Water and Energy Demand Management in Monte Saso Irrigation Sector

Summary

Agriculture sector is accountable for 30% of the total water consumption in Europe, but reaches up to 70% of total water consumption in several European southern countries. In recent years, most of the efforts have been focused on water efficiency, but without taking care of energy aspects, resulting - in some cases - on a significant increase in energy consumption, combined with a scenario of increasing energy costs throughout Europe.

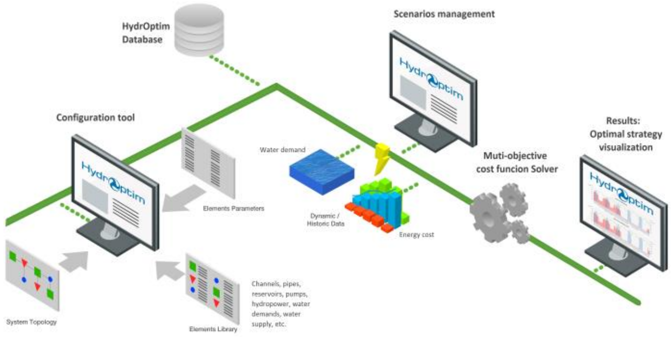
WEAM4i project has covered many case studies to demonstrate innovative techniques for resource efficiency at local level, decision support tools and an ICT/cloud platform for sharing weather forecast and remote sensing data services & applications.

The management of large water infrastructures is always complex. The water demand has to be always met and there is no room for 'what-if' scenarios with the existing infrastructures. The aim of this case study is to provide evidences whether it is worth to change the current energy contracts to new promising indexed contracts under the day-ahead energy market and to quantify the potential savings. HydrOptim is used as a decision support tool to answer this question.

HydrOptim tool

HydrOptim is a graphical decision support tool used for the integral optimal operational planning of hydraulic/hydrologic systems. The different elements of the hydraulic system are connected in the topology model by 'drag-and-drop' and the physical parameters of each element are edited using the configuration tool. The configuration tool generates the equations of the system in a format that can be understood by the mathematical solver. Then, HydrOptim is fed with observed real data (on-line or historical), with forecast information (water demand, energy prices) and it returns the set of process variables that minimises the operational costs for the scenario.

HydrOptim has four modes of operation: edition, simulation, monitoring and reproduction modes.



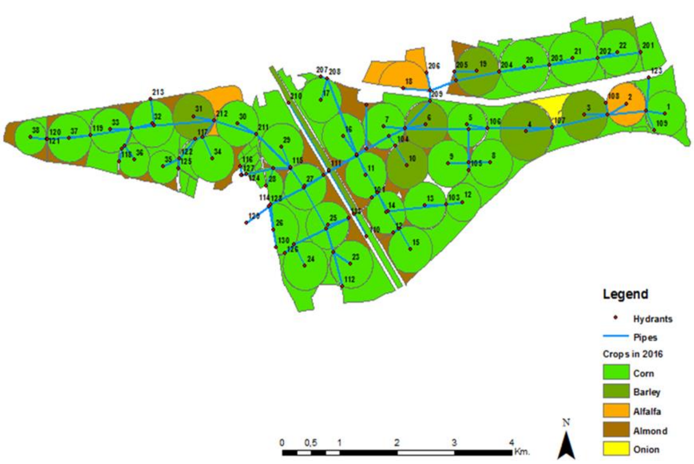
Challenges:

- To increase the efficiency of irrigation while reducing the operational expenditure related to energy, water sources, and process treatment.
- To satisfy the water demand and respect the physical constraints.
- To support the decision about changing the energy contracts in irrigation sectors.

Description of the case study

The case study for illustrating the proposed approach is located in the Ebro Valley, North Eastern Spain, in the Comunidad de Regantes del Canal de Bardenas. The considered area is the Monte Saso sector, belonging to the Irrigation District V. The district is connected to the Bardenas Canal, which started operation in 1959, after completion of the construction of the Yesa dam in the Aragón river. The canal provides water for about 80.000 ha in the provinces of Zaragoza and Navarra.

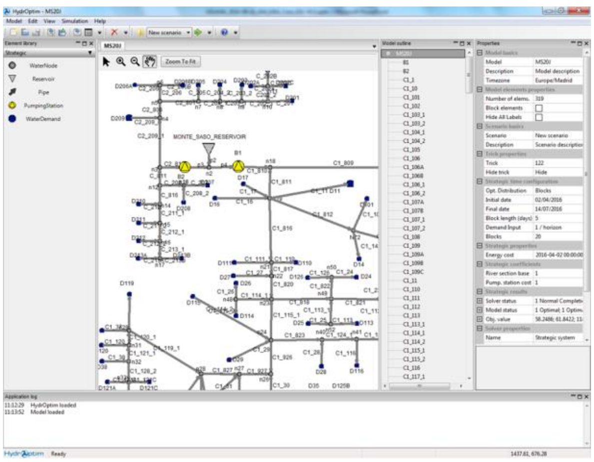
The total irrigated area is 1.200 ha, of which 240 ha are sprinkler irrigated and the rest are surface irrigated (100 ha using drips and 860 ha using pivots). The map shows the 94 hydrants located inside the district (37 sprinklers, 38 pivots and 19 drips). The District V has a pool that is filled on-demand. The pool has a capacity of 150.000 m3 and fills up by communicating vessels through a 1.025 l/s pipe. The infrastructure is not capable of supplying water to hydrants all the same time, thus the water supply is organized in shifts. Currently, the irrigation infrastructure is fully managed in a centralised way by Monte Saso technicians.



Two pumping stations at different levels supply the water to the hydrants. One pumping station with 8 pumps with capacity of 1.538 l/s (irrigates 88% of the total area) and the second pumping station with 5 pumps with of 229 l/s (irrigates 12% of the total area).

Description of the Solution

To demonstrate the proposed methodology and tool, several scenarios have been considered using real water demand data obtained from the system in two irrigation periods: April-September 2015 and April-September 2016. As a baseline, the water and electricity real consumption in this period has been considered.

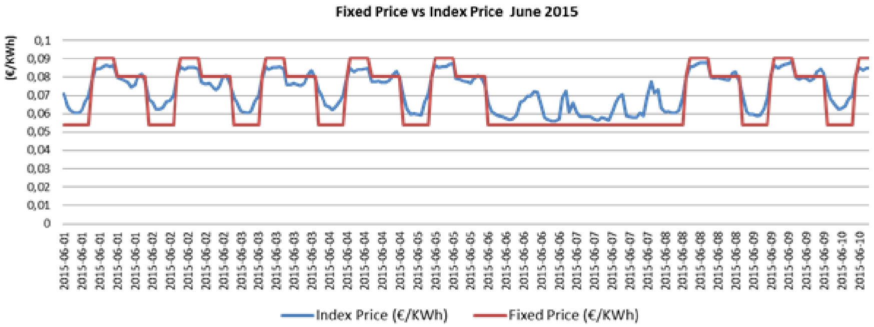


The hydraulic topology of Monte Saso sector was introduced in HydrOptim, and the different elements were configured.

The base line was compared with different scenarios using energy indexed prices for 2015 and 2016, as well as allowing HydrOptim to freely manage the irrigation shifts within a time window of five days (demand management).

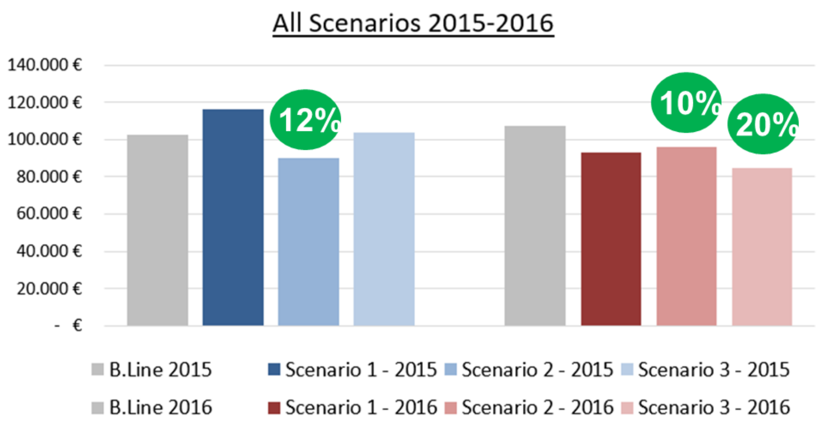
3 scenarios have been simulated with HydrOptim for the 2 periods:

1. Same demand management but with indexed contract
2. Optimized demand management and current fixed contract
3. Optimized demand management but with indexed contract



Results

Real water and energy data have been processed, compared with the results of the scenarios and summarised for the 2 periods in the following graph.



Potential **improvement of average cost/energy (€/MWh)** per irrigation season:

- **20%** with indexed contract and demand management
- **10%-12%** still can be improved by managing the demand with current contract
- Just changing the contract but keeping current demand practices is a risk: **+13%** (2015) to -**13%** (2016)

Learned lessons, conclusions and perspectives

1. Demand management as key factor: in terms of cost saving, the weight of the demand management is higher than the fact of changing energy contracts. Better results have been recorded when managing the irrigation shifts within a time window of five days rather than for one day.
2. An optimal control strategy has been demonstrated to plan how to serve the demanded water within prediction horizon of five days ahead taking into account minimising the electricity prices associated to pumping and taking into account the physical restrictions of the pipes. (€/MWh minimisation)

3. The results have been promising showing the validity of the proposed methodology and tool for the optimal management of irrigation systems. However, data availability and organisational barriers might hinder the adoption of the optimal strategies

4. As future work, the proposed approach will be coupled with water demand forecasting module that will be able to estimate the right amount of water required in each field taking into account the soil moisture, the crop growing status and the type of crop (crop per drop maximisation).

HydrOptim is a key decision support tool for the optimization of the operation of hydraulic systems, whose market driver is the growing concern about energy efficiency, energy cost and operational costs minimization in the water sector.

In Off-line mode, HydrOptim is a support tool for building 'what-if' scenarios for decision making on infrastructure investments, operation during water shortage episodes, contingency plans in case of breakdowns, decisions about new energy contracts, etc.

In On-line mode, HydrOptim provides the optimal set-points for the operation of the hydraulic system for the next period (hour, day) for a given time horizon (day, week). Real time data, water demand forecast and energy prices forecast will be required for the operational deployment.

HydrOptim is applicable to any existing hydrologic/hydraulic system worldwide, such as bulk water conveyance infrastructures, regulated river basins, drinking water networks, sewage systems, irrigation systems, etc. The target organisations are: Water utilities, water authorities and irrigation communities.

Contact point
Sergio De Campos, EU Innovation Programmes Manager
sdecampos@adasasistemas.com
www.adasaproducts.com | www.adasasistemas.com

ADASA

Acknowledgement:
This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration (grant agreement no. 619061).

WEAM4i
Water & Energy Advanced Management For Irrigation

www.WEAM4i.eu