

Maximizing the impact of innovative energy approaches in the EU islands

Modelling the waterenergy nexus of the future smart island

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Motivation

- To study the connection between water and energy system
- Developing innovative solutions for island independence and decarbonisation
- Implementation of RES with water supply system
- Simulation of water system and power system optimization
- To analyse alternative scenarios

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- Unije island
- 88 residents
- Desalination plant 27 kW
- Strategy: "Island Unije self-sustainable island"
- Partners in Croatia:
 - FSB
 - Ericsson Nikola Tesla
 - REA Kvarner
 - Water utility Cres i Lošinj
 - WWF Adria
 - HEP (associate partner)



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Unije Island

Existing state:

Brackish water well and associated pumps

Public water tanks

Desalination unit (80 m³/day) + PV plant 7 kW

Water supply and drainage system under construction

Planned state:

PV plant (1300 kW) + battery system (400 kW/1600 kWh) Water tower (800 m³)



--- Planned pressure pipeline due to terrain

Sewage Pumping Station
 Water treatment plant

Objects

Planned discharge pipeline from Water Treatmen Plant

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EPANET

Water system simulation



Calliope modelling framework

- Energy system optimization
- Wide variety of technology modelling possibilities
- Urban area modelling example
- <u>https://calliope.readthedocs</u>
 .io/en/stable/index.html



Mathematical model

Objective function:

$$\max\left(c_{\exp}D_{\exp,i} - c_{imp,i}P_{imp,i} - c_{desal,i}C_{desal,i} - \sum_{i}c_{mtn}P_{teh,i}\right) \quad [EUR].$$

Costs of maintainance:

$$\sum_{i} c_{\text{mtn}} P_{\text{teh},i} = c_{\text{mtn},\text{PV}} (P_{\text{PV1300},i} + P_{\text{PV7},i}) + c_{\text{mtn},\text{bat}} P_{\text{bat},i} + c_{\text{mtn},\text{des}} C_{\text{desal},i} \quad [\text{EUR}].$$

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Energy conservation equation:

 $D_{\text{el.en,i}} + C_{\text{desal,i}} + D_{\text{exp,i}} = P_{\text{PV1300,i}} + P_{\text{PV7,i}} + P_{\text{bat,i}} + P_{\text{imp,i}} \quad [kW]$

Volume conservation equation:

 $D_{\text{wat,i}} \pm P_{\text{wat,i}} = C_{\text{desal,i}} [\text{m}^3/\text{h}]$

Validation













Additional scenarios



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Scenario	Symbol	Description	
Battery optimization	OB	Battery capacity optimization	
Desalination unit optimization	OD	Desalination unit capacity optimization	
Water tower optimization	OV	Water tower capacity optimiza m ³	ation as addition to planned 800
Existing water tanks	PS	Connecting existing water tanks to the future water system	
House water tanks	KS	Connecting house tanks to the future water system	
Water savings	UV	Implementation of 20% water saving methods	
Gray water recovery	RSV	Gray water recovery for use in agriculture	

INSULAE UC1-Joint management of hybridized RES and storage

- Joint EOTRP (optimal technical connection to the grid)
- Battery system design
- PV and battery conceptual design
- Two meetings on Unije communicating the project with the locals
- Continuous coordination with HEP (croatian energy utility) for PV – battery system integration



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UC2-Smart integration and control of water and energy systems

- 7 kW PV instalation on desalination plant
- Design and mapping of the pipeline
- Continuous coordination with ViOCL and local government
- Soon completion of water pipeline works
- Desalination plant ready for operation
- Two presentations on Unije island discussing the use case with the locals





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UC3-Empowerment of islands' energy communities through 5G and IoT technologies for flexibility services

- Coordination with CIRCE regarding EnergyBox
- HW/SW adjustments made for EnergyBox to be compatible with several planned sensors
- EnergyBox testing at Ericsson Lab in Zagreb
- Backend infrastructure operational (IoT Consolidator) in Ericsson cloud
- Frontend design for data monitoring (energy consumption, temperature...)
- Installation of Meteo station on Unije (near desalination plant)
- Plan for sensors installation and integration with software completed



On-site installations

- Installation of Meteo station on Unije
- Plan for sensors installation and integration with software completed
- Data collection electric power demand







Thank you for your attention goran.krajacic@fsb.hr

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