2030 NOW
THINK/CREATE/ACT

AALBORG UNIVERSITY

AN ENERGY MANAGEMENT SOLUTION FOR RENEWABLE ENERGY: INTEGRATED RESIDENTIAL MICROGRIDS

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Which SDG does your project relate to?

Sustainable Development Goal 7
- Ensure access to affordable, reliable, sustainable and modern energy for all

Sustainable Development Goal 11
- Make cities and human settlements inclusive, safe, resilient and sustainable

Sustainable Development Goal 13
- Take urgent action to combat climate change and its impacts

What is the concrete problem you have worked with?

Earth is the only planet known to this date where humankind can flourish. However, due to climate change, our planet is in grave danger which requires immediate action and adequate solutions. After the ratification of the Paris Climate Accords, there is a greater push to move away from the polluting centralized power generation source based on fossils like coal and natural gas.

This has led to the addition of more distributed energy sources like solar and wind. Microgrids (MG) are small-scale electricity networks that integrate distributed electricity generation with consumers who also produce electricity (prosumers) and potentially with storage systems.

Following the European and Danish strategies to increase the share of renewables (RESs) and reducing greenhouse gas (GHG) emissions, this project aims at representing the residential prosumers to utilize the maximum available RESs potential and energy storage possibilities to:

1. Decrease the electricity grid burden and consequently CO2 emission by locally generating their electricity demand from renewable resources
2. Smooth out the electricity demand curve of the electricity grid and make it more resilient
3. Raise the prosumer's awareness to benefit from generation, consumption, and price fluctuations to maximize their revenue.

What is your solution to the problem?

The residential microgrid has solar photo voltaic (SVP) modules with a 3kW capacity, a small wind turbine with a 2.4 kW capacity (Skystream 3.7), and a battery with 2kWh. In the project I used advanced modelling (Particle Swarm Optimization) to optimize the Energy Management System, aiming at designing the battery capacity.

With the modelling, I found that when the electricity-price is high, energy was supplied by the battery i.e., the battery is discharging and the state of charge (SoC) of the battery is low. Likewise, when the electricity-price is low, battery charges and SoC is high. The outcome is higher economic savings for prosumers as they can use electricity when the cost is low and sell the same when the cost is higher.

Modelling results show that when electricity-buying rate is maximum at 20:00 (evening), and state of charge (SoC) of battery concurrently is 37% and discharging. Likewise, the lowest rate of electricity is at 04:00 with SoC nearly 77% and charging.

The modelling residential microgrids, show net power-saving and if this technology is implemented in all residential homes (or alternatively in community level microgrids), then all homes and devices can be powered by clean solar and wind energy with a battery as a storage device. This would be an essential contribution to fulfilling the challenging Danish target of 70% emissions reductions by 2030 and climate neutrality by 2050.