Summary

- **About i-EM**
- **Tecnological challenges**
  - **Smart grid and Energy Efficiency**
- **The potential**
- **Forecasting**
- **i-EM in Energy@home**
- **Residential Architecture**
- **Trial results**

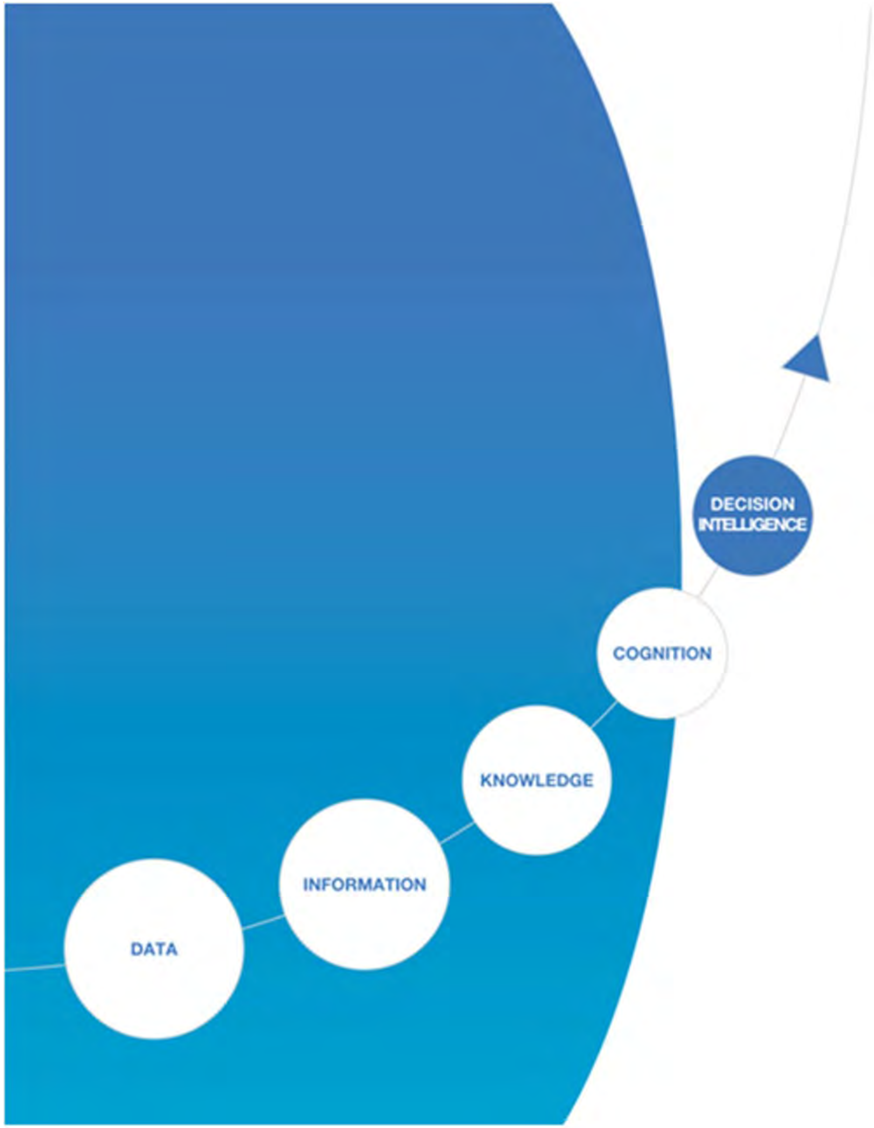


i-EM: about us

i-EM is a Company that operates in renewable sector since 2005, developing **Business intelligence solutions for Energy Management**.

Field of application:

- **distributed generation** from renewable sources
- **smart grid** and **energy storage** systems
- **energy efficiency**, control and optimization of energy consumption
- **electric vehicles** and sustainable mobility



Mission

To make intelligent any generation, storage, transfer and energy exploitation

Vision

To drive energy users from “**rough data**” through “**knowledge**” to the “**best decision**”

Awards and initiatives 2013 / 2014

May 2013 - i-EM won first **Enel Lab Competition**.

Enel Lab aims to foster innovation in the energy sector by developing all possible joint activities with Enel's core business.

December 2013 – i-EM was selected from **Italy Cleantech Network** as one of the 10 most innovative startups

February 2014 - i-EM has been identified by **Italia Camp** as one of the most interesting Italian startups (Wall Street NYC).

May 2014 - i-EM has been identified for the the **European Cleantech Challenge**, aimed at supporting the best cleantech startups from European countries.

i-EM Solutions

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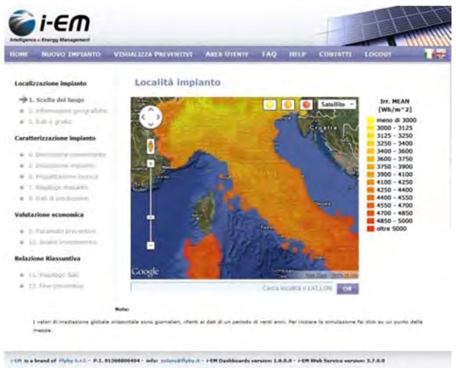
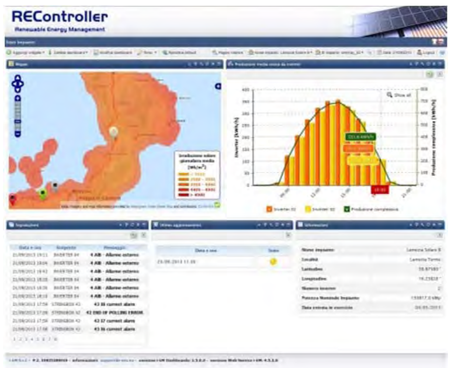
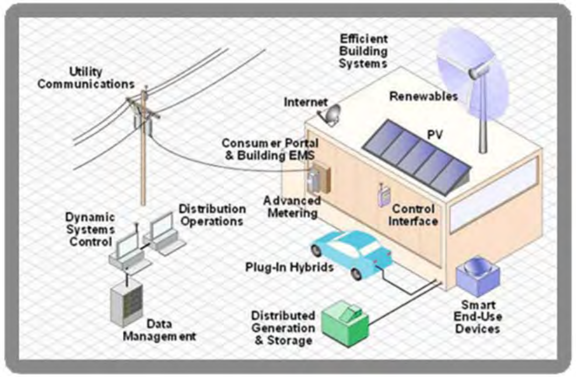
REPlanner Renewable Energy Planning	REController Renewable Energy Management	E2M Energy Efficiency Management	RES2Grid Renewables To Grid
Integrated web-satellite system dedicated to the feasibility analysis and economic simulation of RE plants	The system for remote supervision and management of renewable energy plants	The integrated solution for the monitoring and the active management of energy efficiency	DSS for VPPs, smart micro-grids management and Distributed Energy Resources optimal grid integration

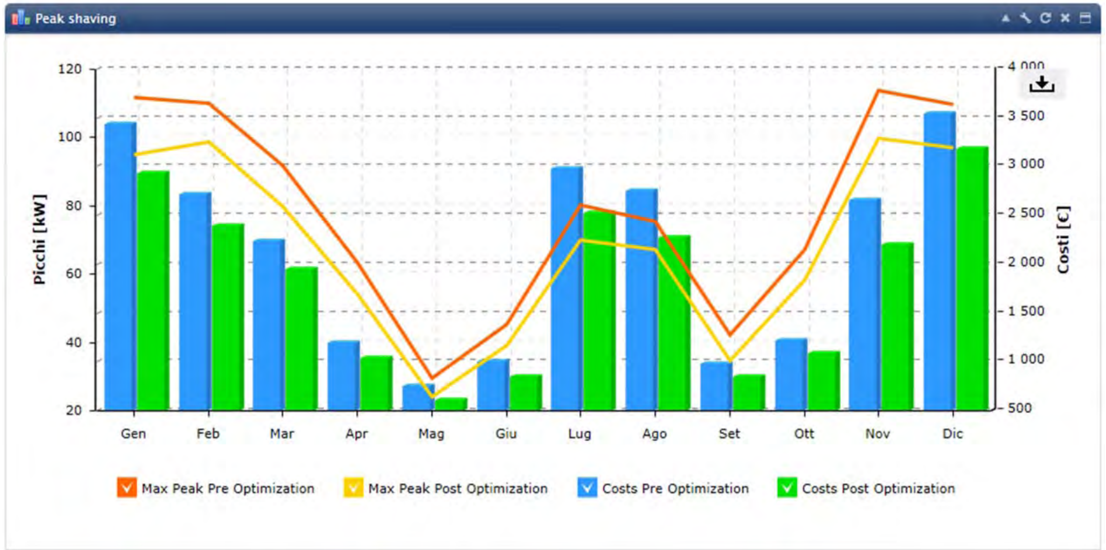




Our intelligent energy management solutions are completely customizable on demand and are provided as **SaaS (Software as a Service)**

Tecnological challenges





The **Smart Grid** is an electricity network interactive and intelligent

Energy Efficiency is the possibility to satisfy the same demand for service with a lesser amount of energy

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How to reduce / optimize consumption?

To achieve this, we turn to the use of efficient technologies, management and optimization of user behavior and communication of information

Technologies

Reduce

- Heat pumps
- Smart appliances
- Smart plugs
- Efficient lightening

....

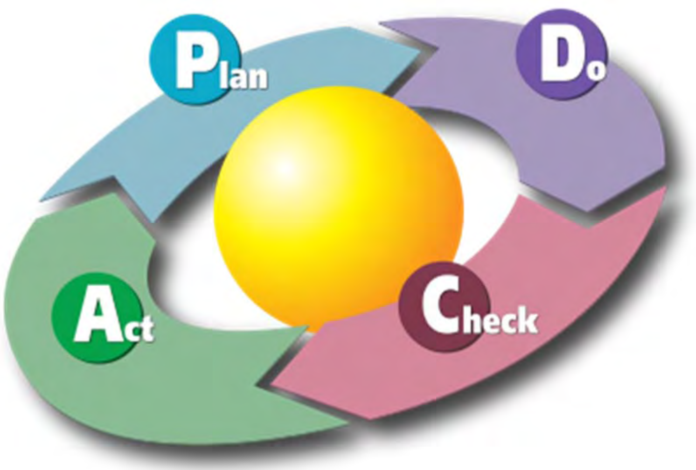
Optimize → Self consumption

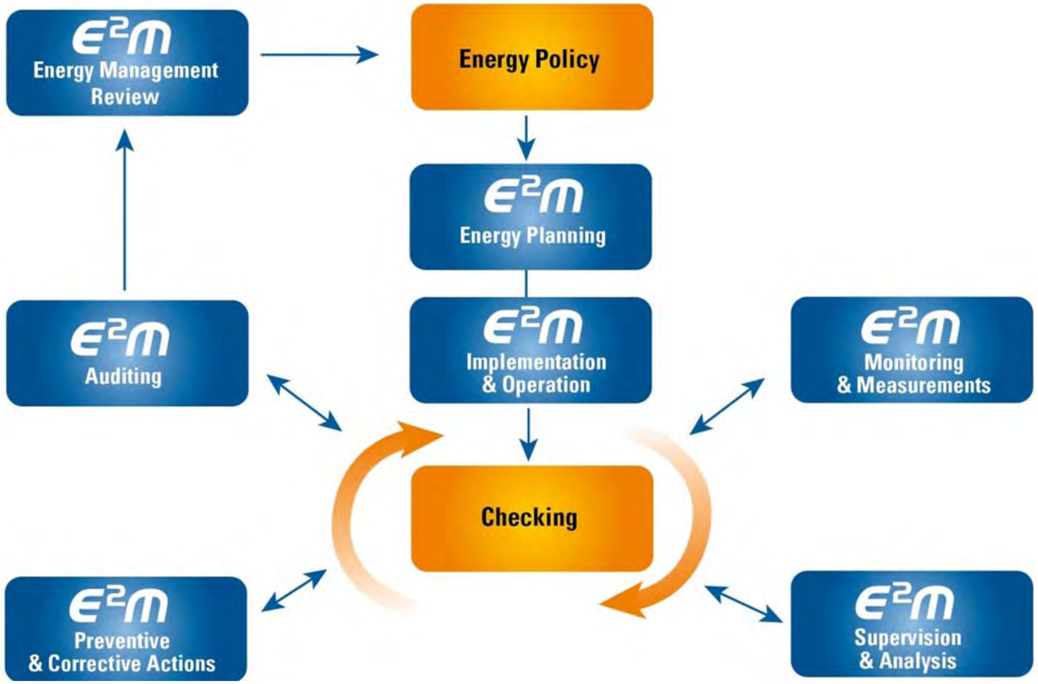
- PV production
- Storage systems
- Forecasting

ISO 50001 ➔ Energy Management System (**EMS**)

Easily integrated with other management systems already present in the organization.

Approach Deming cycle (**PDCA**: Plan, Do, Check, Act) "systemic" aimed at the continuous improvement of the energy performance of the organization.





The potential

The potential 'theoretical' **energy savings** associated with the adoption of the 2020 technologies for energy efficiency in the areas analyzed is approximately 297 TWh, compared to a **potential "expected"** amount to **94 TWh**

≈6% consumi nazionali

≈11% consumi nazionali

SETTORE	RISPARMIO TEORICO		RISPARMIO ATTESO	
	Elettrico [TWh]	Termico [TWh]	Elettrico [TWh]	Termico [TWh]
INDUSTRIA	26,2	74	11,6	16,5
RESIDENZIALE	8,6	157,4	4,5	47
TERZIARIO	9	22	4,5	9
TOTALE	44	253	21 (48% del teorico)	73 (29% del teorico)

Source "*Energy Efficiency Report*" Dicembre 2013, Energy & Strategy Group

In residential a massive use of more efficient technologies make it possible to achieve reductions in consumption up to **12 %** by the year 2020. **Source ENEA**

Benefits (residential)

	ADDED VALUE	€ / year
Quantifiable	**Optimal self-consumption of generated energy** *from 40% to 70%*	100 – 280
	Overload control: lower max contractual power *from 4.5 kW to 3 kW with same energy consumption*	190-240 (*)
	Energy awareness: self-optimization of energy consumptions *-5% / -10% consumption*	37 - 70
	Dynamic pricing schemes: reduction of cost	In the future
Non Quantifiable	**Low impact in installation (wireless)**	
	Greater comfort thanks to overload control	
	Ready to internet connection	

Cost estimations based on average consumption in Italy 2.700 kWh/anno, tariff «maggior tutela», data from trovaofferte AEEG

(*) 190 € for a consumption of 4047 kWh/year, 240 for 2700 kWh/year

From Energy@home presentation, April 2013

Benefits (residential)

ADDED VALUE	€ / year
Optimal self-consumption of generated energy *from 40% to 70%*	**100 – 280**

How to increase the self consumption?

Storage Systems

Forecasting

Forecasting

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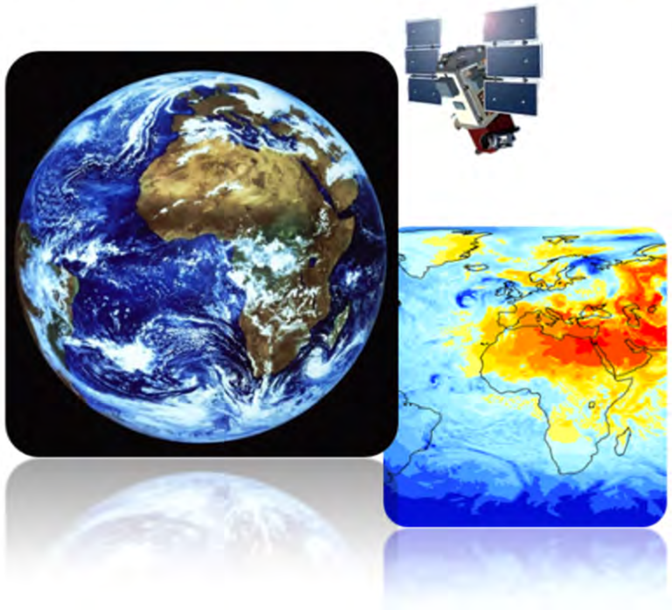
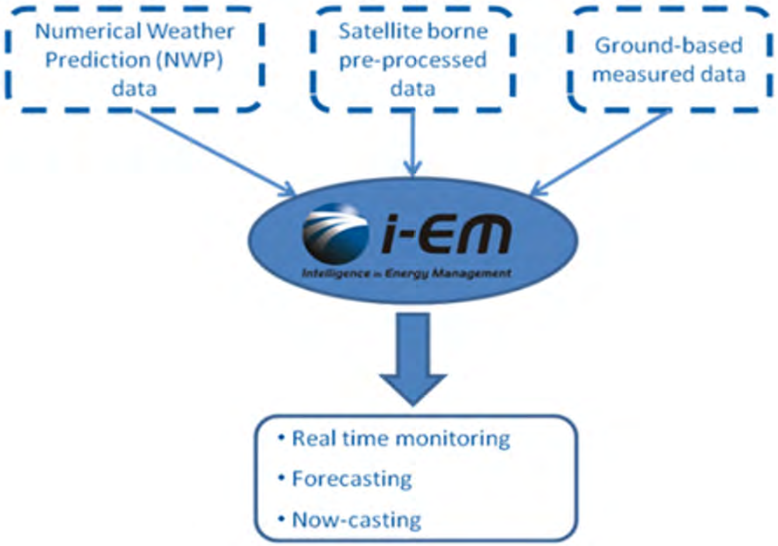
In order to support the improvement of the electric grid reliability and sustainability, i-EM developed PV-Forecasting. The service provide:

- accurate and locally-detailed forecasts of photovoltaic (PV) plants energy production
- hourly AC energy yield data predicted for the next 72 hours
- forecasts constantly updated every 3 hours

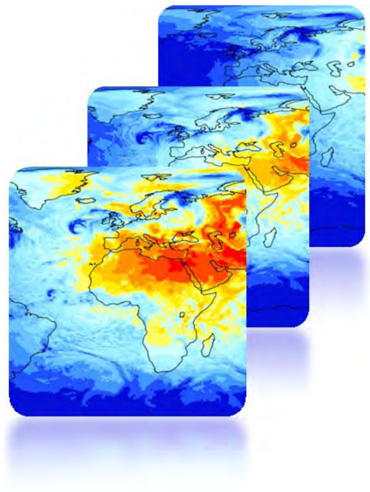




Forecasting

Key value added values:

- Real-time satellite data processing and data fusion techniques
- Accurate mathematical deterministic modelling
- No need of in-situ installed devices (dataloggers or sensors)
- Near real-time elaboration and AI post-processing
- Open, modular and highly interoperable IT system architecture



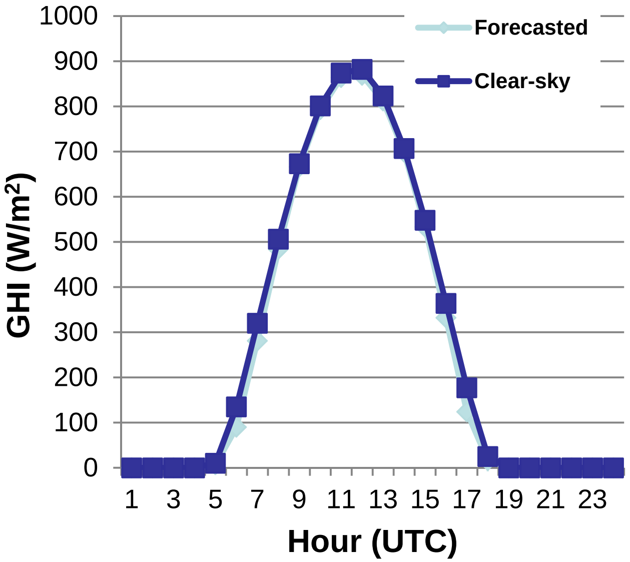
Forecast Reliability Index (FRI)

- FRI is a daily index (values from 0 to 100%) that indicates the reliability of the forecasts provided and that is related to the variability of the meteorological conditions.
- FRI is calculated comparing the daily GHI forecasts (for 0-24h, 24-48h and 48-72h) with the results of PV-F’s model for the daily behavior of clear-sky GHI.

Forecast Reliability Index: examples

Near clear-sky case

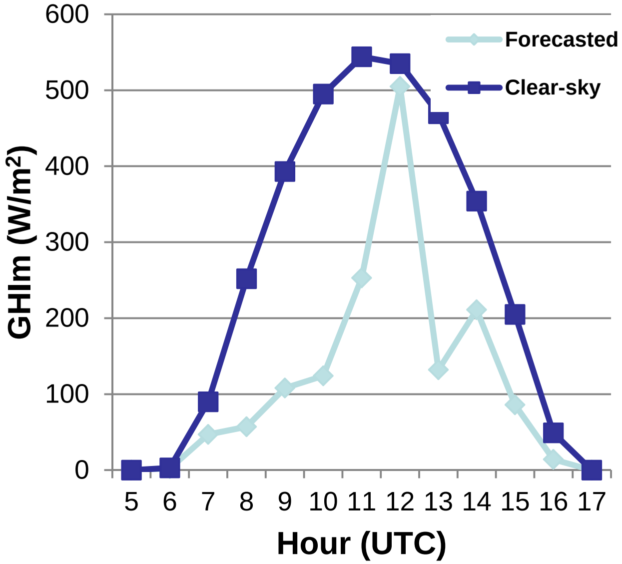
Baucina, August 29th 2012



FRI = 96.14%

High variability case

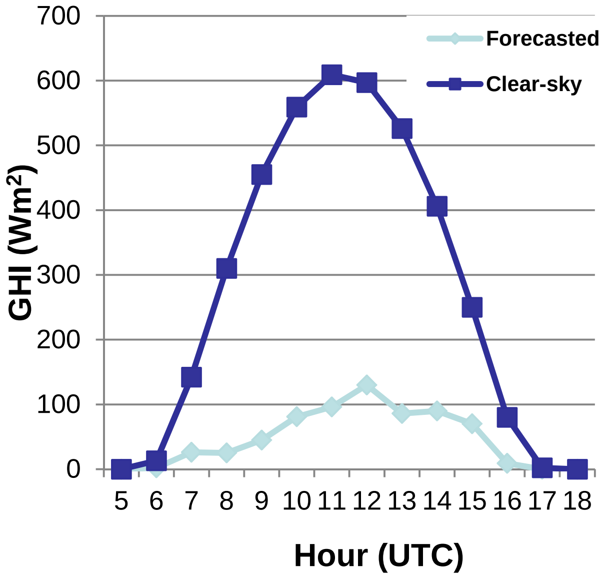
Baucina, November 15th 2012



FRI = 25.63%

Fully cloudy case

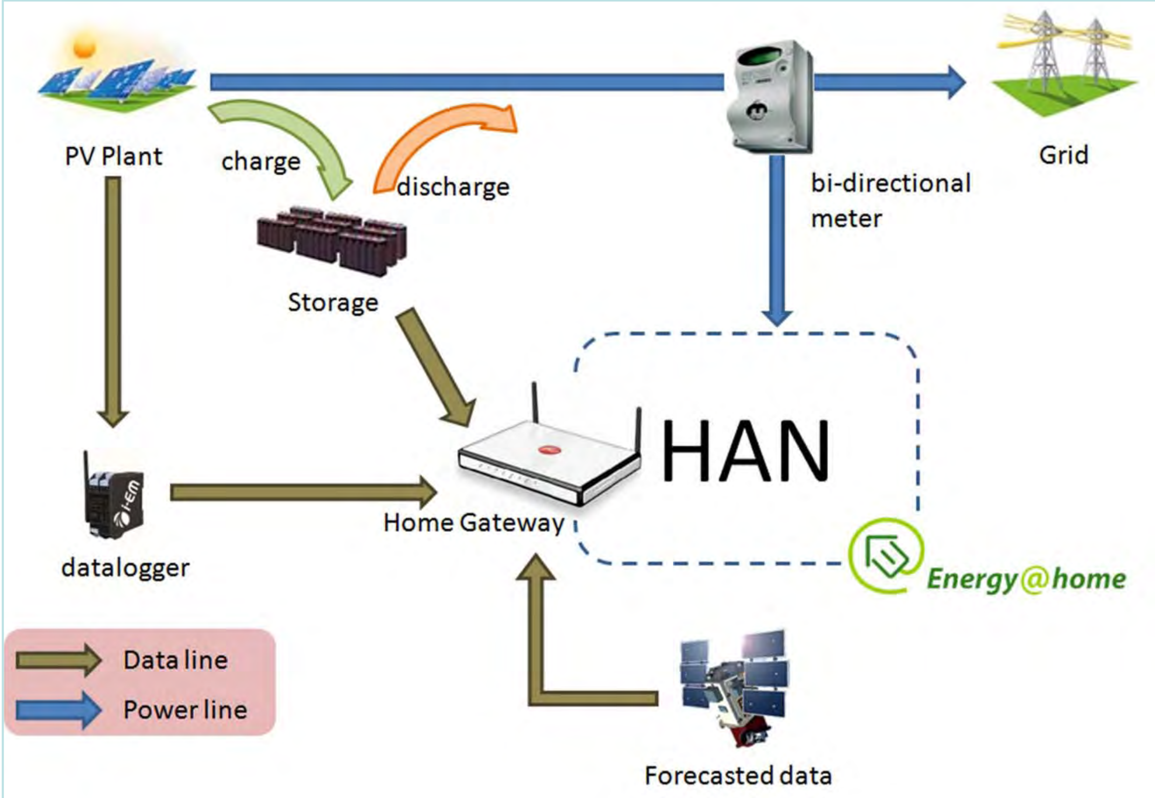
Baucina, November 3rd 2012



FRI = 86.08%

i-EM in Energy@home

i-EM is associated to **Energy@Home** (www.energy-home.it)



i-EM is responsible for the use case: "**Energy production / storage Use Case**“ and partecipate (with Enel Distribuzione and ST Microelectronics) to the use case: “**EV Recharging**”

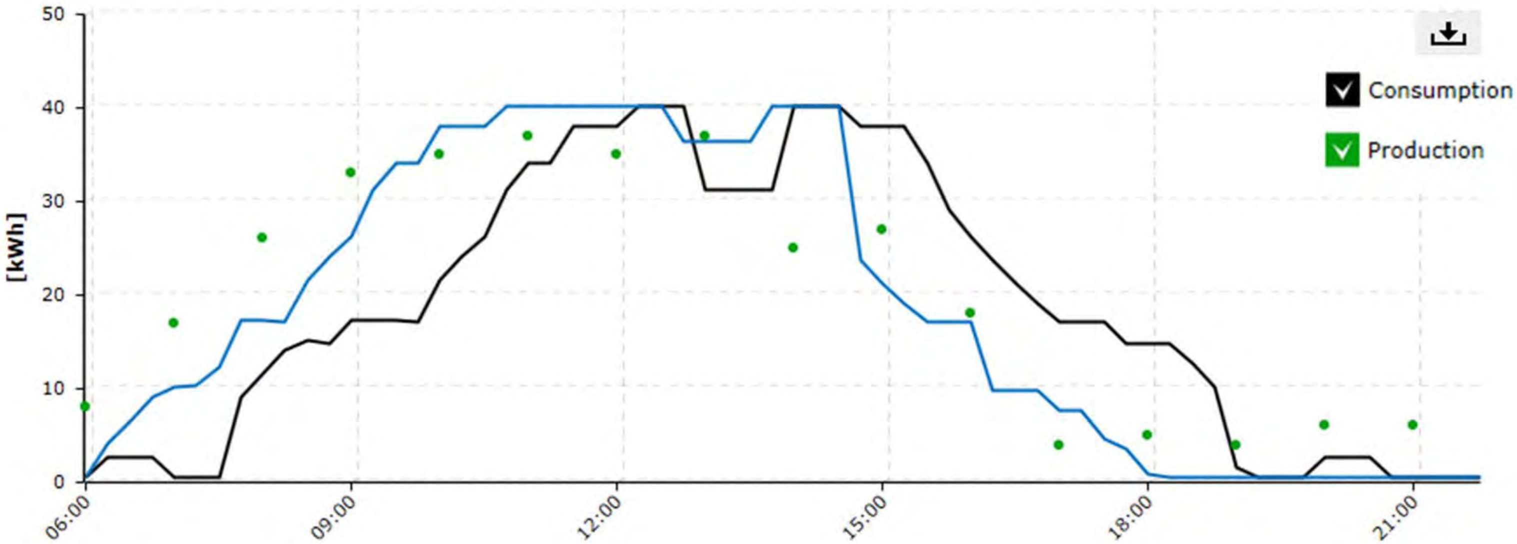
Energy production / storage Use Case

Scope

The goal of this use case is to integrate the production from domestic photovoltaic (PV) plants and the storage systems that could be linked to a PV plant in the Energy@Home architecture.

Objectives

a. Monitoring system for all the significant quantities related to the production system, through a user-friendly interface;
b. Tuning of the appliances timing algorithms using information about current and forecasted energy production



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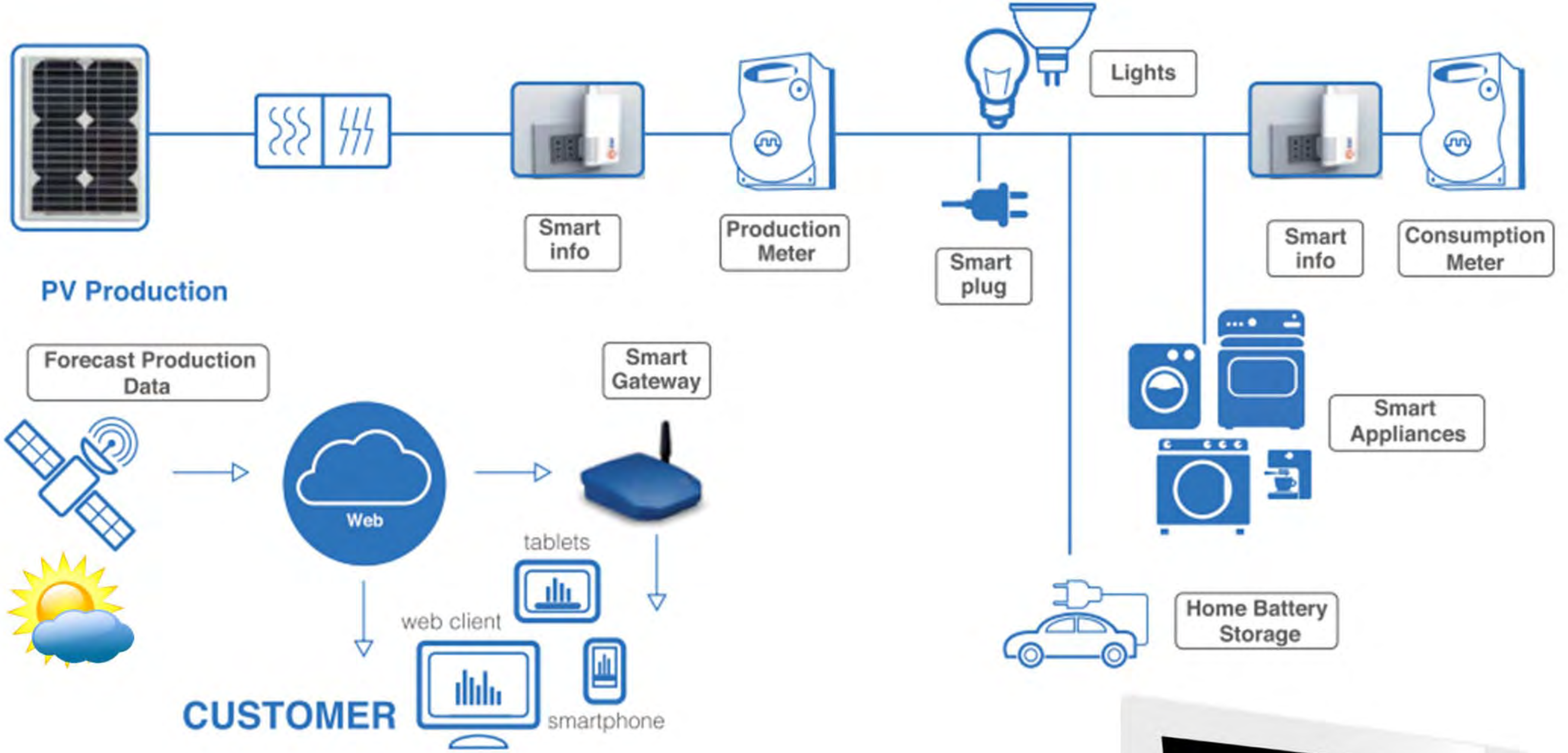
i-EM partecipated to Energy@home demo in **Amsterdam** (Utility Week 15-17 October 2013)

European Utility Week

Energy@home

Residential architecture (extended)



E@Home Demo Interface

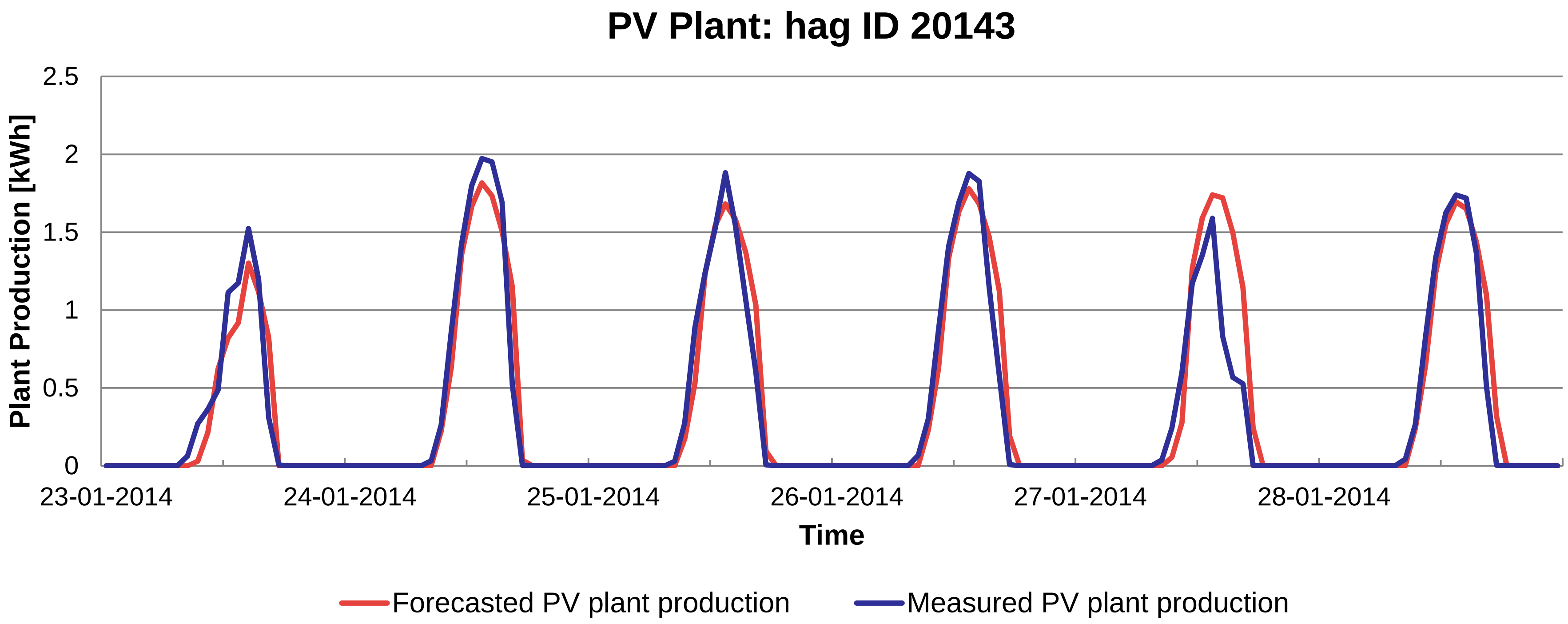
Energy@home interface 1/2

Energy@home interface 2/2

PV-power forecast trial

Trial of forecasting service on **21 residential PV-plants** all over Italian territory, different for size and PV-modules characteristics.

Good agreement between forecast and measured power production



PV Plant: hag ID 20143

Measured and forecast plant production comparison:

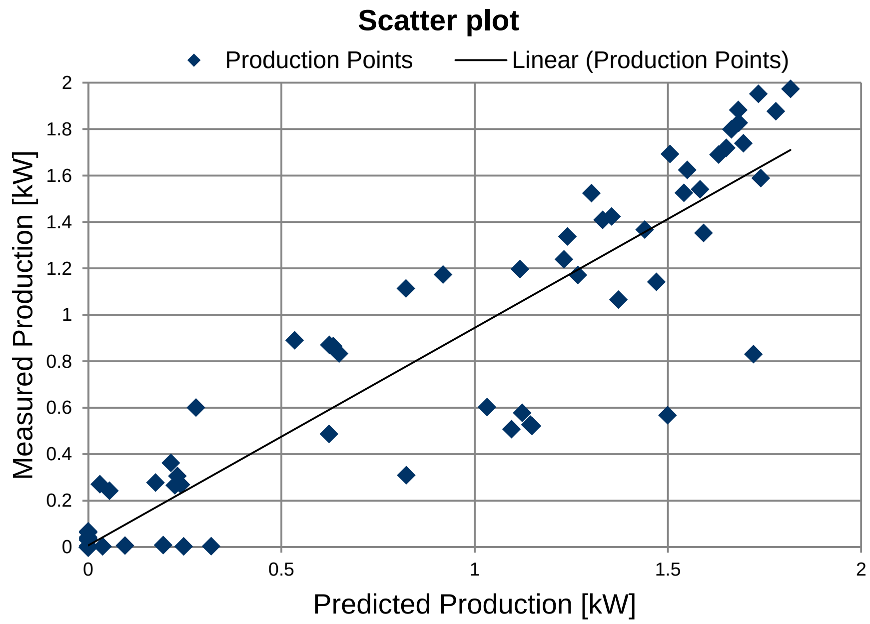
Errors:

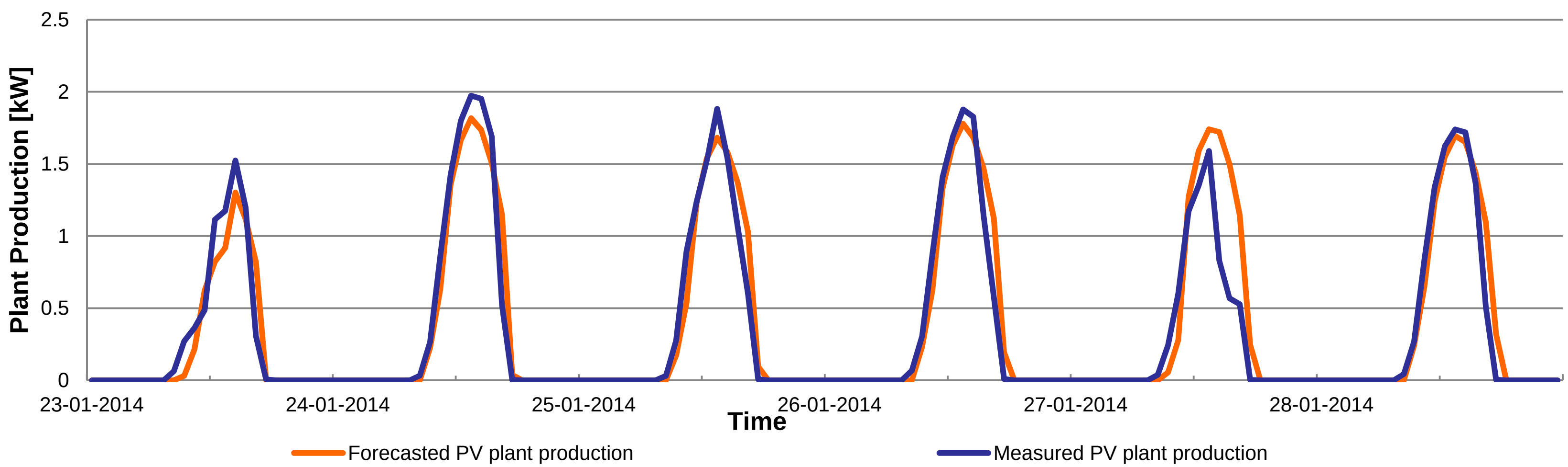
RMSE = 0.35 kWh

NMAE ≅ 10% (Pni = 3kW)

Correlation Coefficient:

R^2 = 0.9086





PV Plant: hag ID 153

Measured and forecast plant production comparison:

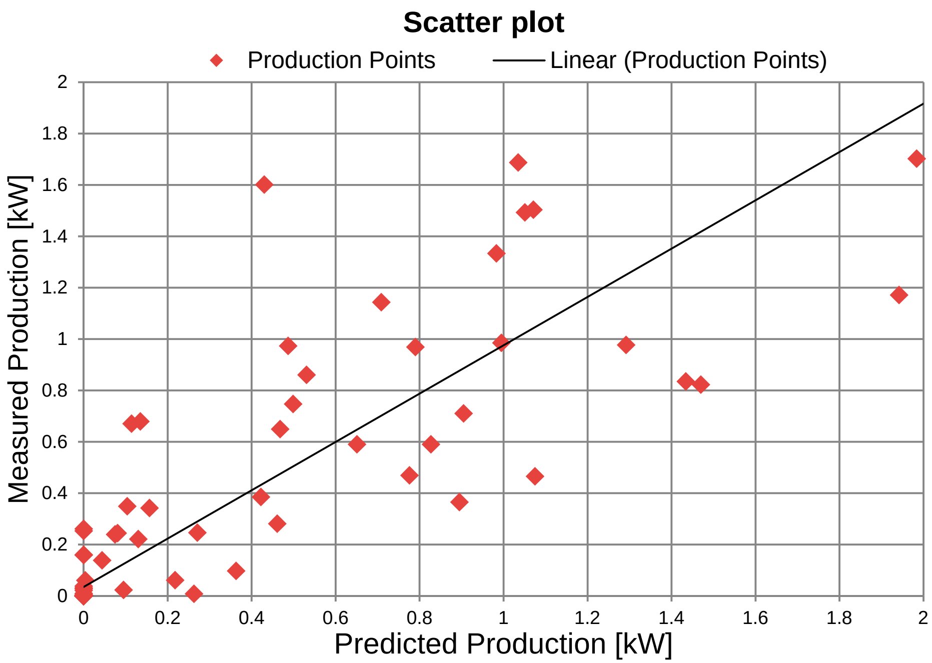
Errors:

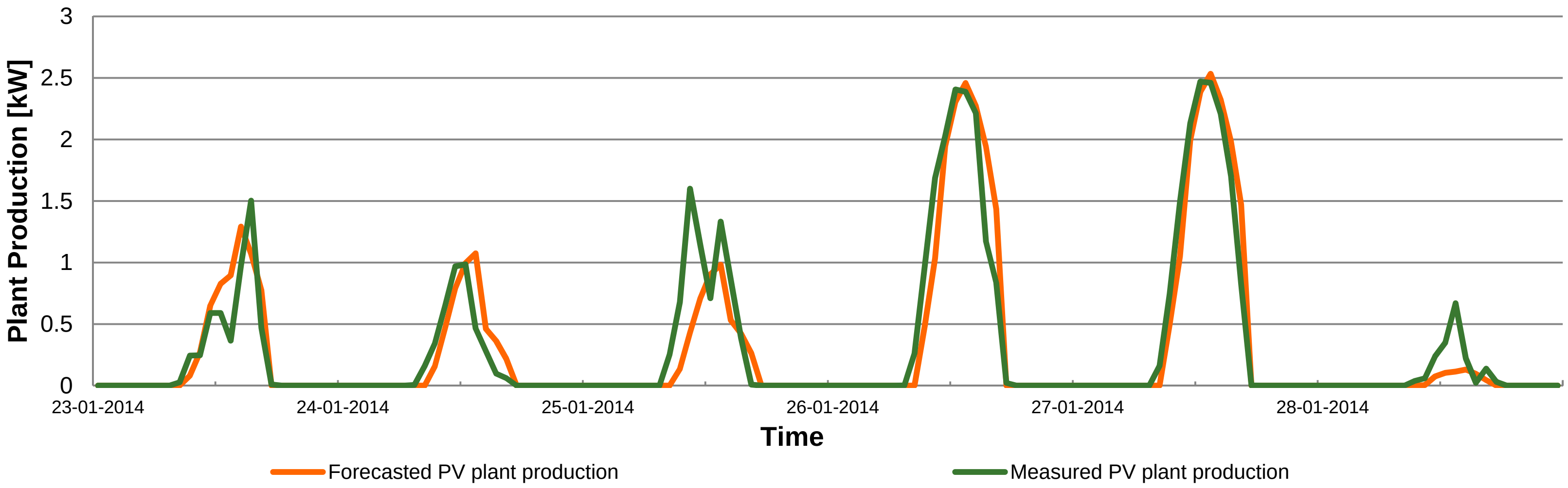
RMSE = 0.52 kWh

NMAE ≅ 15% (Pni = 3kW)

Correlation Coefficient:

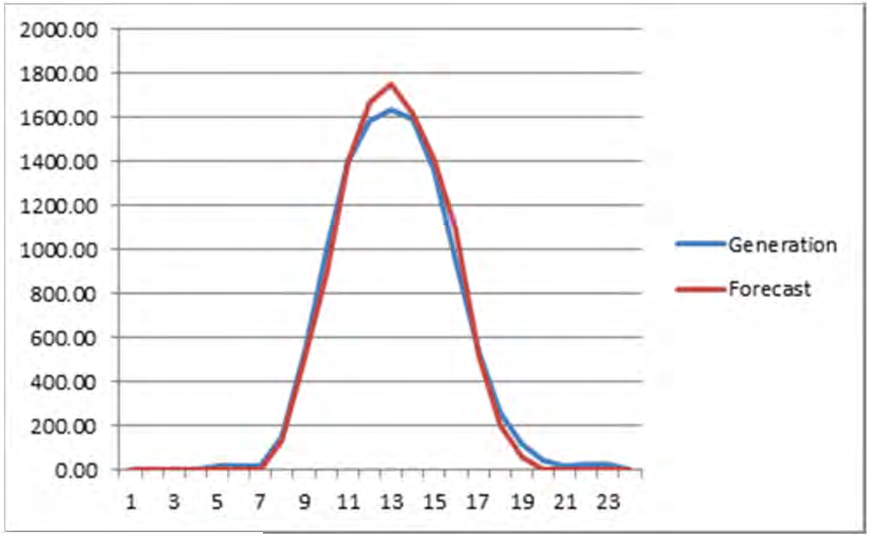
R^2 = 0.8849

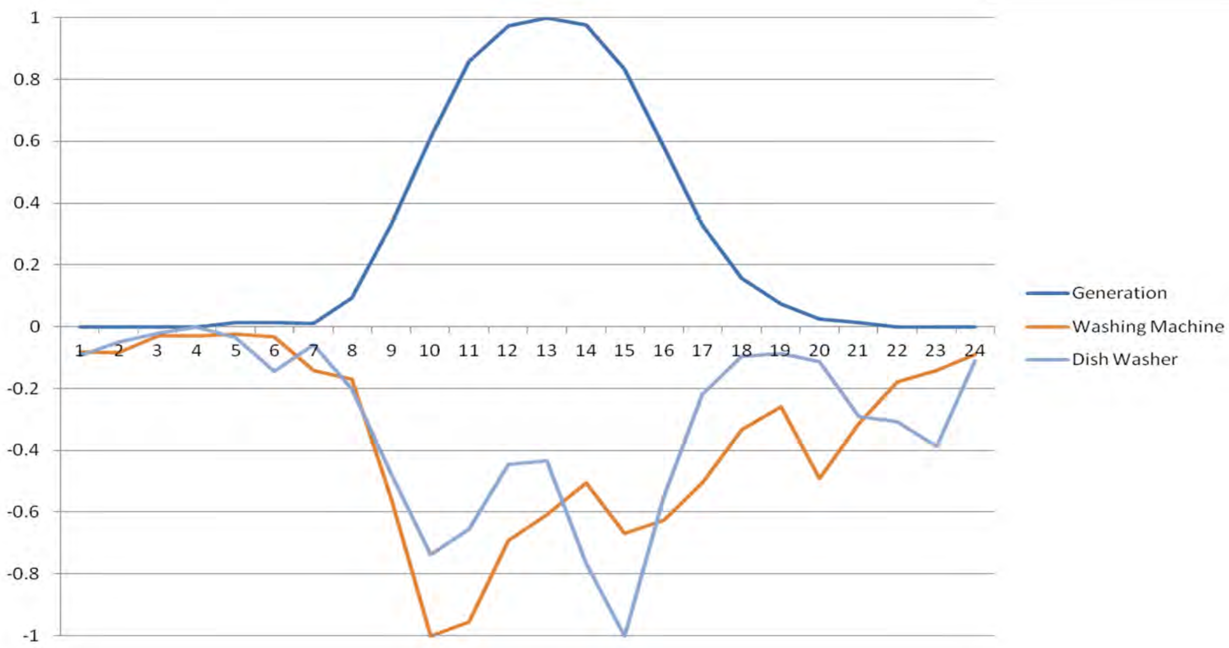




Trial comments

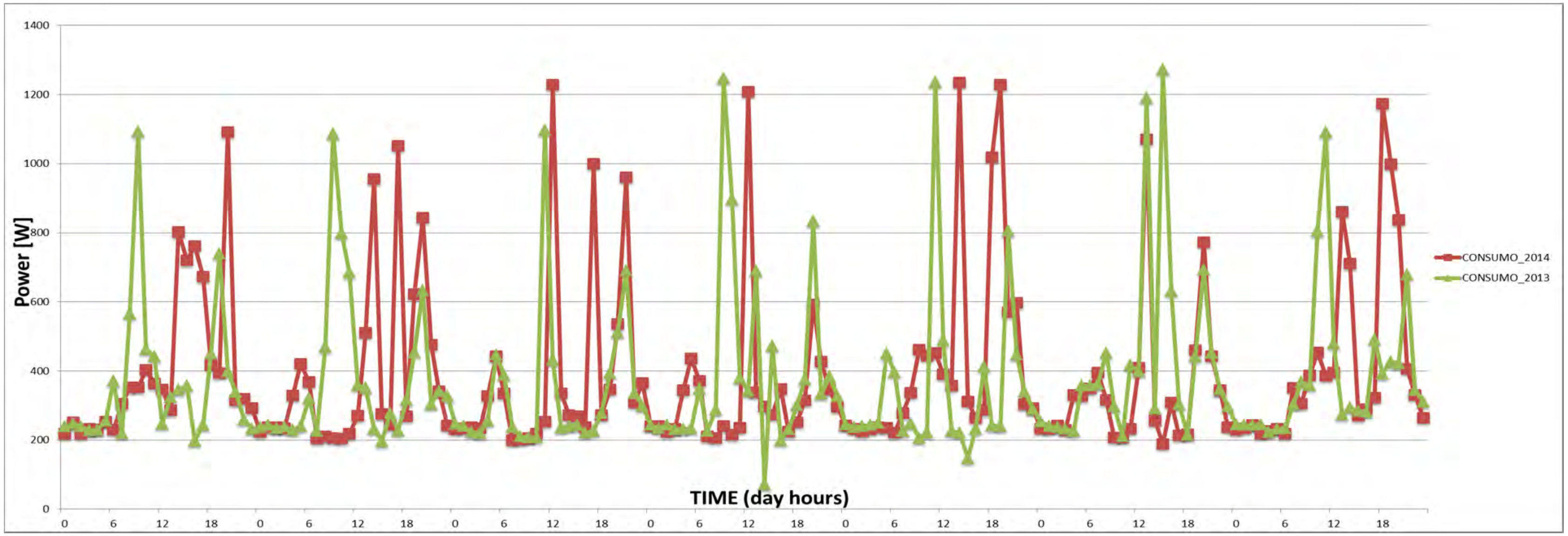
Good agreement between forecast and measured power production



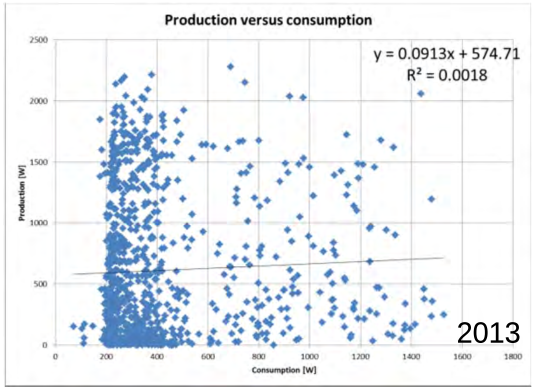


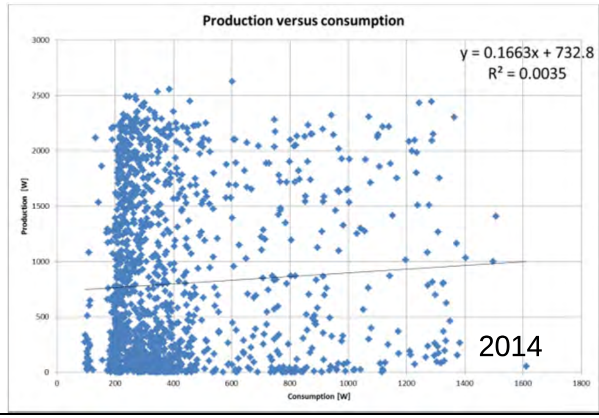
Change in user behavior

2014 consumption (**red**) moved to higher prod hours wrt to 2013 (**green**)



In fact, the coefficient of determination between consumption and production increased twofold, suggesting an better awareness of energy savings routine.





Conclusions

- Energy efficiency **technological challenge**
- Great potential for **energy savings** also in residential sector
- Most of the **technologies** are **mature** for the market
- The **distributed generation** is becoming more widespread

↓

The use of forecasting production data can improve the efficiency of self-consumption in home

Thanks for your attention

i-EM contact points:

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www.i-em.eu

Visit Energy@home boot to enjoy the demo!

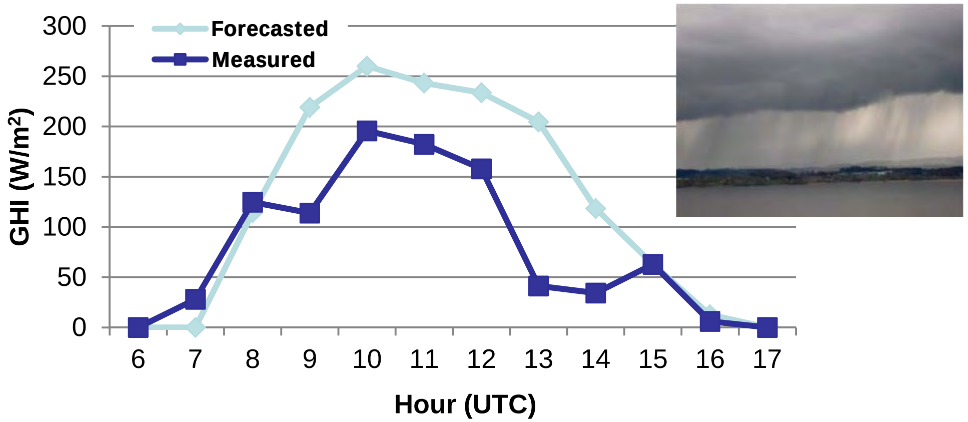
BACKUP

Forecast 0-24h results

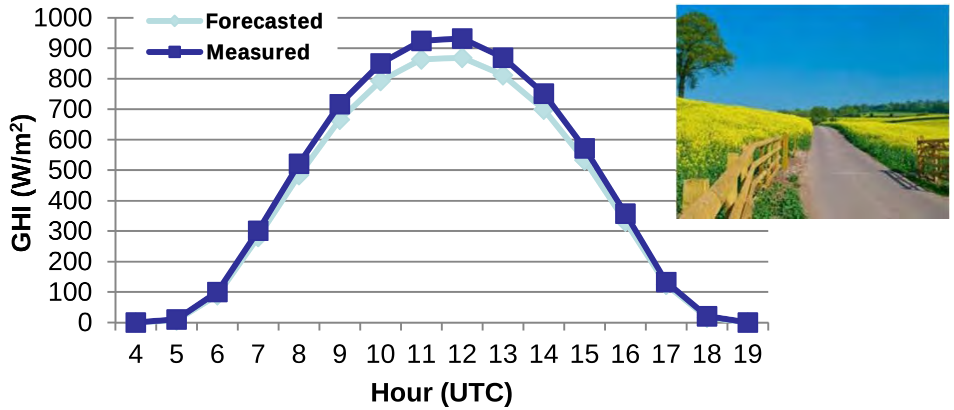
The 0-24h predictions of the PV-Forecasting service currently have an accuracy that ranges from 5-7% (best case) to 10-12% (worst case).

The variability of PV-FC's accuracy is due to the strongly dependence that NWP forecasts, the basic inputs for PV-FC, have on meteorological conditions:

- in periods with many weather discontinuities and turbulences (like in winter), NWP predictions generally have a worse accuracy



- in periods when the meteorological conditions are much more stable (like in summer), there is a consequent better accuracy in NWP forecasting



Trial comments

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