Towards 100% Renewable Energy Islands: the role of the water cycle

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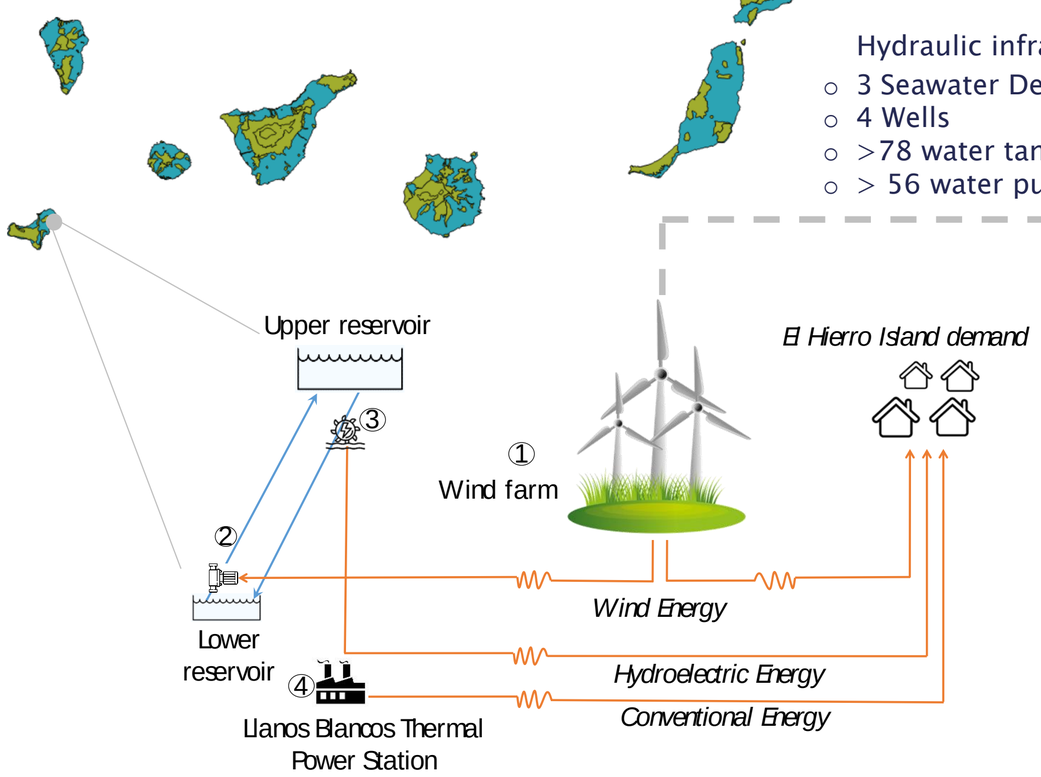
INTRODUCTION AND OBJETIVES

El Hierro Island (Canary Islands, Spain) has become a referent of 100% renewable energy island. Gorona del Viento Wind-Hydro Power Plant already covers around 60% of its annual electricity demand (2018), often hitting peaks of 100%. In this context, the energy-water nexus is one pillar to become a 100% renewable energy island. Water resources management, which includes groundwater extraction, seawater desalination, water pumping and distribution, represents around 35% of the annual electricity demand of the island, a clear sign of the interdependency between energy and water. In this context, the aim of this study is to propose a strategy to increase the share of renewable energies by supplying the water cycle load only with wind energy. The potential surplus of wind energy has been estimated, concluding that the wind production could theoretically be increased by 28% (wind energy that is currently not being produced). Therefore, the scenario proposed is to supply the whole water cycle (groundwater extraction, seawater desalination, pumping and distribution) only with wind energy and propose the strategies needed to guarantee the water supply during the whole year.



Hydraulic infrastructure:

- 3 Seawater Desalination Plants
- 4 Wells
- >78 water tanks
- > 56 water pumps

Wind energy surplus
5,802 MWh/year

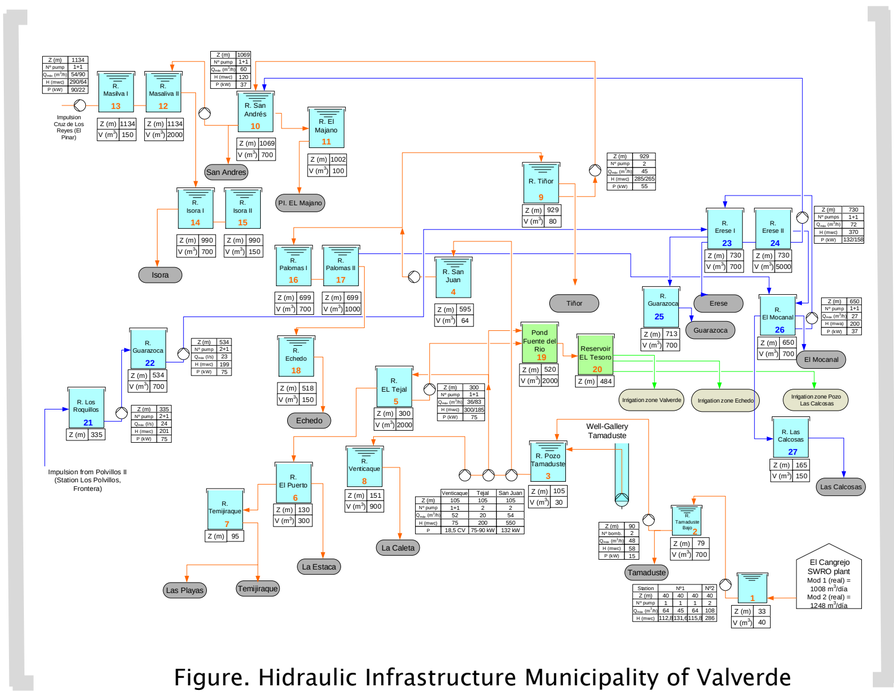


Figure. Hidraulic Infrastructure Municipality of Valverde

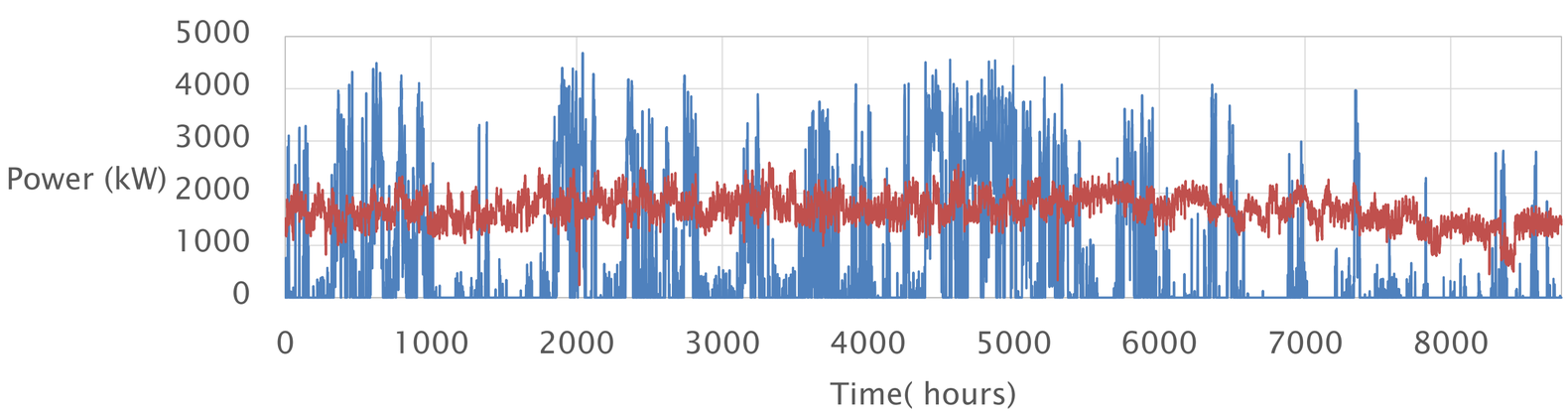


Figure. Wind energy surplus production versus energy needed to supply the water cycle during 2018

METHODOLOGY

The methodology can be summarized in 4 steps:

- Step 1: Data collection (energy data, water data, hydraulic infrastructure).
- Step 2: Estimation of the water cycle energy demand.
- Step 3: Recalculation of the island's energy demand (extracting the water cycle demand).
  - Calculation of the electricity production from wind, hydro and diesel.
  - Calculation of the wind energy surplus (to be used to cover the water cycle energy demand).
- Step 4: Strategies development.
  - Determination of the hydraulic lines and the critical tanks.
  - Coverage of the water cycle energy demand by wind energy surplus.
  - Simulated scenarios in the three municipalities of the island (Valverde, Frontera and El Pinar municipalities).

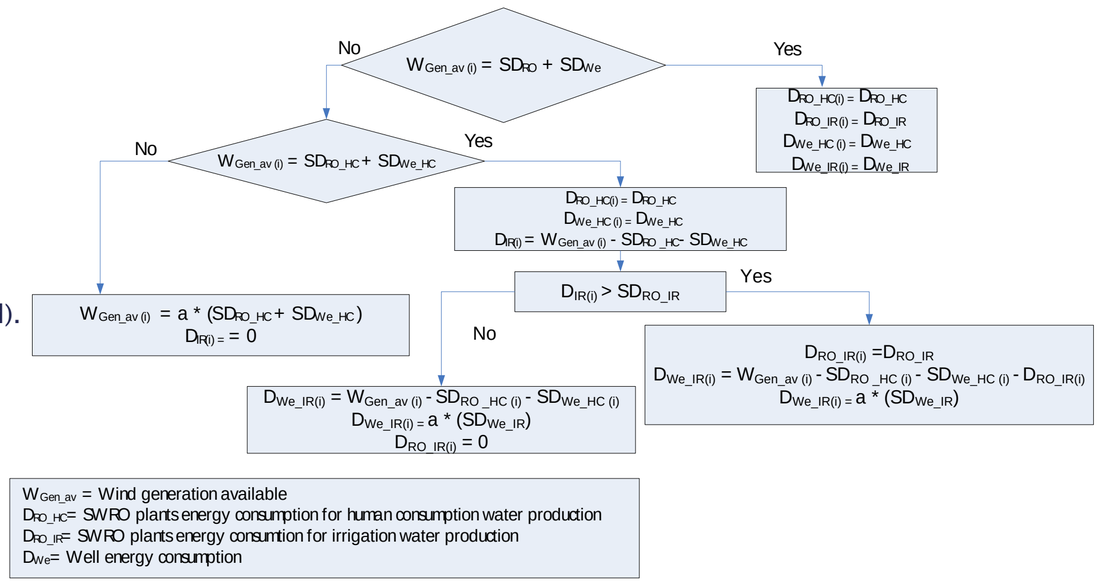


Figure. Logical diagram of the proposed methodology

RESULTS

Simulated Scenarios

- Current situation
  - Current water distribution losses: Frontera 27%, El Pinar 20%, Valverde 45%
  - Percentage of the wind energy surplus utilized: 76,5%.
  - Coverage of the water cycle: 28%.
  - 4 reservoirs expansion needed.
- Distribution losses reduction
  - Reduction of the water distribution losses: Frontera 15%, El Pinar 10%, Valverde 15%
  - Percentage of the wind energy surplus utilized: 76,5%.
  - Coverage of the water cycle: 33%.
  - 4 reservoirs expansion needed.
- Distribution losses reduction & energy consumption reduction in one RO plant
  - Reduction of the water distribution losses: Frontera 15%, El Pinar 10%, Valverde 15%
  - Percentage of the wind energy surplus utilized: 68%.
  - Coverage of the water cycle: 40%.
  - 4 reservoirs expansion needed.

CONCLUSIONS

- The best analysed option allows a water cycle coverage of 40%. This option utilizes 68% of the available wind energy surplus, while the remaining 32% cannot be used since the total water demand of the cycle is already covered.
- In this scenario, the wind energy utilized in the water cycle represents an increase of around 8% of the wind energy already used in the island and, consequentely, the global renewable contribution increased by 13%.

REFERENCES

[1] National Statistics Institute. Demography and population Available at:< https://www.ine.es > [accessed 20.02.2008].
[2] Elistratov, V. V., Vinogradova A. V. Autonomous WPP/HPP power system operating modes study. International Journal of Hydrogen Energy 42.17 (2017) 12355-12363.
[3] Brahim, B. Performance investigation of a hybrid PV-diesel power system for remote areas. International Journal of Energy Research (2018).
[5] Consejería de Economía, Industria, Comercio y Conocimiento. Anuario Energético de Canarias 2017. Available at:< http://www.gobiernodecanarias> [accessed 26.02.2008].
[6] Gorona del Viento S.A. Available at:< http://www.goronadelviento.es/> [accessed 26.02.2008].

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