Multi Vector Energy Units

ACTIVE BUILDING CENTRE RESEARCH PROGRAMME

Introduction

This project focuses on the development and evaluation of a novel Multi Vector Energy Unit (MVEU) that intelligently leverages both electrical and advanced thermal storage options to maximise flexibility within the home and at community/national level. A core element of the work is the development of a scalable predictive control strategy based upon hierarchical model- and data predictive control (MPC and DPC, respectively).

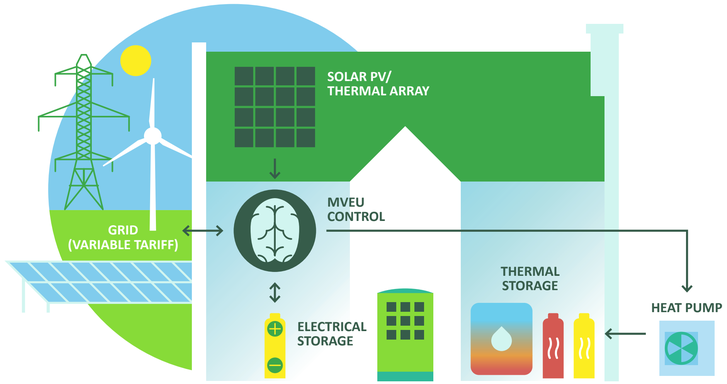

Fig 1. Schematic representation of an MVEU system

Aims and Objectives

The overall aim of the work is to develop a Minimum Working Example (MWE) of an MVEU system.

The MVEU system is expected to comprise control hardware and 1-2 thermal stores within a central unit, with interfaces for the addition of further components (heat pump; solar PV/thermal array; electrical battery; advanced thermal storage based on thermochemical storage (TCS) and phase change materials (PCM)) in a modular and system-agnostic fashion.

The objectives being pursued to achieve this are:

- Demonstration of technical feasibility via numerical modelling, optimisation and uncertainty analysis
- Development of data-and model-based modules for PCM and TCS components, informed by laboratory-based prototypes developed by academic partners
- Development of a laboratory-based test bed for experimental validation of the MVEU approach, including identification of practical challenges

Methodology and Progress

A hierarchical control strategy has been implemented, with system-level supervisory control used to arrive at set points for individual components, and direct control used to achieve these set points. Optimisation makes use of (multi) day ahead forecasts of electricity price (or carbon intensity), weather conditions and occupant demand.

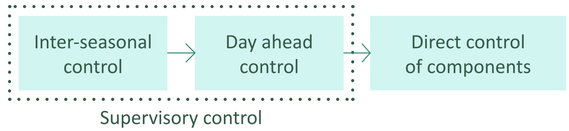

Fig 2. Outline control strategy

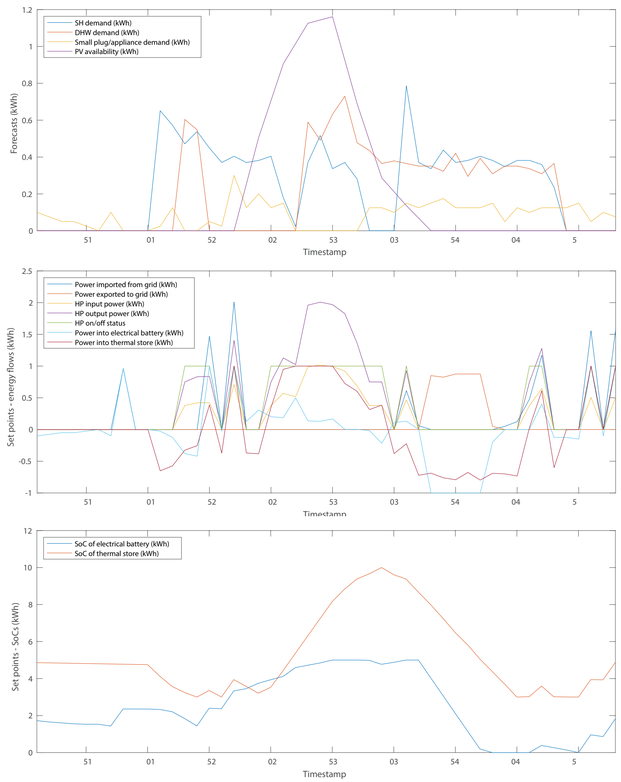

Fig 3. Example of day ahead optimisation via mixed integer linear programming (MILP)

Next Steps

- Integration of a thermochemical storage module based upon prototype lab data
- Evaluation of inter-seasonal control strategies
- Development of a State of Charge (SoC) estimation method for PCM module
- Development of demand forecast models, including uncertainty estimates
- Progression to laboratory trials

Georgios Grigoriou, Dr Rob Barthorpe • Active Building Centre Research Programme

Transforming Construction Impact Programme (TCIP)

10-week Market Exploration using Lean Launch Process to examine the market desirability of the Multi-Vector Energy Unit.

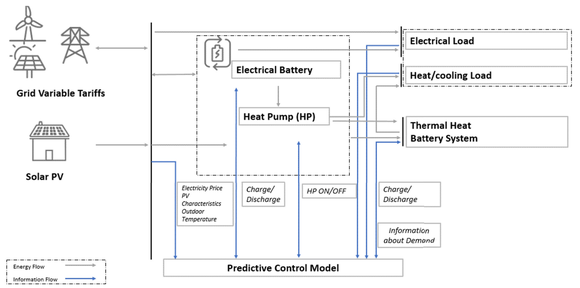

Fig 4. Concept Block Diagram of an MVEU System

Verbal Business Card

With the view to decarbonising domestic heating, MVEU will sit at the heart of the low/zero-carbon home and act as the brain within a modular system, allowing devices such as heat pumps, solar panels, electrical batteries, and thermal storage devices to be easily integrated and intelligently managed in a plug-and-play fashion. Through the MVEU, the aim is to leverage flexibility services like Demand-Side Management & Energy Storage Solutions in buildings to reduce cost and carbon emissions, maximise self-consumption while not compromising indoor comfort.

Customer Discovery Journey

Meetings were held with a large number of companies representing relevant market sectors. The TCIP process concluded with a pitch to a panel of impact investors.

Housing Services Providers

Module Providers

Energy Suppliers & Aggregators

4 Capital Project Profile

Top 3 Project Capitals & SDGs

CAPITALS	CATEGORY	DELIVERY PHASE Example Outcome Statements	OPERATIONAL PHASE Example Outcome Statements
Natural Capital	**Climate**	Low carbon end-to-end supply chain	Optimisation of a system for maximisation of renewable sources
Human Capital	**Health**	Make people feel good	Improvement of Indoor Air Quality & Comfort
Produced Capital	**Resilience**	Building MVEU in a sustainable & low carbon way	Deliver highly resilient assets to mitigate external threats & operational risks.

SUSTAINABLE DEVELOPMENT GOALS

Initial Hypotheses and Key Outcomes

Market engagement activity led to a significant shift in understanding of commercial case for an MVEU solution and the potential impact that could be delivered.

Replacement of Gas Boilers with Heat pumps & Advanced Thermal Stores + Distinct Component Units

Awareness about Climate Targets & Appetite for Zero Carbon Systems

Appetite for Digitalisation for a Sustainable World

Medium-Income, Tech Savvy, Climate-Aware People

‘Storing 2-3 Weeks worth of heat & use it when there’s no wind during winter can be very beneficial’
Head of Data Science, Limejump

‘Awareness should be raised to make people understand the value & Return of Investment that they can receive’
Project Manager of Smart Buildings, tado

‘Social Housing & New Builds are promising potential candidates for the MVEU’
Project Manager, EnergieSprong| COO, Mixergy| CEO, SmartKlub

Prifysgol Abertawe Swansea University

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