



WEAM4i

Water & Energy Advanced
Management For Irrigation

WEAM4i Technical summary

**Jornada: El regadio de Bardenas de Aragón y
Navarra en la cuenca del Ebro**

22th September 2016, Ejea de los Caballeros

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WEAM4i Technical Objectives

Resource efficiency at local level

- Demonstrate innovative techniques for resource efficiency at local level: saving water and energy (kwh/m³) in the local irrigation systems

Decision Support Tools

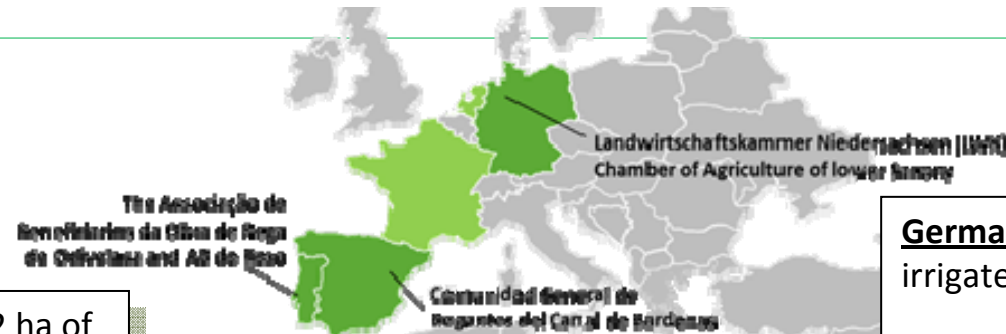
- Demonstrate an innovative water & energy smart grid for irrigation: matching demand-side management with available energy offer

ICT Platform and Webportal

- Develop an innovative integration approach: an ICT/cloud platform based on Service Oriented Architecture (SOA) for weather forecast and remote sensing data services & applications



European dimension



Portugal: total for both 17.362 ha of irrigated land.

Water source: Odivelas and Roxo reservoirs, main the conveyance infrastructure from Alqueva not included

Organisation: 2 irrigation districts, ABORO and ABROXO

Energy for irrigation: 0.34 kWh/m³ (average)

Main Crops: Olives, maize, rice, pasture, sunflower, almonds

Type of irrigation: Drip, sprinkle and pivot systems.

Spain: 81.000 ha of irrigated land

Water source: Yesa reservoir, including the main conveyance infrastructure

Organisation: 24 irrigation districts and 1 general irrigation board

Energy for irrigation: 0.16 - 0.21 kWh/

Main Crops: Alfalfa, corn, winter cereal (wheat, barley), sunflower, vegetable and fruits

Type of irrigation: 80% flooding system & 20 % pressurized system - dripping & sprinkling

Germany: ca. 300.000 ha of irrigated land.

Water source: groundwater, with an environmental constraint of 80mm/year of extraction

Organisation: individual farmers and some irrigation sectors

Water energy consumption 0,5 - 0,8 kWh/m³

Main Crops: potatoes, sugar beets, grain, corn, onions, vegetables

Type of irrigation: High pressure gun spray-jet on reel wagon (95%)





Resource efficiency at local level

Concepts to be demonstrated **at field and irrigation sector level**:

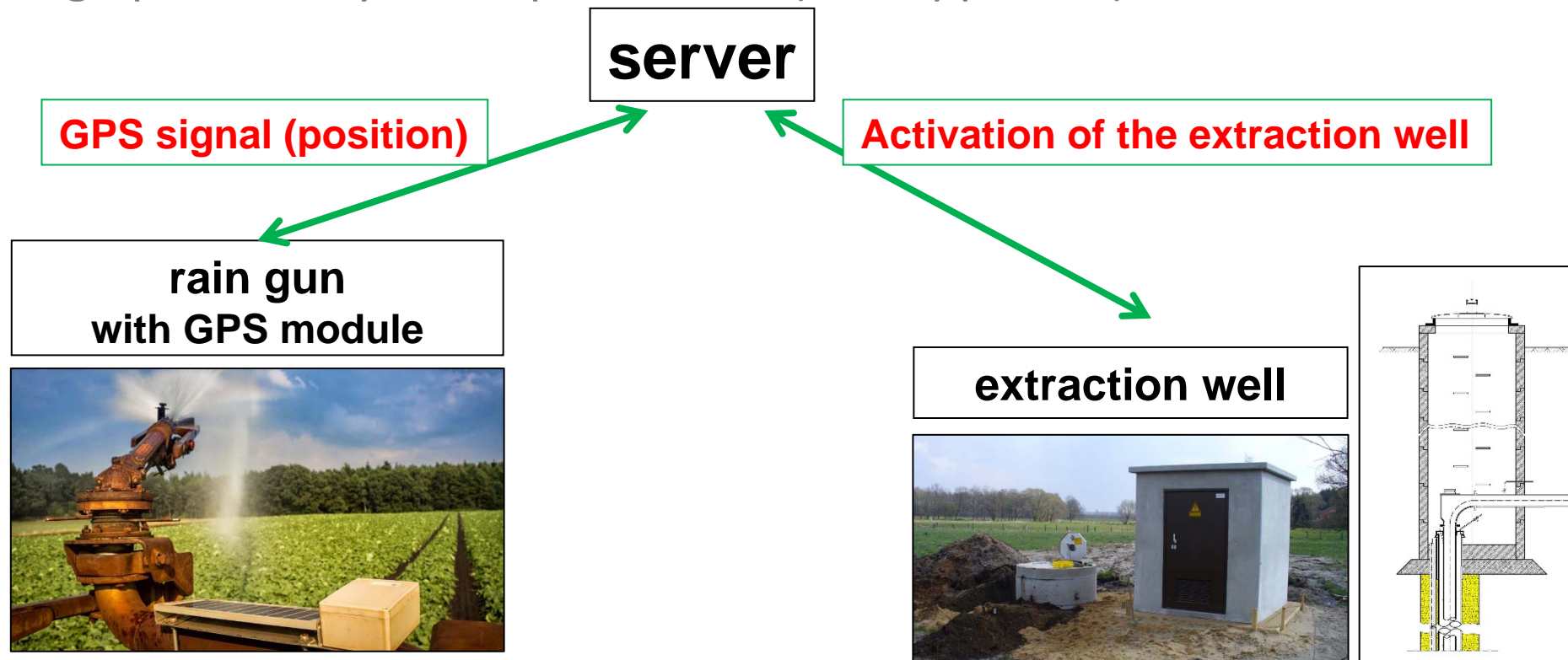
- High pressure system optimization (GPS approach)
- Alternative power systems for low pressure irrigation systems
- Genetic Algorithms (GA) for improving water and energy use efficiency at the farm and irrigation sector level
- Leaf and soil water status sensors for water efficient irrigation scheduling protocols





Resource efficiency at local level

High pressure system optimization (GPS approach)



The GPS sends the location of the mobile rain gun to a control panel and varies the performance of the well pump



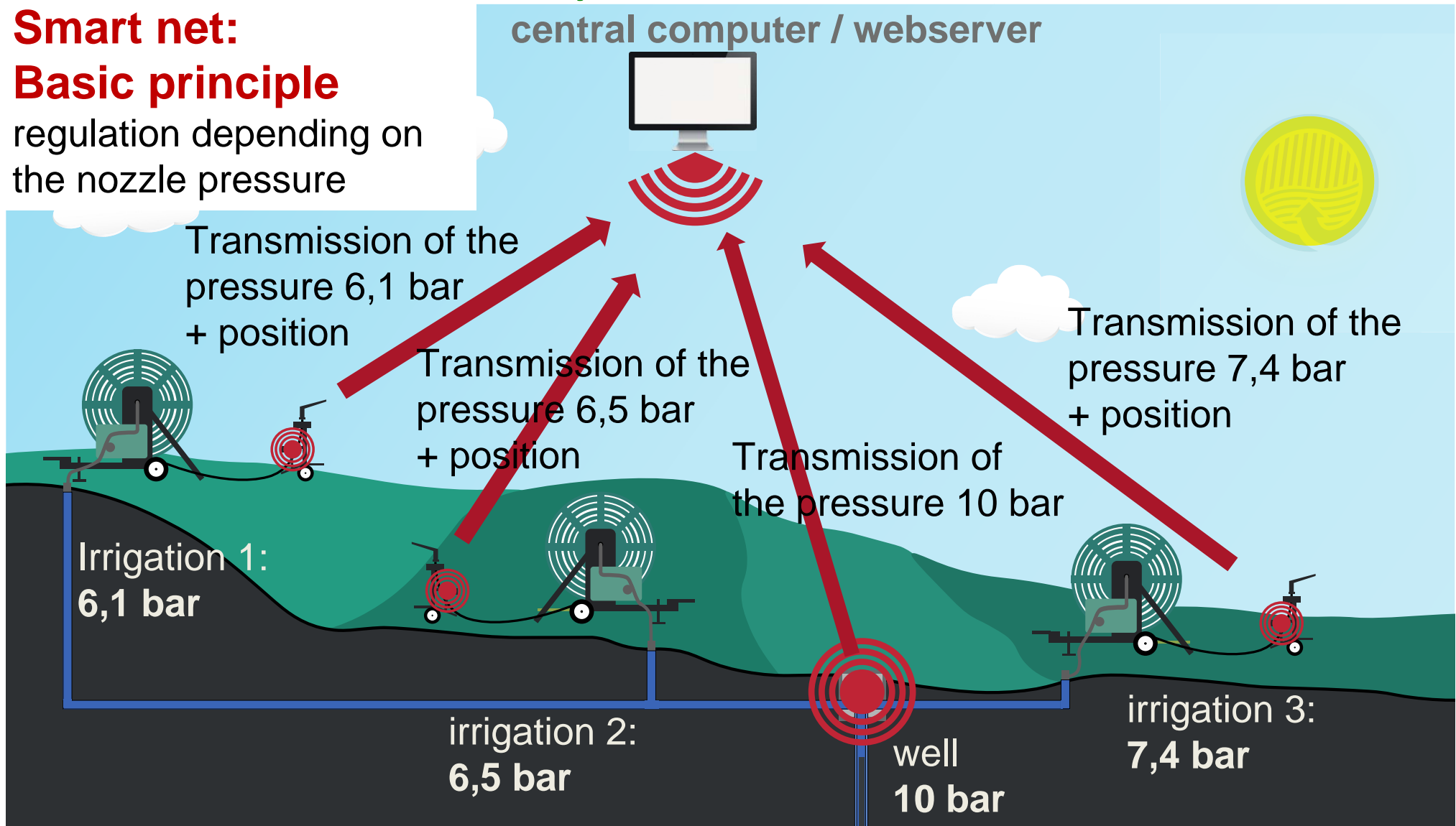


Resource efficiency at local level

Smart net:

Basic principle

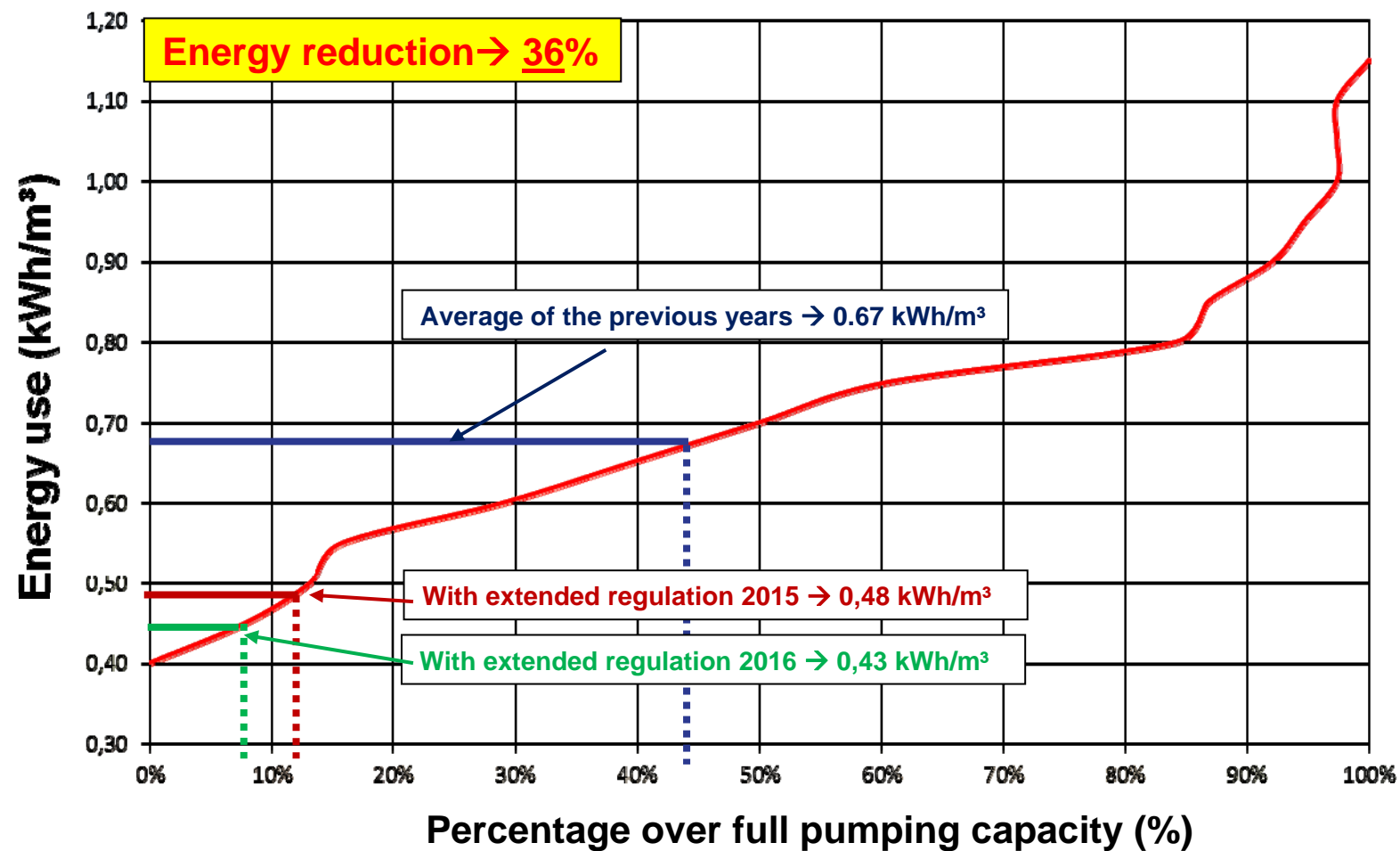
regulation depending on
the nozzle pressure





Resource efficiency at local level

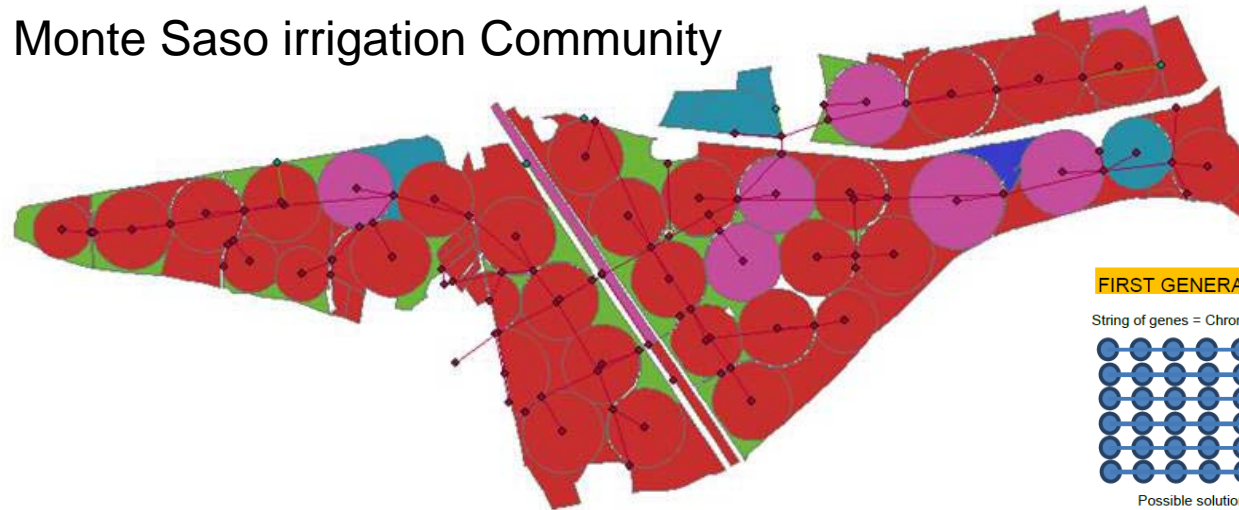
Energy consumption Jiggl



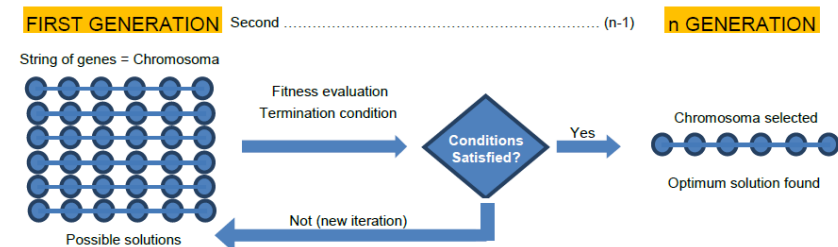


Resource efficiency at local level

Monte Saso irrigation Community



Genetic Algorithm



The sectoring model allows the sectors to group together in a way that the sum of the intake flows for a given pressure head drops in areas where pump efficiency is higher.

Energy efficiency can be improved by using genetic algorithms by 4.7% (kWh/m³) for Monte Saso district and up to 16% in less optimized situations





Resource efficiency at local level

Improving irrigation management by delivering the water needed by the plants (save water and energy)

Yara Water-Sensor is a new method to determine the water status of plants in a non-invasive manner by measuring changes in the turgor pressure of leaves.

Tests were conducted with Yara Water-Sensors in herbaceous and woody crops





Resource efficiency at local level

Maize optimal irrigation EU-WEAM4i 2016

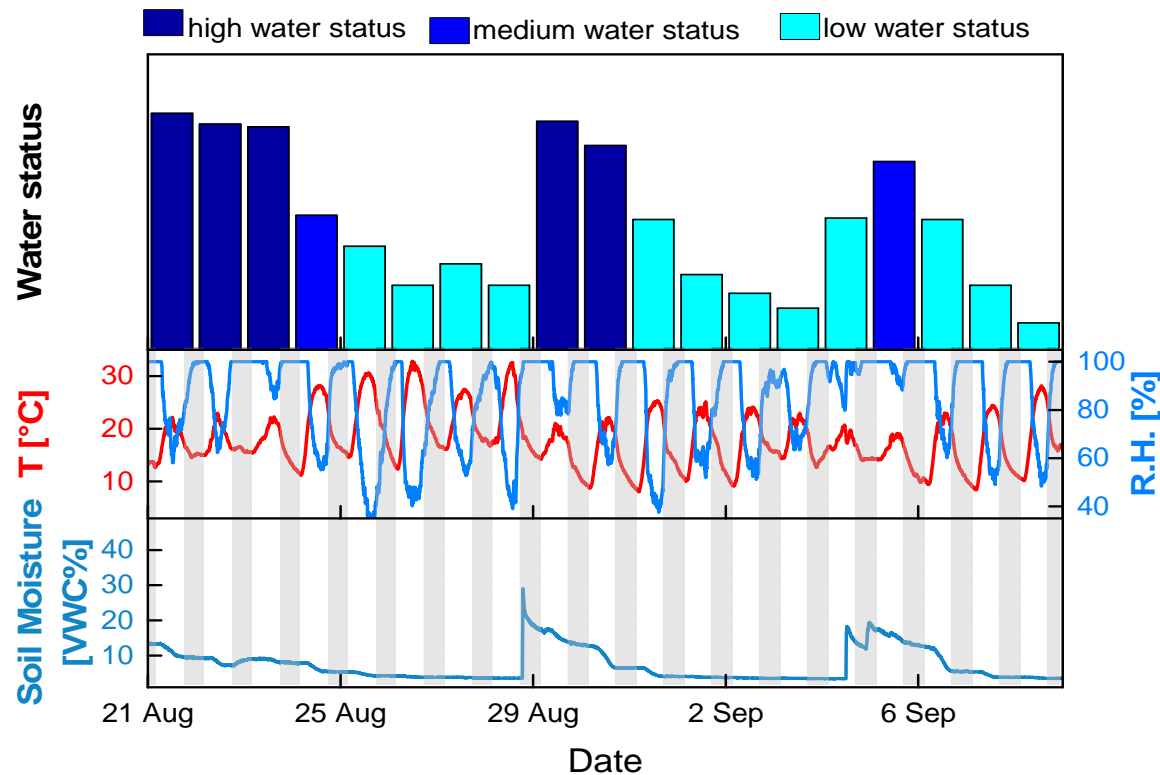


Foto: Riedel

The sensor is able to detect severe plant water stress. It is still to be determined the yield to water responses to different levels of stress to be detected with the sensors

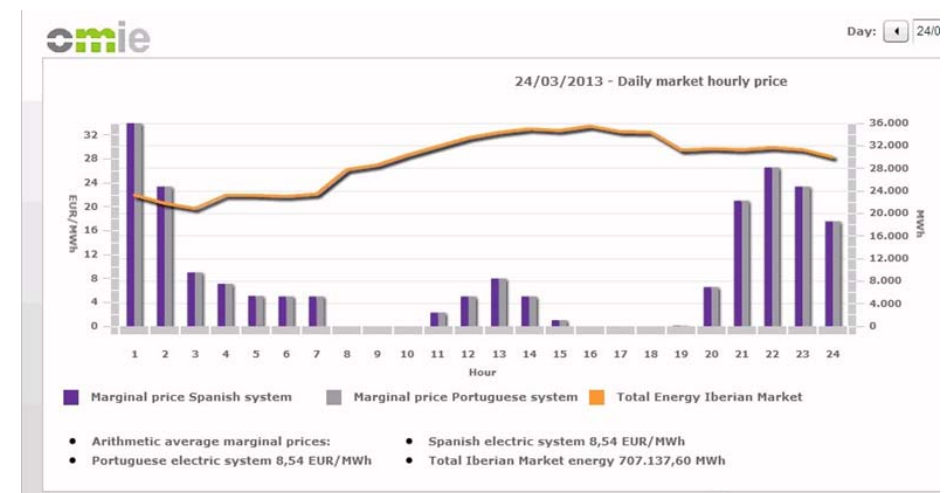
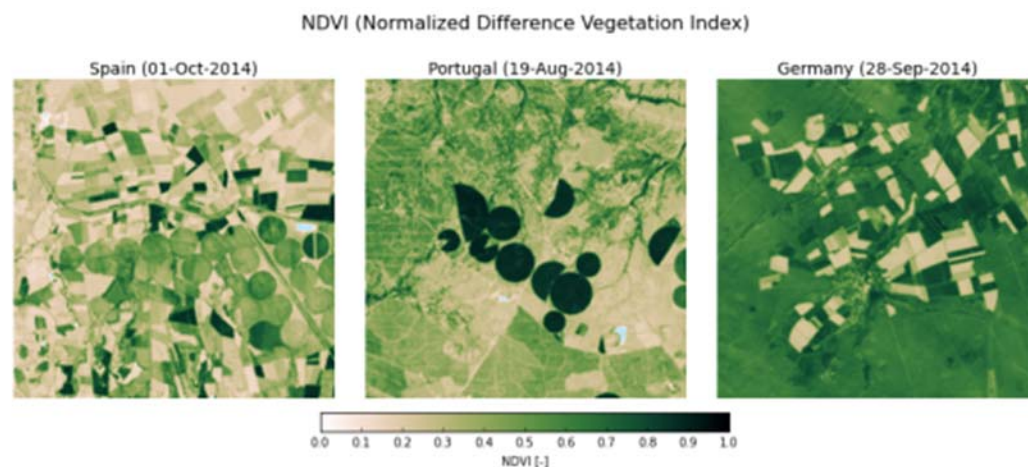




Decision Support Tools

Concepts to be demonstrated:

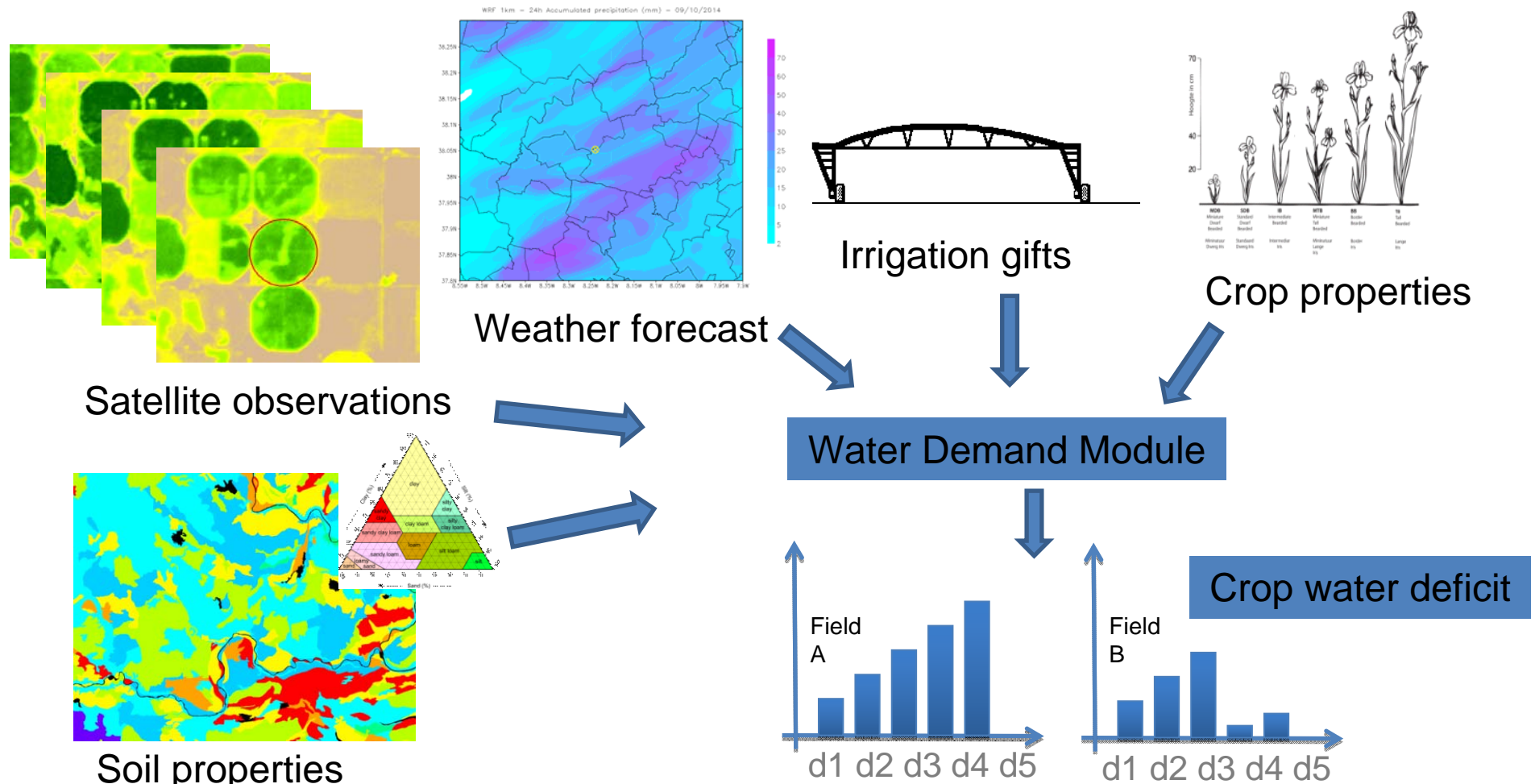
- Water demand forecast: Water needs per field for the next 5 days
- Energy market forecast: day-ahead market + 4 days forecast
- Strategical and demand management: Hydroptim tool





Decision Support Tools

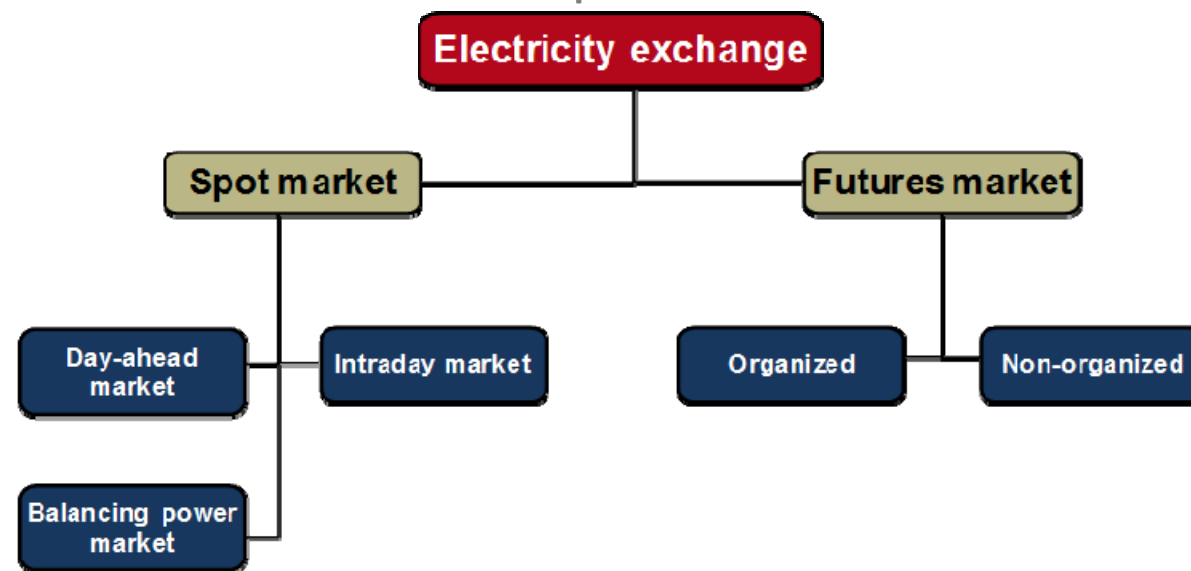
Water demand forecast: Water needs per field for the next 5 days





Decision Support Tools: energy market

An analysis of energy market regulation in Germany, Spain, and Portugal has been conducted in the scope of WEAM4i



As conclusion:

Source: Cream analysis

- The day-ahead market seems more interesting and suitable for the need of irrigation communities: The day-ahead market trades electricity one day before delivery for a given day





Decision Support Tools: energy market

- The day-ahead market prices are updated daily and integrated into the ICT platform and WebPortal
 - The energy prices for the next 24h are available
 - The historical energy prices are recorded
- In addition, a + 4 days forecast for energy prices has been developed and integrated



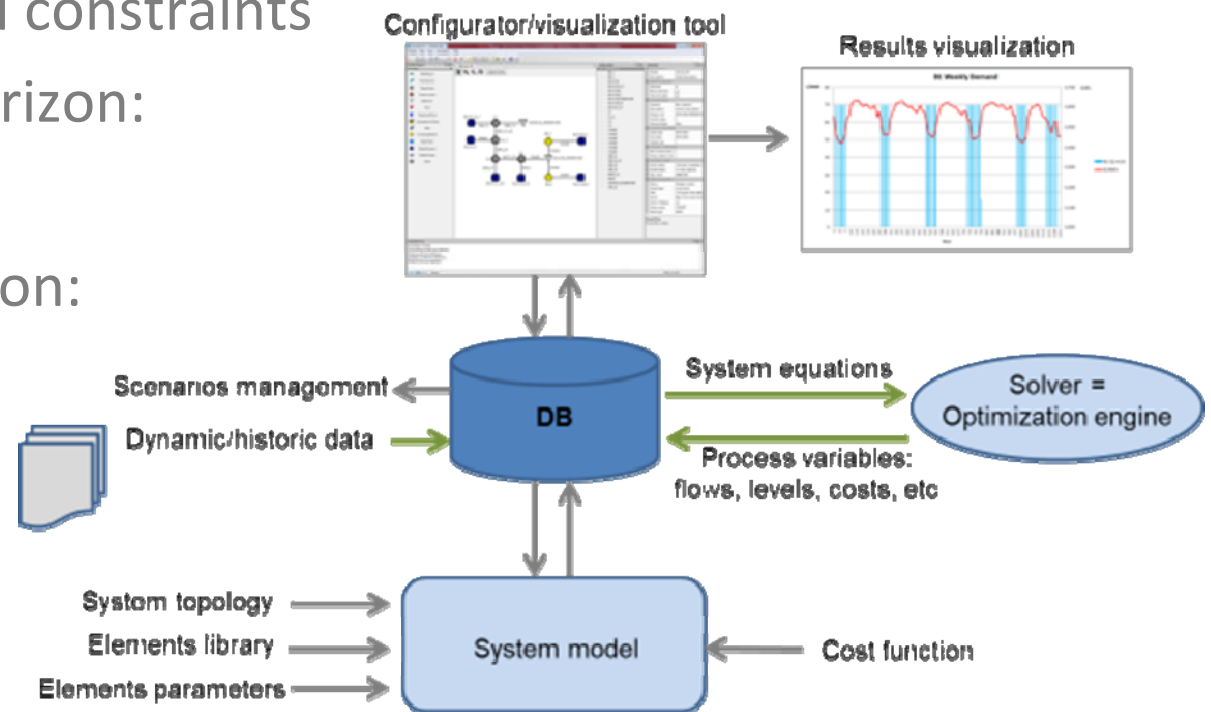


Decision Support Tools

Hydroptim tool:

- Minimizes the cost function
- while satisfying the demand
- and respecting the physical constraints
- for a specific simulation horizon:
 - week, month, season
- and a specific time resolution:
 - hour, day, month

Hydroptim

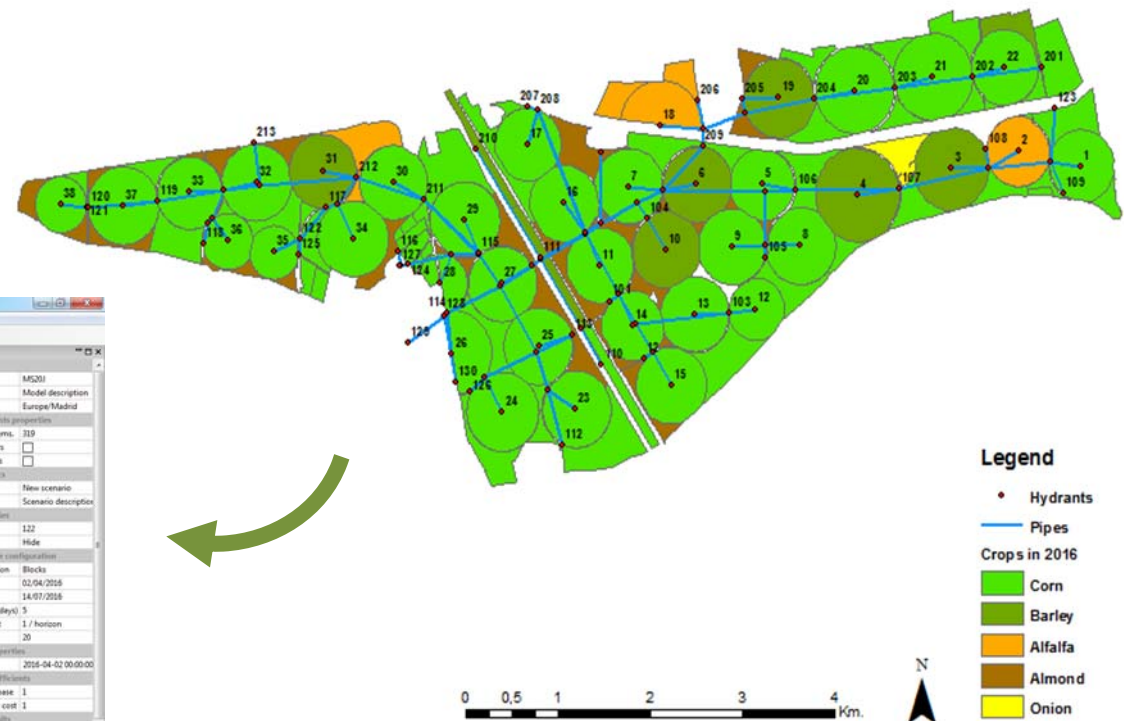
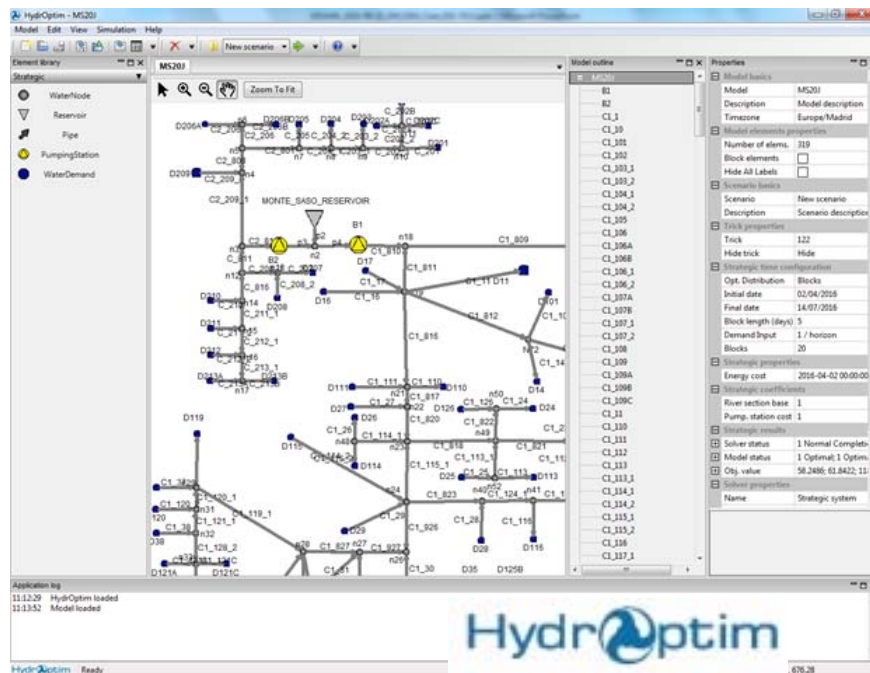




Decision Support Tools

Hydroptim tool: Monte Saso modelization

- 2 pumping systems
- 1200 Has
- 94 hydrants



- Horizon = 5 days
- Resolution = hour





Decision Support Tools

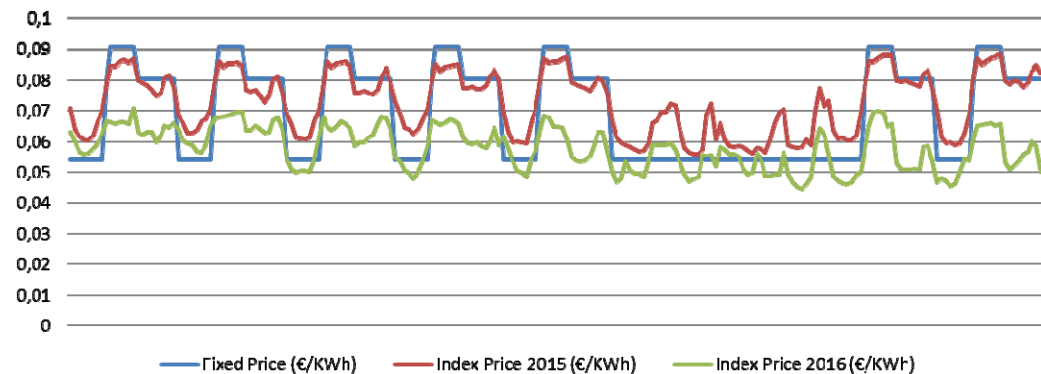
Hydroptim tool: preliminary results for Monte Saso 2015-16 up to July

Scenarios 2015-2016 resume



Base line

Energy prices June 2015 - 2016



→ Demand management

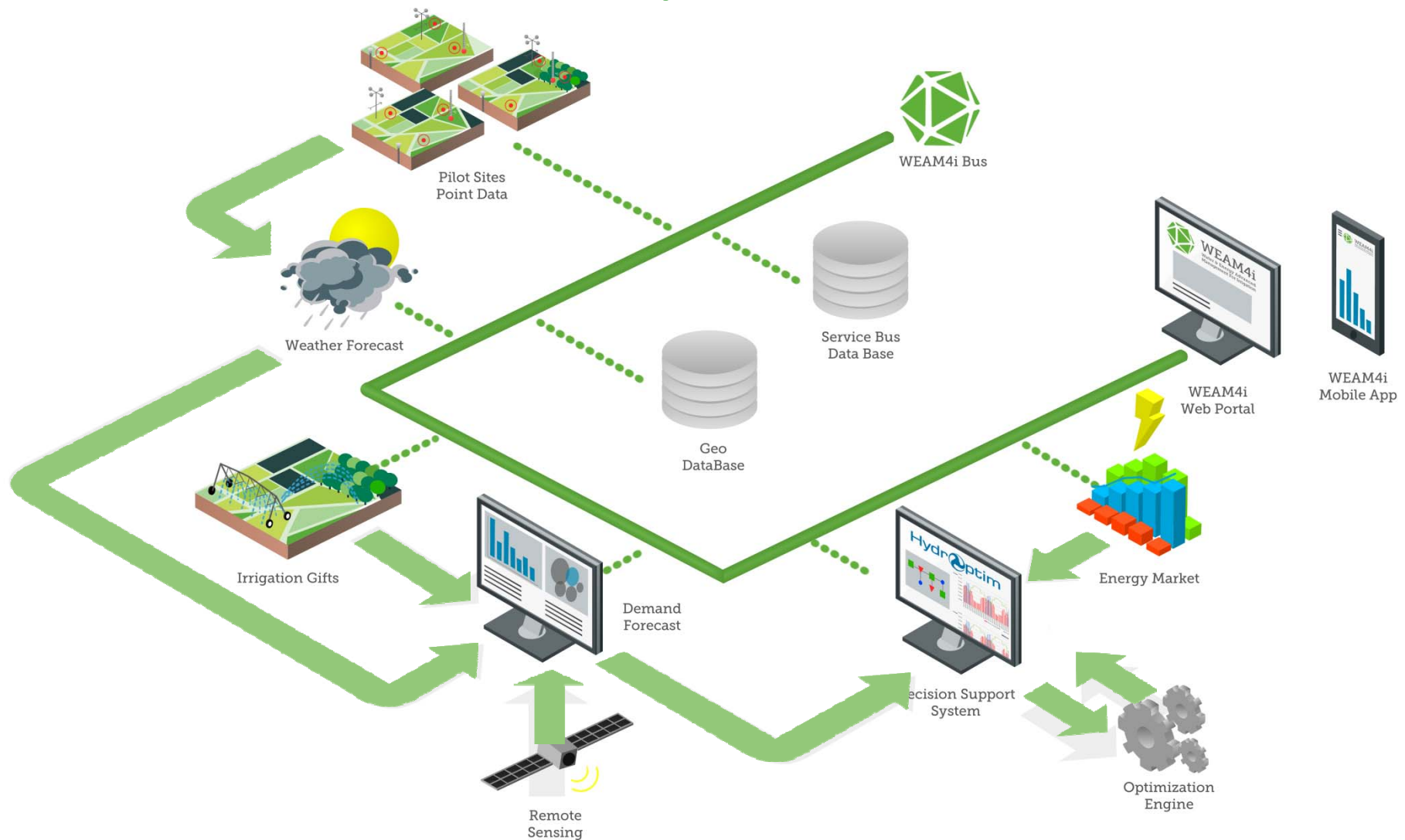
Energy prices	Real	Optimized
Fixed	Base line	-14,86%
		-14,51%
Indexed	+7,98%	-5,54%
	-18,41%	-28,83%

2015
2016



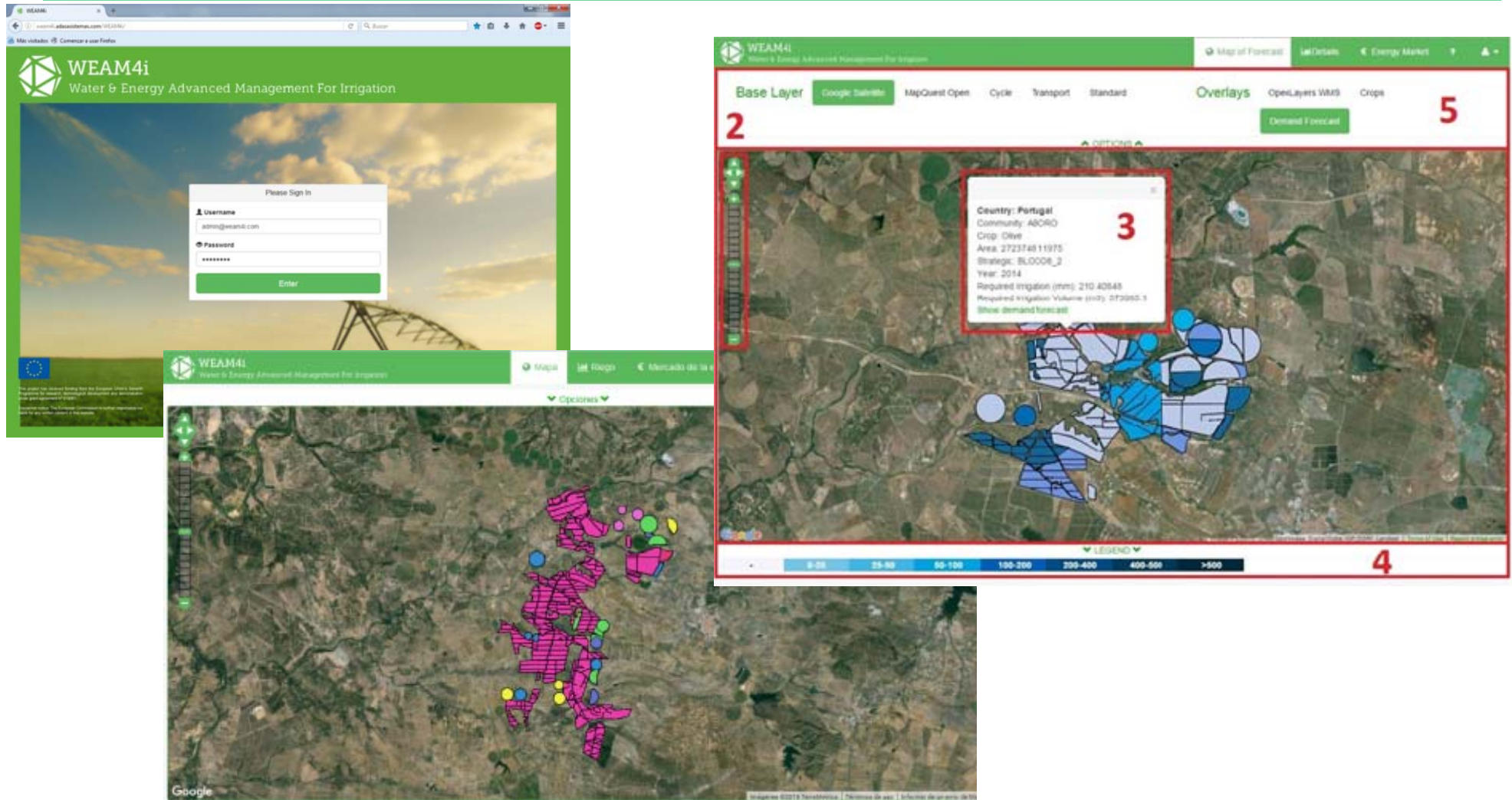


ICT Platform and Webportal



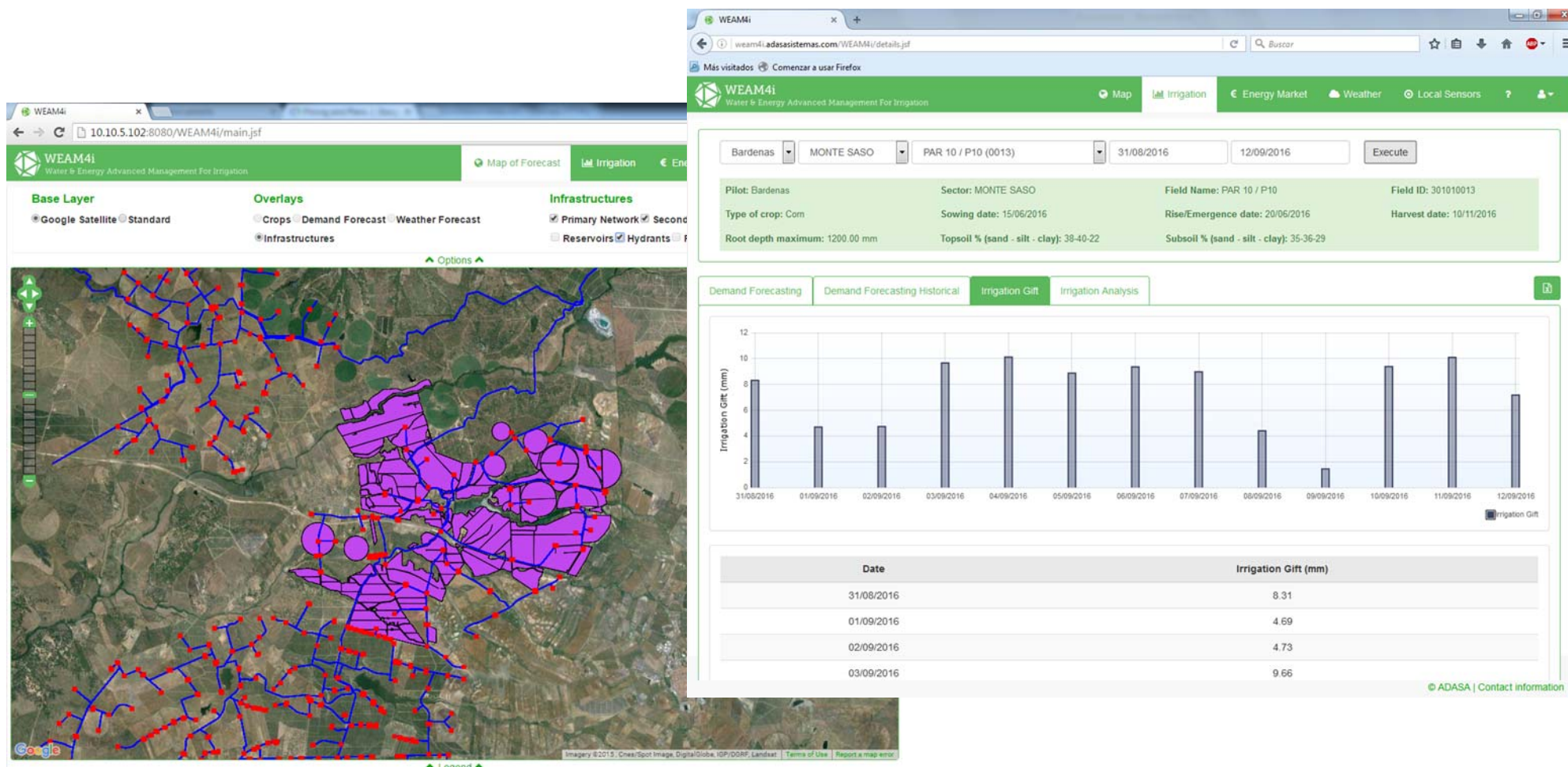


ICT Platform and Webportal





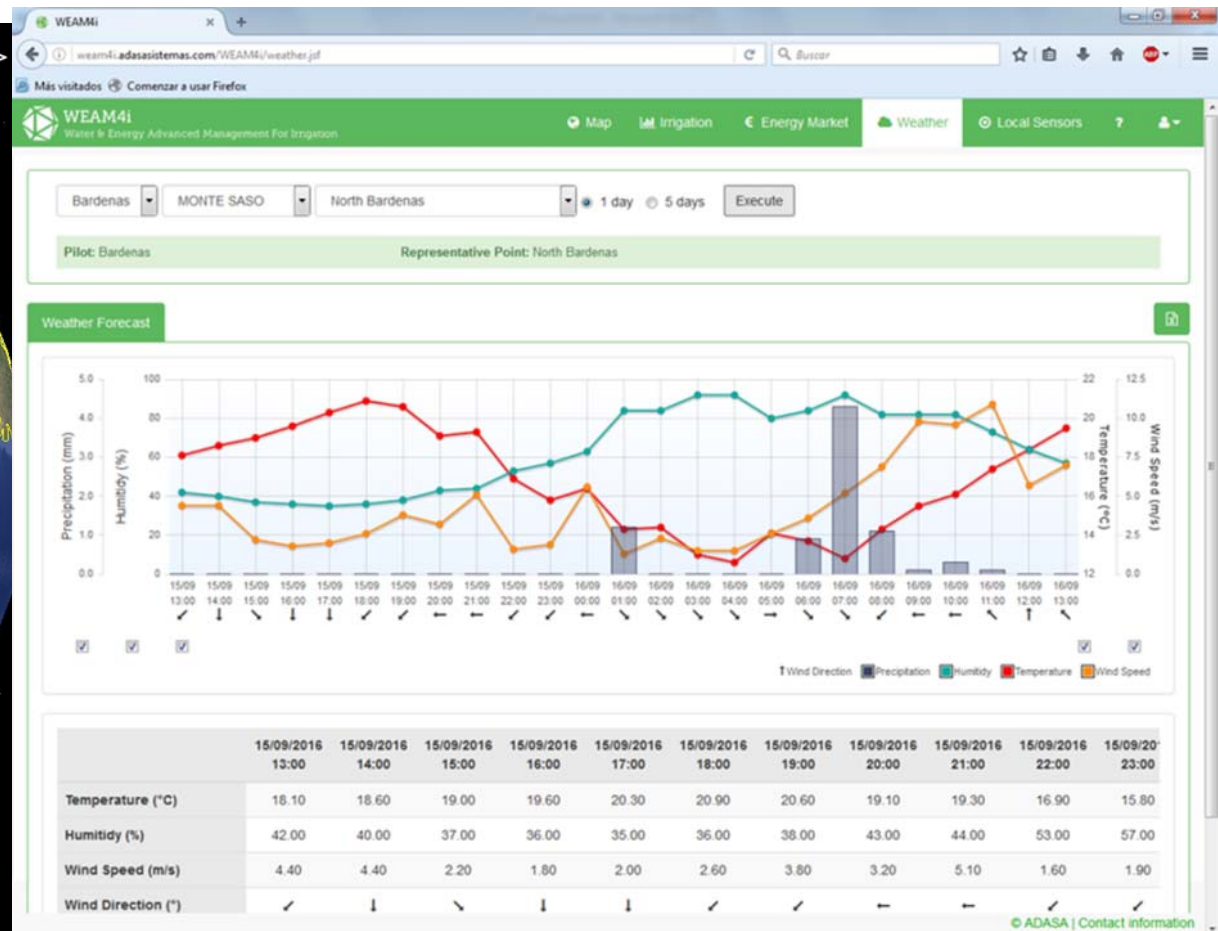
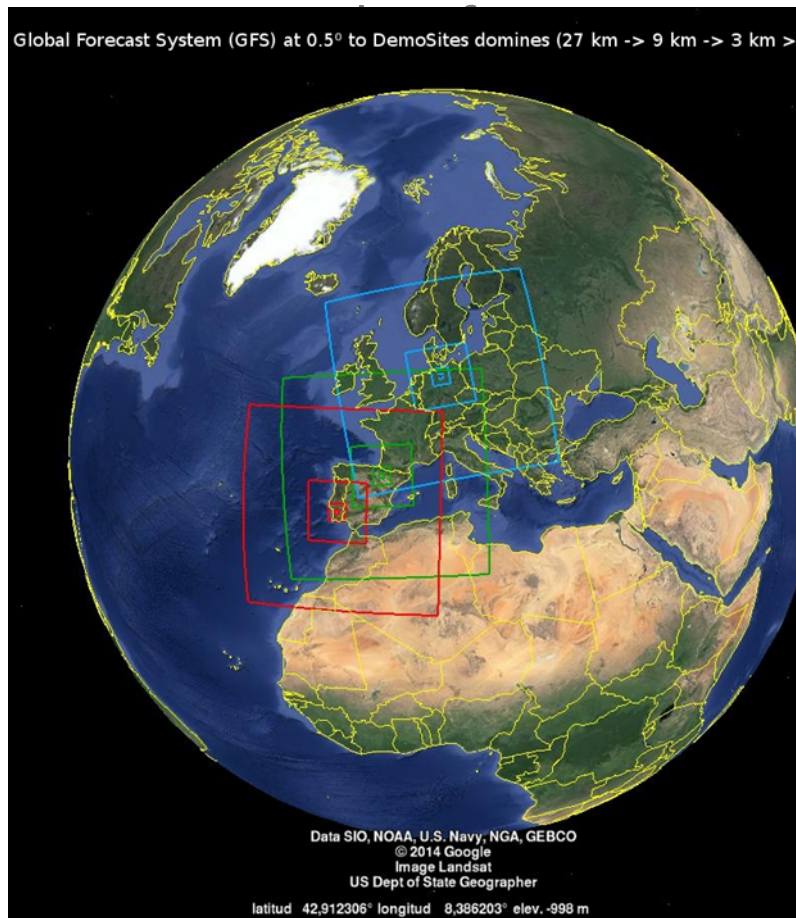
Webportal: water meters and irrigation gifts





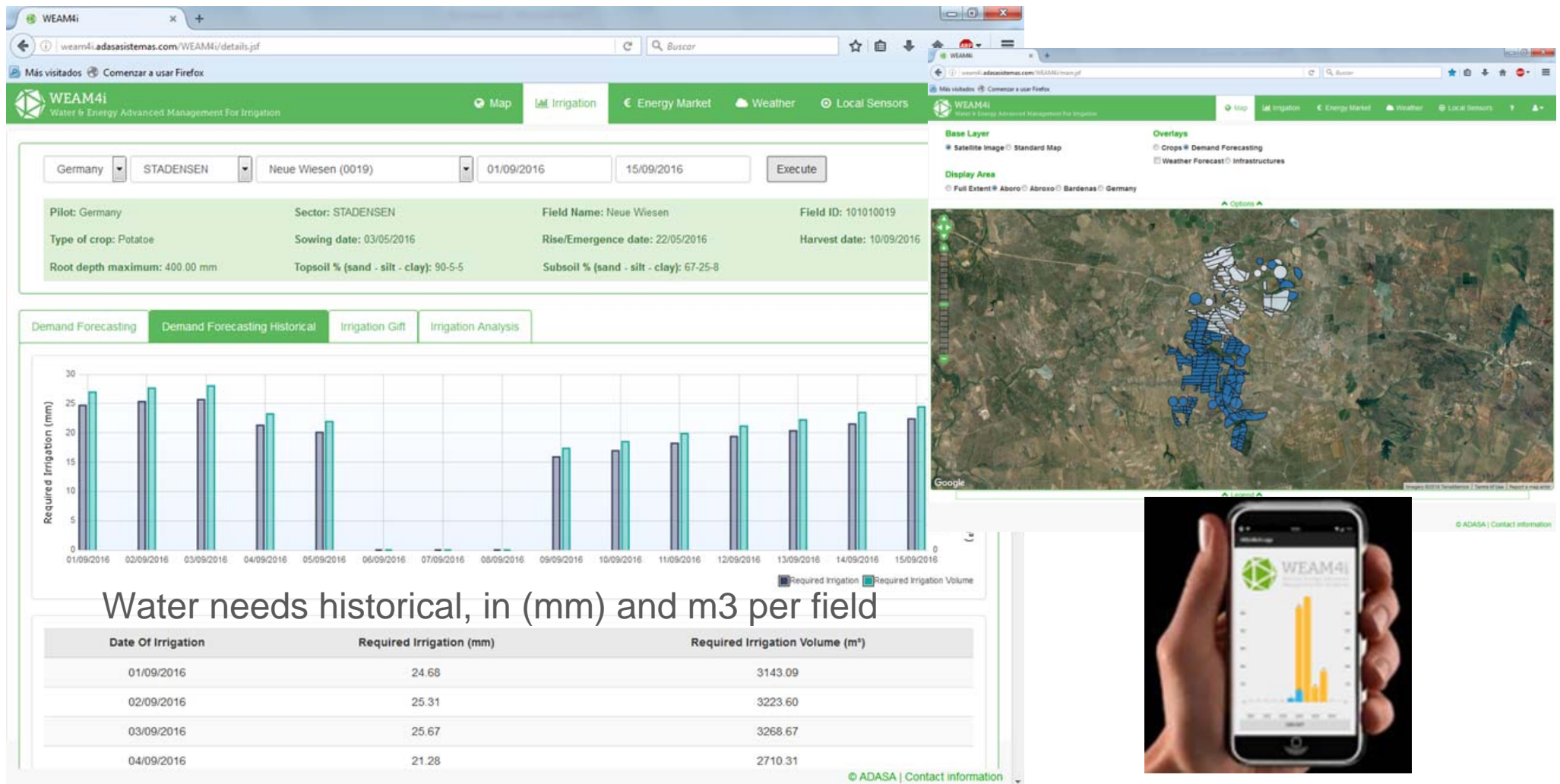
Webportal: weather forecast

- Demosites domains (27km => 9 km => 3 km => 1 km)





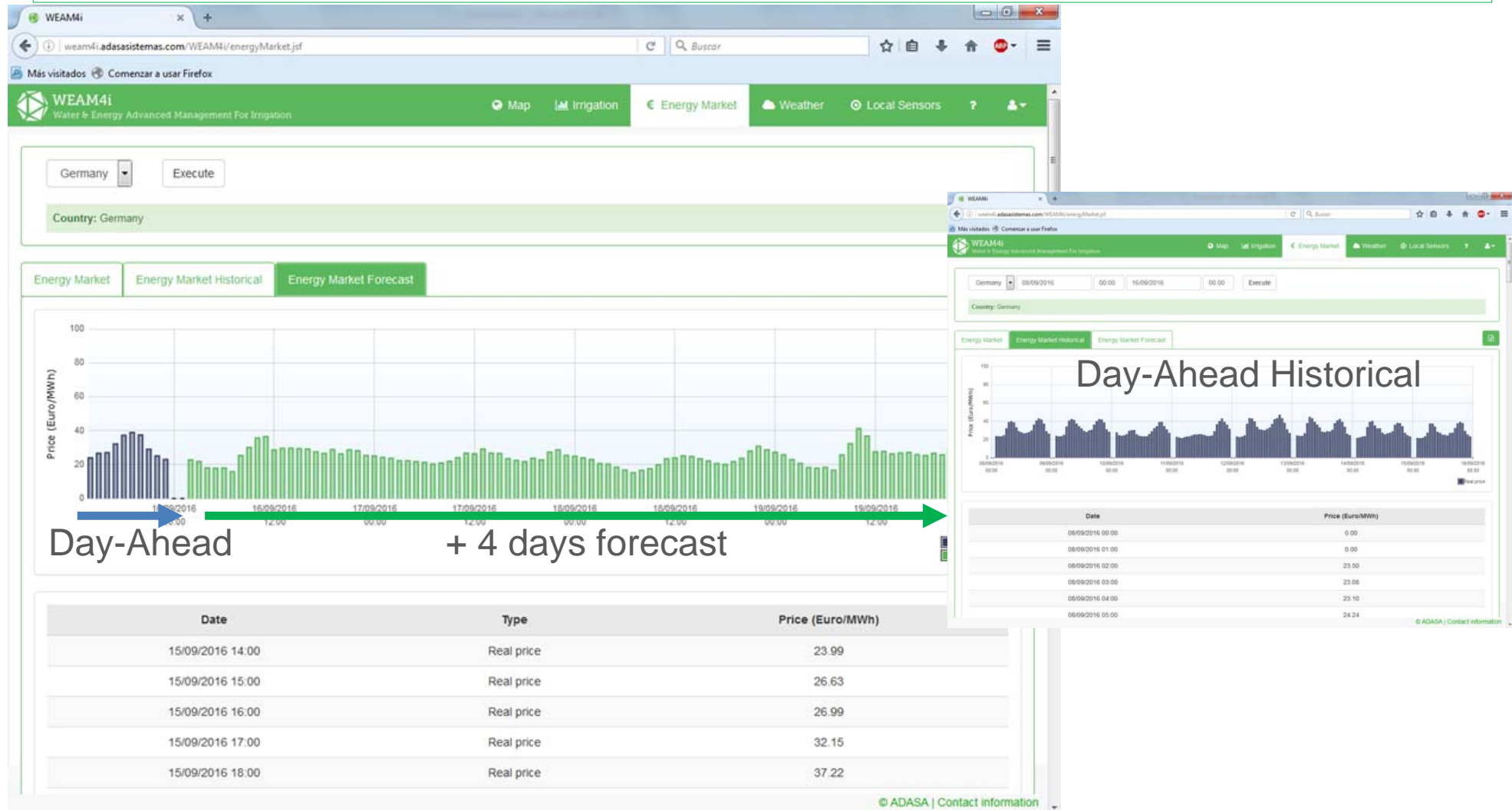
Webportal: Water needs



Water needs historical, in (mm) and m3 per field



WebPortal: Energy Market





Expected outcomes

- Improve the energy efficiency (kWh/m³) by an average of 10 - 15% while reducing the operational costs (€/m³) of the irrigation systems, thus improving the competitiveness of the irrigated agriculture
- Provide success cases to help overcome the current barriers that prevent the water users to access the interactive energy market.
- Creation of market opportunities for WEAM4i innovations, inside and outside Europe





Impacts assessment

- First promising results

Concept	PT	ES	DE	Comments
Energy efficiency (kWh/m ³)	Yet to be quantified	5-16%	11-36%	Optimizing irrigation districts organization
Operational costs (€/m ³)	11.5%	5-28%	Yet to be quantified	Optimizing pumping operations

- The evaluation and quantification of the results will be completed during the next months





WEAM4i key messages

- **Energy** and **Water** use efficiency can be improved by using several tools depending on the irrigation technologies and levels of organizations (single farms or districts)
 - In single farms, Water-Energy can be improved mainly by employing tools for an improved water management and energy price forecasts
 - In districts, energy efficiency can be additionally improved by using optimization technologies and algorithms for gaining pumping efficiency and an adaptation to energy prices
- To achieve this potential benefits, it is required an integration of different sources of information. Nowadays, advances in ICT and sensor technologies allow operational tools to be used at real commercial level





After WEAM4i

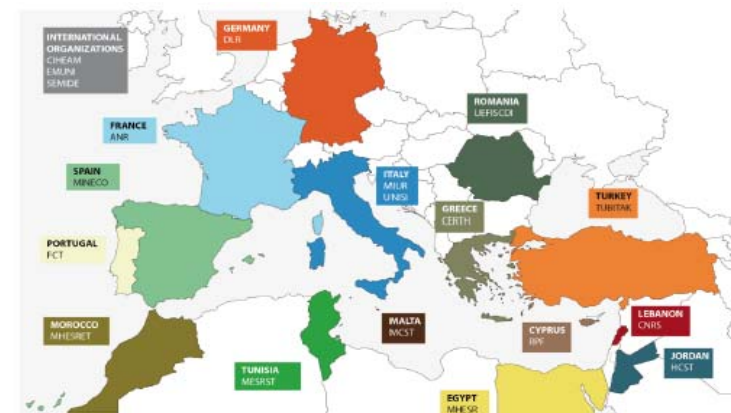
- Modernization will have to continue by incorporating decision support system tools to facilitate the use of technical information for scheduling irrigation.
- The long-term sustainability of precision irrigation practices will have to be assessed considering the soil-plant water systems and risks of salinization
- Improved water management systems will have to consider energy forecasts and pricing scenarios, which are highly variable
- Irrigation models adapted to conditions of full water availability will have to be adapted to new possible scenarios of water scarcity higher water pricing and water quality constraints.





After WEAM4i

- Funding for this need of research & innovation will continue to come from public-private collaborations.



<https://it.surveymonkey.com/r/PRIMAPrioritizationSurvey>

On-line survey still opened to general public until 30 September

A 425M€ cash contribution has been committed by participating PRIMA countries for the initiative, over a 10-year period as from 2018.





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