



Optimal real-time data treatment and displaying in power system operation in Spain

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RED ELÉCTRICA
DE ESPAÑA



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Introduction





INTRODUCTION: WHO IS RED ELÉCTRICA?

Red Eléctrica de España (REE) is the Spanish transmission system operator (TSO)

System Operation:

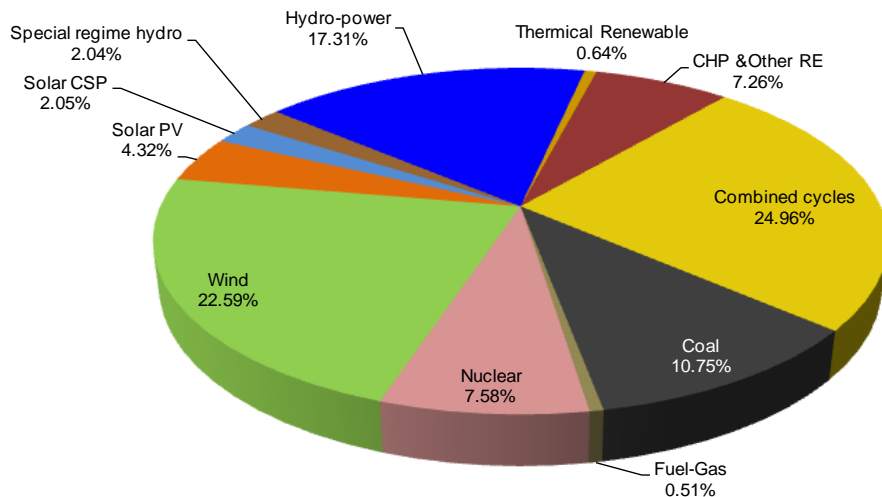
- ❑ *Operate the grid & coordinates its uses with the generation facilities in order to ensure the security and continuity of the electricity supply.*

Transmission (Since 2007 as exclusive transmission company):

- ❑ *The development and the maintenance of the transmission facilities*
- ❑ *Provide maximum service reliability*
- ❑ *~ 41,000 km of lines and 78,000 MW of transforming capacity*



INTRODUCTION: INSTALLED CAPACITY AUGUST 2013



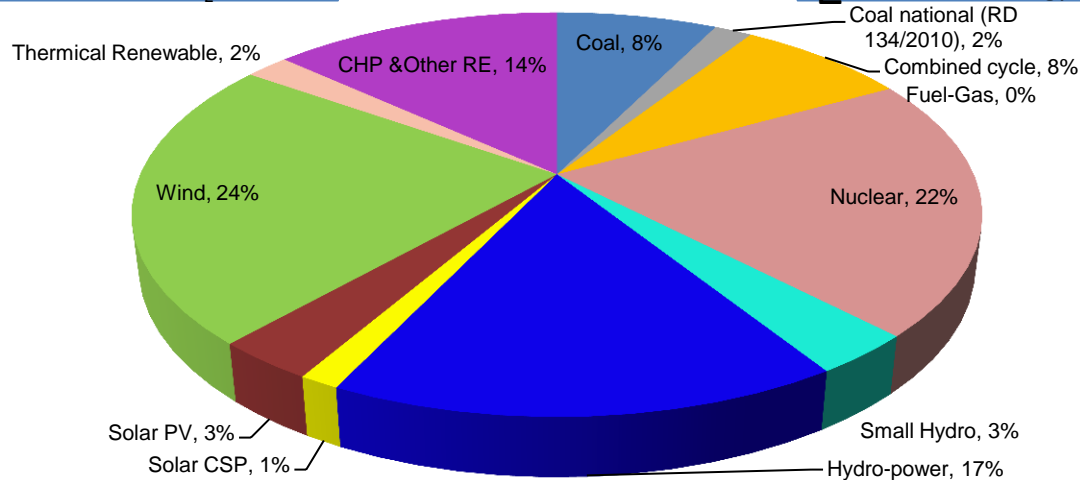
Technology	MW	%
Combined cycles	24947	25.0
Hydro-power	17303	17.3
Coal	10740	10.7
Nuclear	7572	7.6
Fuel-Gas	506	0.5
Total (ordinary regime)	61068	61.1
Wind	22573	22.6
CHP & Other RE	7252	7.3
Solar PV	4313	4.3
Special regime hydro	2039	2.0
Solar CSP	2050	2.1
Thermal Renewable	639	0.6
Total (special regime)	38866	38.9
Total	99934	



DEMAND SUPPLY 2013 (FROM 01/01/2013 TO 01/07/2013)

Σ Energy without emissions CO₂ \approx 72%

Σ Renewable Energy \approx 50%





INTRODUCTION

- ◆ REE demands a constant flow of Real-time Data, such as:
 - ◆ System Frequency
 - ◆ Active & Reactive power of generation units **(more than 2.800 units, most of them belonging to the Special Regime –Renewable Energies- and distributed all around Spain)**
 - ◆ Voltage values of Transmission Network
 - ◆ Active & Reactive Power Flow values through the Transmission Lines
- ◆ The complex nature of this process implies the availability of high capacity telecommunications and computerized systems which display the information received in real time from all the facilities and participants of the electrical system.
- ◆ This requires of REE's control system, the management of more than 220.000 variables (90.000 analogue and 130.000 digital) at intervals of 4, 8 and 12 seconds and the ability to issue remote control instructions through 40.000 signals.



INTRODUCTION

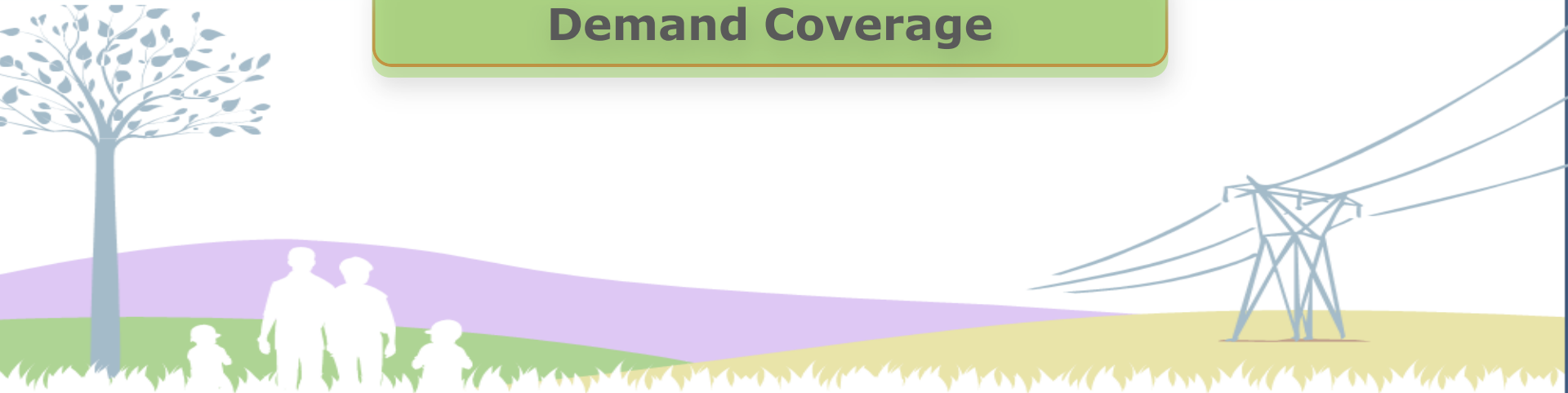
- ◆ All this information must be easily available in order to help the system operator to make optimal decisions, hence the interest of REE in data management.
- ◆ System Operator retrieves all this data through the SCADA System. Which provide a sufficient graphical representation.
- ◆ However a more complex both real time and historical data treatment and graphical representation, requires other specific tools.

PI DataLink provides an easy way to retrieve to Real-time and Historical Data using a friendly interface via Excel

For the time being, Spanish TSO, retrieve through PI DataLink only 12.454 tele-measurements, most of then related with Renewable Energies and involved in automatic processes.

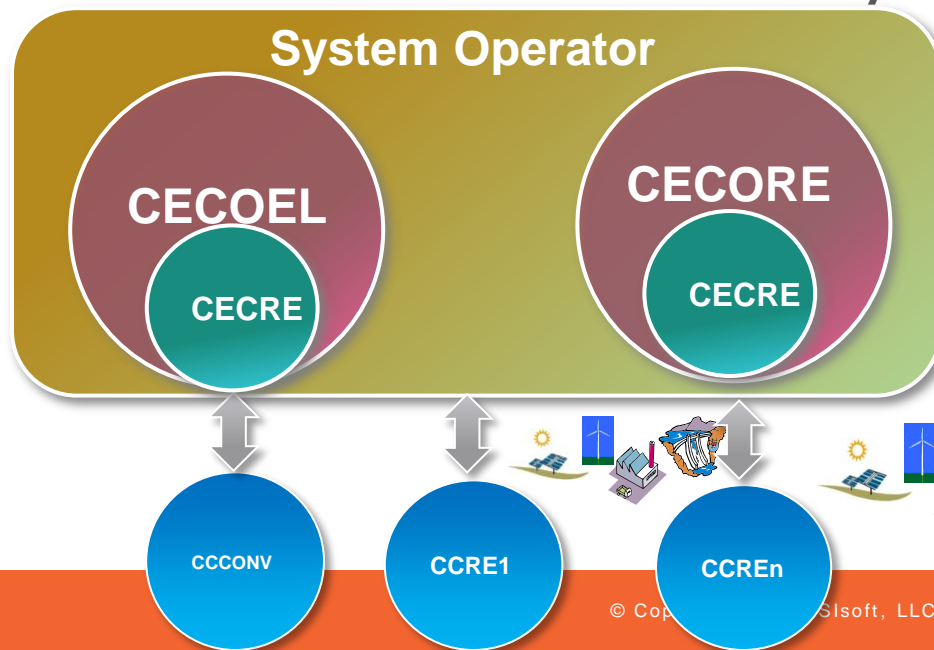
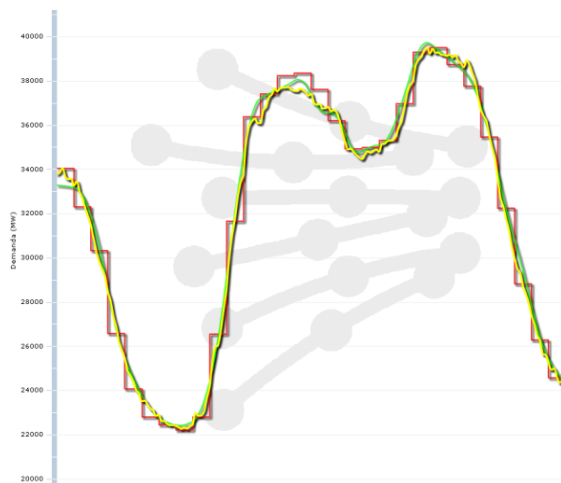
Necessity of Real-time Data in System Operation

Demand Coverage





- ◆ Generation must adapt to demand in each moment
- ◆ Continuous manageable generation actions are needed in order to maintain system equilibrium

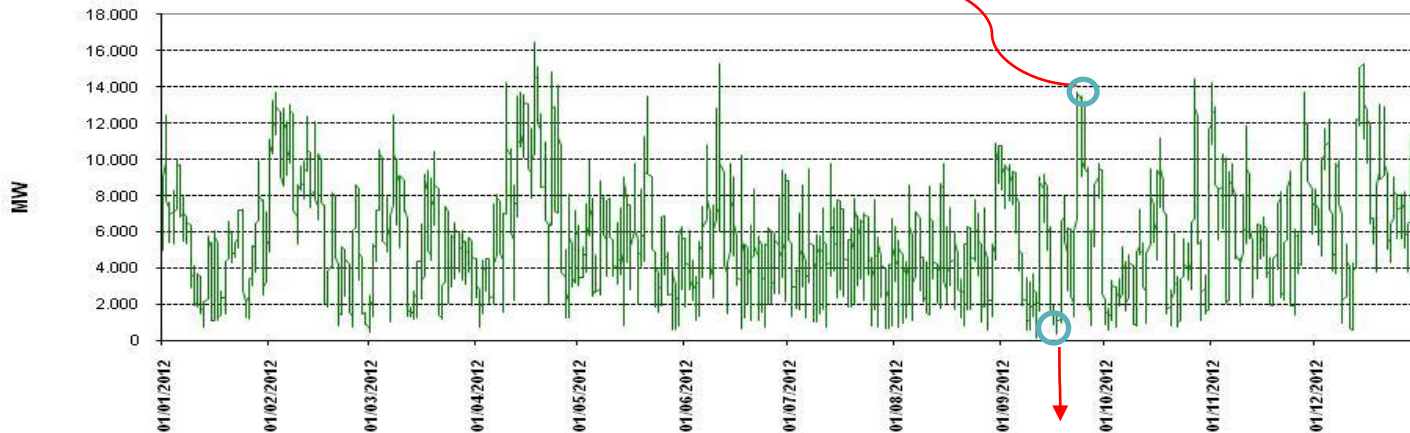




The PI System allows System Operator to retrieve a huge amount of Real-time and historical Data instantaneously using a friendly Excel interface.

Wind Generation in year 2011 (II)

Maximum coverage 2012 (24/09/2012): 64% wind production = 13285 MW

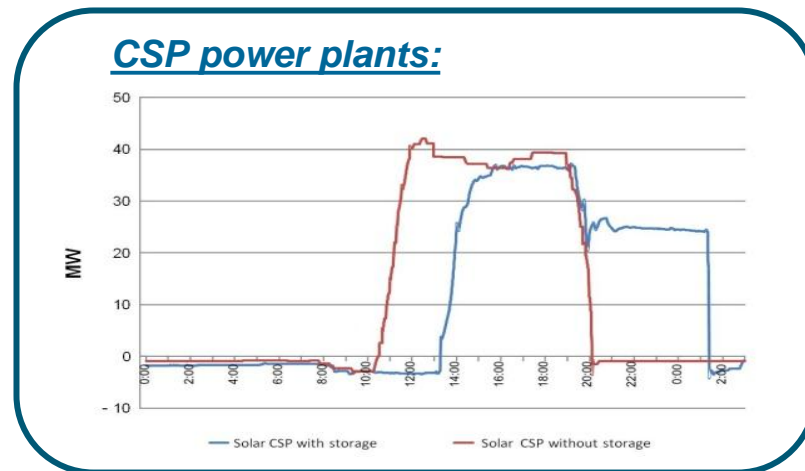
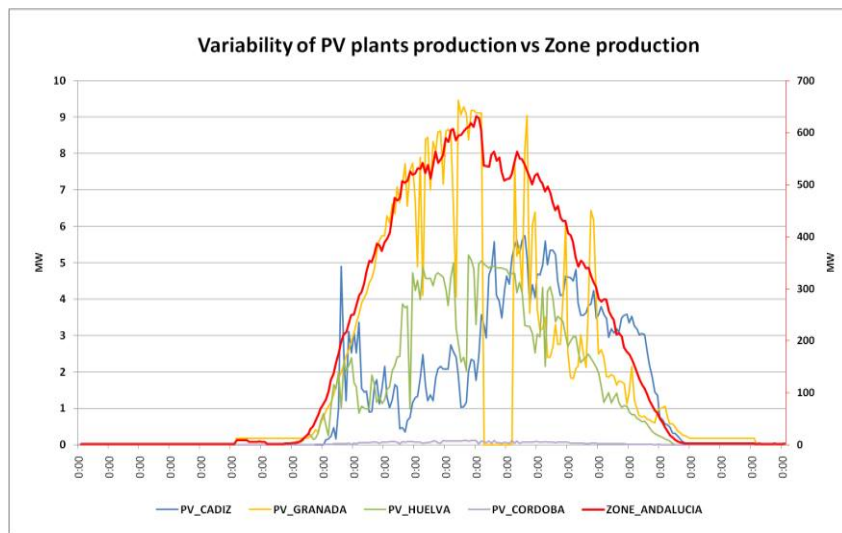


Minimum coverage 2011(11/09/2012): <1% wind production = 81 MW



DEMAND COVERAGE

Solar Photovoltaic and Solar CSP production



Necessity of Real-time Data in System Operation

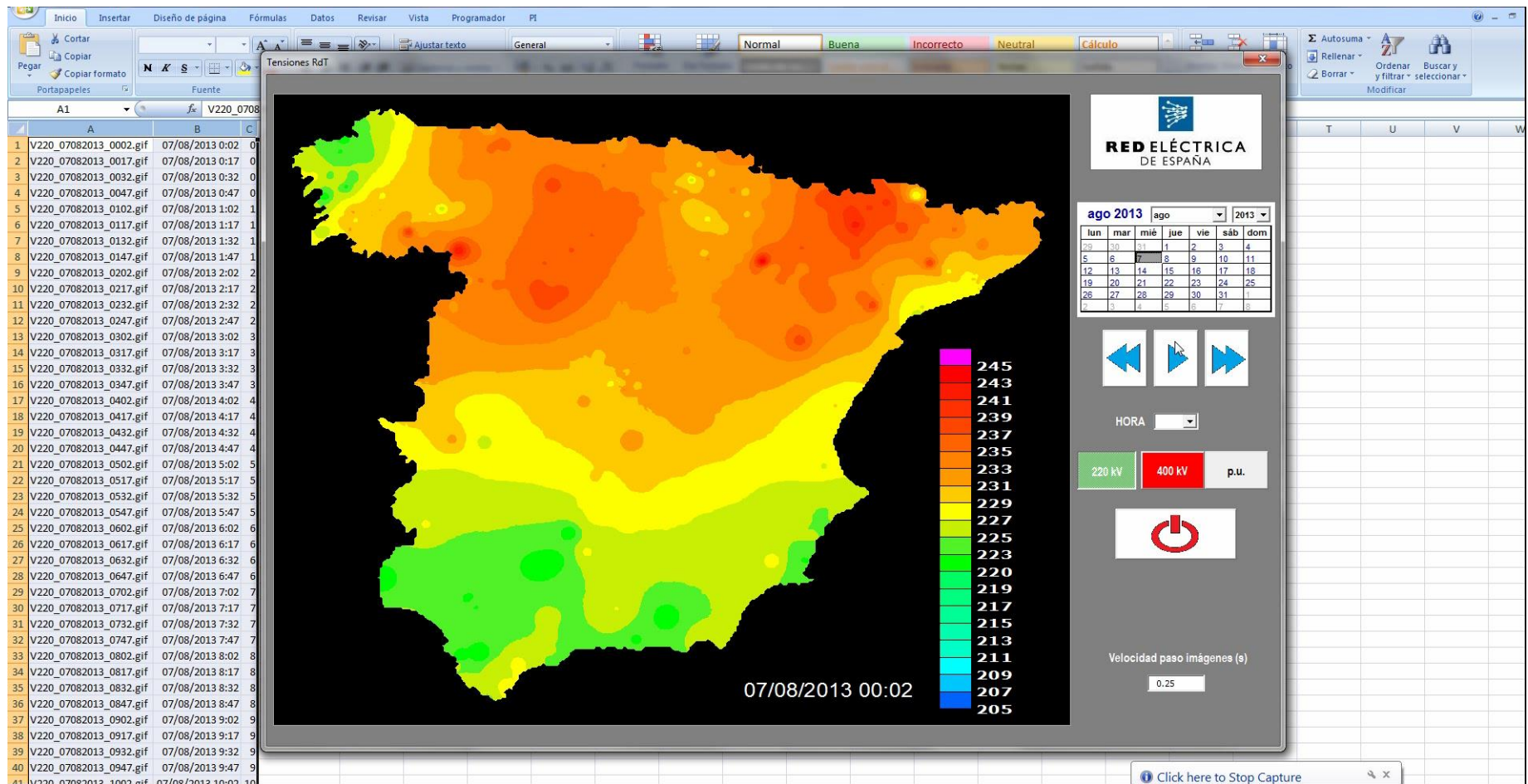
Voltage Control





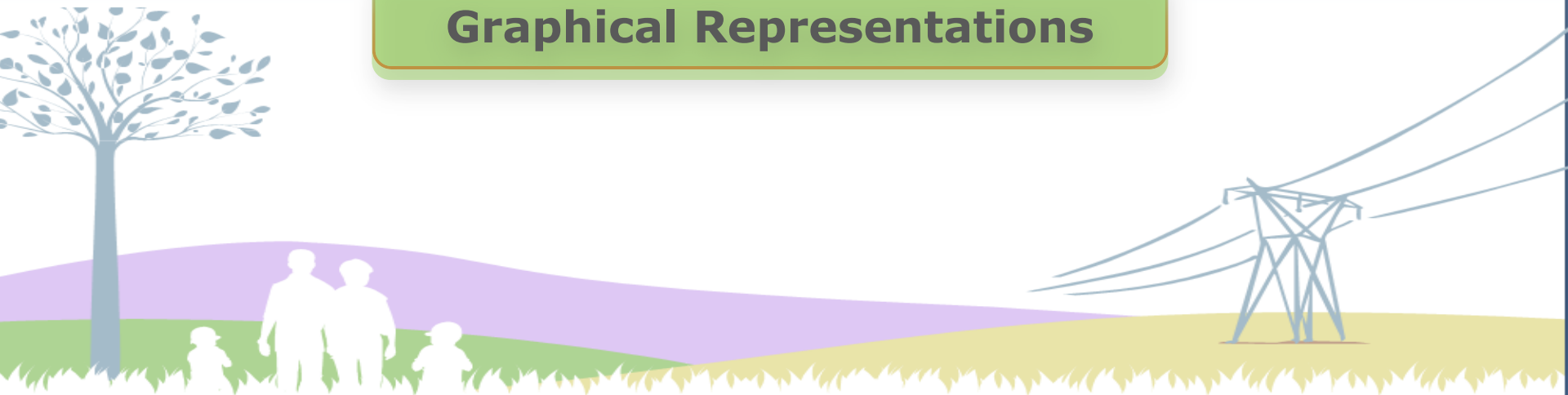
- Parameter that determines system quality.
- Conventional generation, through reactive power injection/absorption, play an essential roll in continuous system voltage control at the substation level.
- Nowadays, **RES generators only maintain power factor.**
- System Operator require Real Time Voltage Data from both renewable and ordinary production to supervise voltage profile.

The PI System allows System Operator to retrieve this information instantaneously, and its subsequent graphical representation.



Necessity of Real Time Data in System Operation

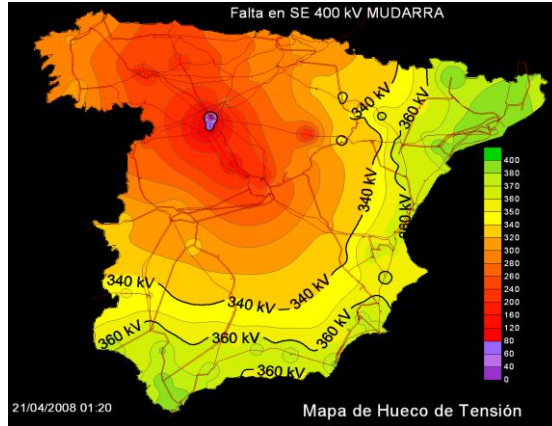
Graphical Representations



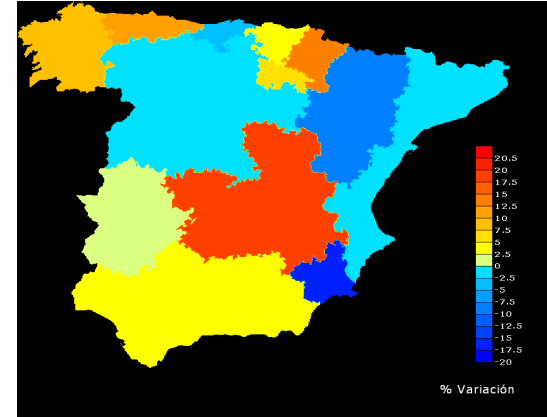


GRAPHICAL REPRESENTATIONS

- ◆ Graphical representations help System Operator Dispatchers to take optimal decisions.
- ◆ Some examples of graphical representation using PI DataLink:



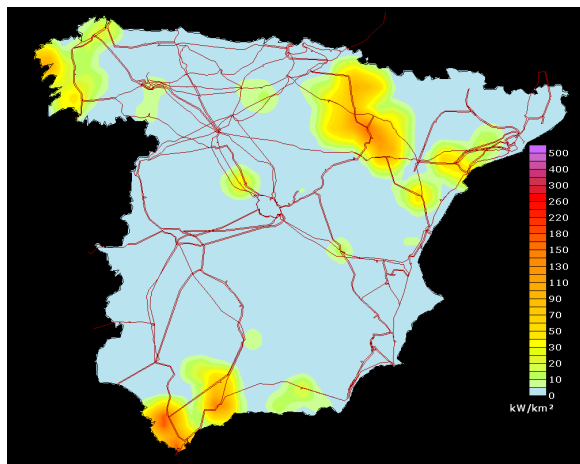
- Calculated voltage dip surface after the simulation of a three-phase dead fault in a 400 kV substation



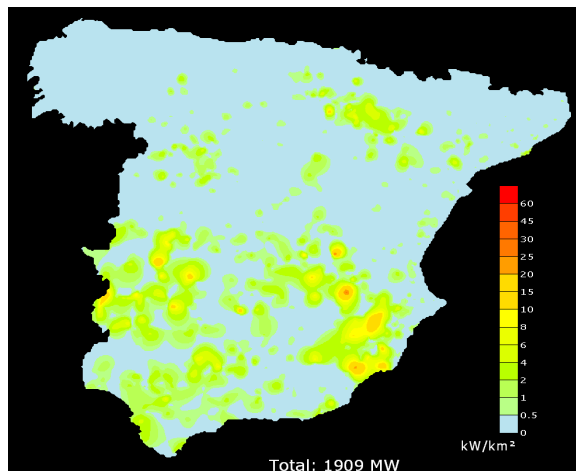
- Diary Area consumption Variation



GRAPHICAL REPRESENTATIONS



Real Time Wind
Production
(09/08/2013 9:45 h)



Real Time SP
Production
(09/08/2013 9:45 h)

Necessity of Historical Data in System Operation

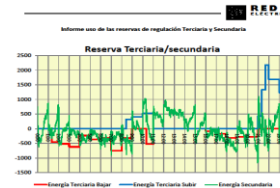
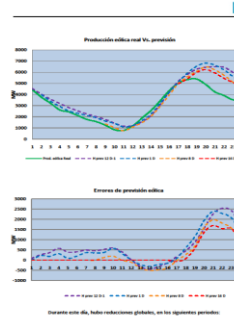
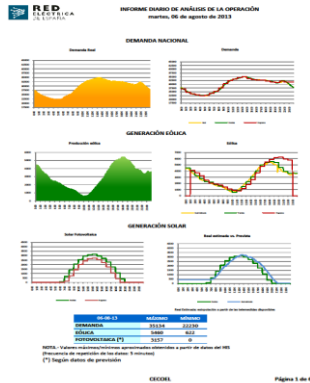
Operational Reports





OPERATIONAL REPORTS

- ◆ REE is requested to elaborate reports in order to analyze System Operation in the past.
- ◆ Combining PI DataLink with Excel and Visual Basic programming is possible to generate daily reports automatically.

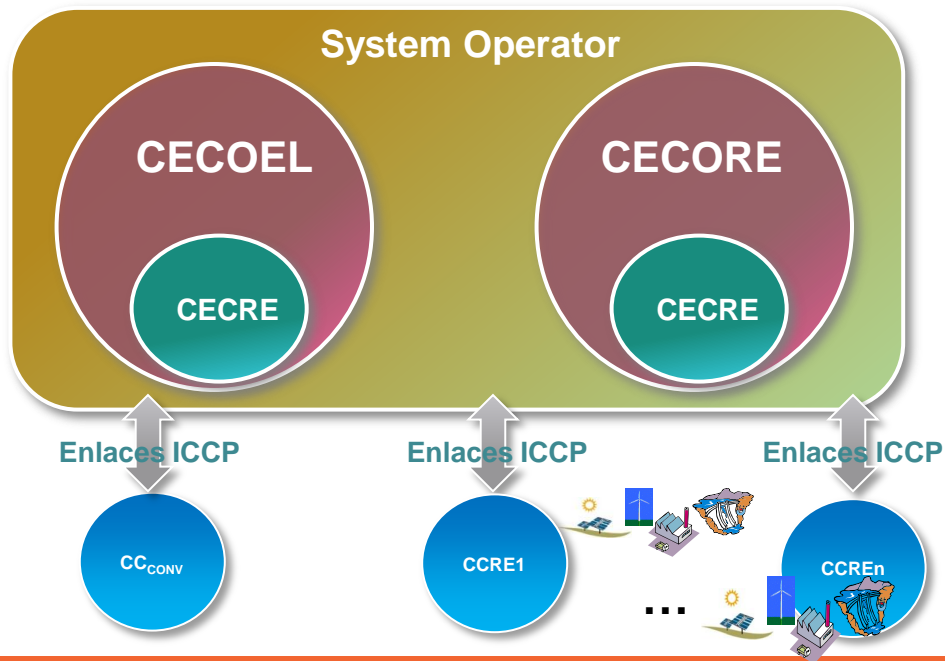


CECRE: Control Centre for Renewable energies





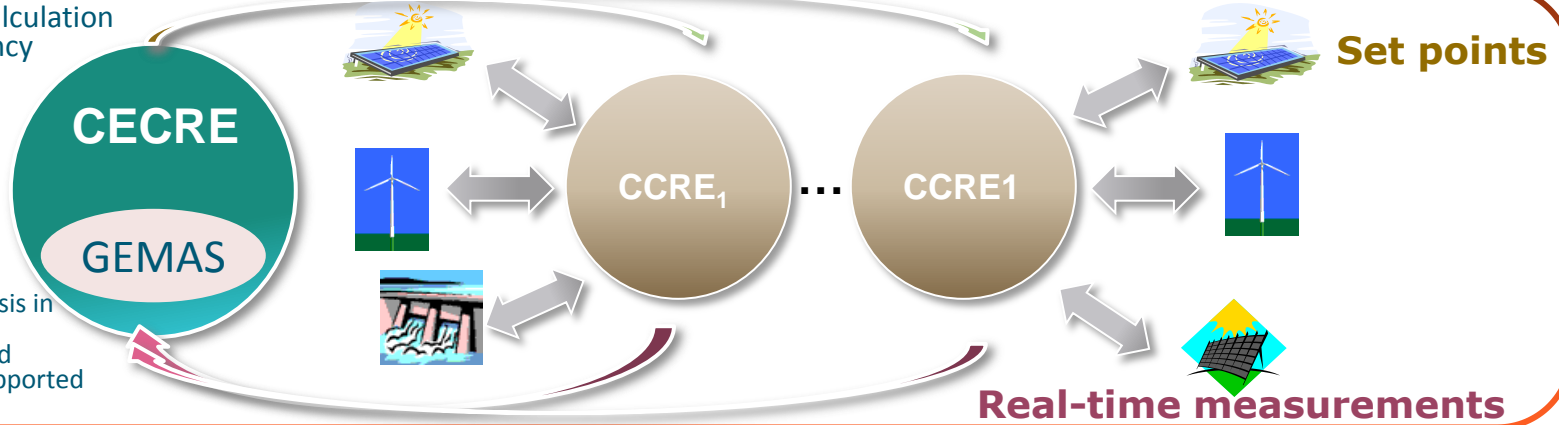
CECRE: FUNCTIONAL SCHEME



- ◆ Generators are dispersed and belong to different companies with different operation policies.
- ◆ Communication is needed in case of emergency, outages or maintenance of the transmission or distribution assets.
- ◆ CECRE communicates to 31 Control Centres which aggregate more than 3 000 generation units
- ◆ According to RD1065/2010, aggregations larger than 10 MW must be linked to CECRE

CHECKING THE SECURITY WITH THE REAL-TIME WIND SCENARIO

20 minutes calculation frequency



GEMAS: Analysis in real time the maximum wind generation supported by the system.

- ◆ CECRE analysis in real time the maximum wind generation supported by the system.
- ◆ If curtailments are needed, wind generation set-points are calculated and sent.
- ◆ Wind farms must adapt their production to the given set-point within 15 minutes.
- ◆ Presently only done for wind generation, but a similar methodology can also be applied for all renewable energy sources

Conclusions





CONCLUSIONS

- ◆ **System Operation demands a constant flow of Real-time Data.**
- ◆ **Continuously, REE's computational systems must be able to manage thousands of variables at different time periods, issuing more than 40.000 signals as remote control instructions.**
- ◆ **In many cases, it's necessary a complex real time data treatment and graphical representation.**
- ◆ **OSIsoft PI DataLink is powerful tool able to retrieve both Real-time Data and Historical records easily, allowing Spanish TSO an Optimal real-time data treatment and graphical displaying.**

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