

INTEGRATION OF COMBINED COOLING, HEATING AND POWER MICROGRIDS IN ZERO-**ENERGY PUBLIC BUILDINGS UNDER HIGH POWER QUALITY AND CONTINUITY** REQUIREMENTS

Jesús J. Martín Pérez jesus.martin@cnh2.es

CNH2 Lisbon, 26 October 2023

Centro Nacional del Hidrógeno





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Consejeria de la Presidencia, Administración Pública e Interior Consejería de Hacienda y Financiación Eur







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Introduction

In recent years, numerous projects have been developed to reduce energy consumption in buildings, both from the point of view of energy efficiency and integration with renewable energies.

However, the specific problem of integrating this type of energy systems in facilities, is that the reliability of the electricity supply has to be considered as a fundamental aspect.





Introduction

There are some places where power outages can mean more than economic losses:

- For health reasons in hospitals
- Scientific considerations in technology centers and universities
- Defense conditions either in military installations
- Security and surveillance in transport stations and airports









Objectives

The main objective of the IMRPOVEMENT project

To convert public buildings into zero energy buildings by integrating renewable energy microgrids with combined heat, cooling and power generation with inverters with active neutral control using hybrid energy storage systems (Hydrogen, batteries, ultracapacitor) that will ensure power quality and continuity of service to equipment sensitive to power quality disturbances (high-tech equipment) while increasing energy efficiency in this type of buildings.







Objectives

Specific Objectives

- Development of a system to improve energy efficiency in public buildings through a solar heating and cooling generation system and the incorporation of active/passive techniques for buildings with zero energy consumption.
- Development of a fault resistant power control system for microgrids under high quality design criteria and continuity of supply.
- Development of an energy management system for renewable generation microgrids with a hybrid energy storage system under criteria of minimum degradation, maximum efficiency and priority in the use of renewable energies







Microgrid as solution

- Resilience to grid failures
- Flexibility
- Economic optimization of energy prices
- Solve grid congestion problems
- Quality of supply







Power Management System

The inclusion of IoT sensors in Power Quality Advanced Metering Infrastructure Dual Power Source



(((-ESP 8266 Wi-Fi

WEB/MOBILE

ENERGY MANAGEMENT

SERVICE

Ś

Appliance embedded

IoT PQ sensor

ATMESA328

MCU

ADE7758

IGEN ENERGY DOMETREND



Power Management System

The development of a three-phase fourleg inverter to improve the power quality of the complete system









Energy Management System

<u>Objectives</u>

- manage thermal energy
- satisfy thermal comfort constraints

Control strategies

- reference strategy: PID+rulebased control
- advanced strategy: model predictive control (MPC)+PID

Portuguese pilot

- solar collectors
- hot water tank (HWT)
- thermal energy storage (TES)
- heat pump
- fan coil units (FCU)
- 4 rooms



Rule-based control

Reference strategy: PID+rulebased control



Energy Management System

FCU control: PID \rightarrow MPC+PID

- PID: turns on the FCU from 6AM to 6PM (all rooms)
- MPC: turns on the FCU from 7:30AM to 2PM (room 4)
- FCU is less used and energy consumption is reduced with MPC+PID (all rooms)
- Comfort constraints are satisfied with both control methods



Rooms in the building



 T_{sin4} : temperature of the room 4 (°C)

 F_{s4} : volumetric flowrate of the air leaving the FCU (m³/s)

25 0.8 **Femperature (°C)** 0.6 20 0.4 0.2 Tsin4 Fs4 15 0 10 15 20 25 0 5 Time (h) - Room 4 Air temperature regulation in room 4 (PID) 25 25 Temperature (°C) 20 20 Tsin4 TrefMPC TrefPID Trefm TrefM 15 15 0 5 10 20 25 15 Time (h) - Room 4

Air temperature regulation in room 4 (MPC+PID)



Energy Management System

One of the techniques used in the second algorithm developed is Resilience-Oriented Schedule of Microgrids







LNEG Pilot Plant

The main objective is to achieve and offer a thermal comfort situation in the facilities.





LNEG - Thermal EMS Pilot Plant

Pilot Plant



Electrical Production System





Thermal EMS System plant











LNEG - Electrical Pilot Plant









EUROPEANHYDROGEN ENERGY CONFERENCE



CNH2 Pilot Plant











ABB



Geothermal installation exterior part







Geothermal installation internal part









Cold Energy Storage System









Heat Energy Storage System

Where we have a circuit of water to recover the heat from the Fuel Cell and the Electrolizer and use it to store heat to reduce the power consumption of the building









developed in Labview.



Graphical Interfaces

Digine Spee



Thanks you very much!

www.improvement-sudoe.eu

Javier Tobajas Blanco Javier.tobajas@cnh2.es

Applications Unit Madrid, 19 May 2022















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