Acadamh Ríoga na hÉireann
Royal Irish Academy

Royal Irish Academy Grants Report

Title:	Dr
First Name:	Andrei
Surname:	Marinescu
Discipline:	Sciences
Year of Award:	2018
Project Title	Optimizing residential renewable energy usage using reinforcement learning and model predictive control in a real-world EV-based scenario

1. Research background:

I am a postdoctoral researcher in CONNECT, the SFI Centre for future networks, in Trinity College Dublin. During my PhD I was involved in research in the smart grids domain, where I investigated the application of machine learning techniques to ease the power grid's transition in integrating renewable energy sources and electric vehicles. Currently, I conduct research involving the application of deep learning in mobile networks.

I have a general interest in predictive analytics and reinforcement learning based control, and their application in the smart-grids, micro-grids, and telecommunications domains.

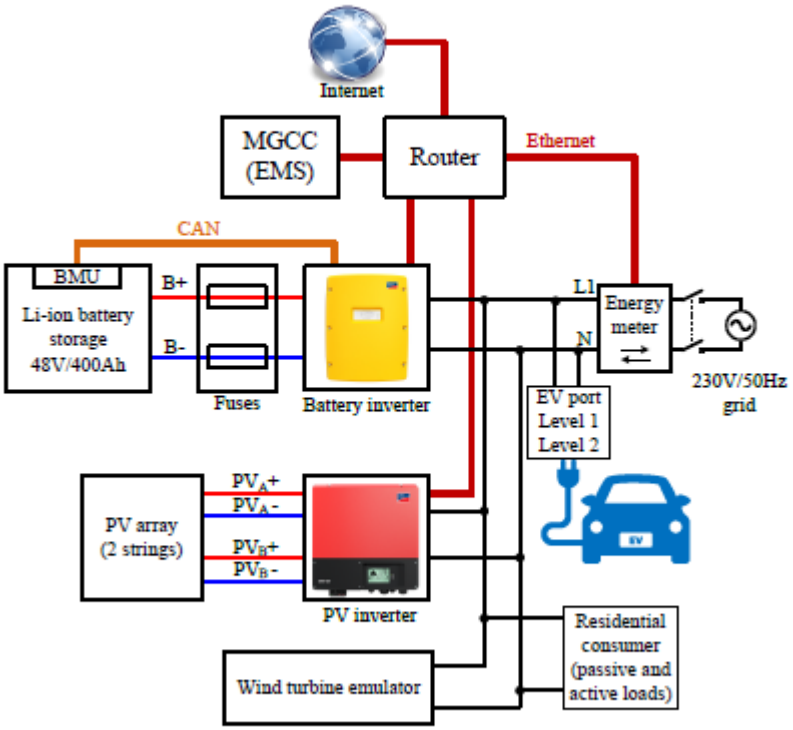
2. Please outline the findings of your research and/or milestones achieved (did you achieve the primary objectives - if not, what did you learn from the process)?

We investigated two control solutions, one based on deep reinforcement learning, and one based on model predictive control using recurrent neural networks. The second solution produced better results, so our efforts were focused on developing the control framework around it. Two additional forecasting modules, one for solar power and one for wind power, which were able to achieve high forecasting accuracy, of up to 94%. We have evaluated the control system in software simulation; results showed that our solution is 80% optimal in terms of minimizing the energy costs associated with electric vehicle charging. The costs minimisations occur when renewable energy integration is maximised by buffering excess renewable energy in a residential energy storage system (i.e., battery).

Note that the level of efficiency is also dependent on the accuracy of residential energy usage forecasts. Since at residential user level (the scenario considered) the energy demand is highly variable and uncertain, we consider the level of efficiency achieved by our control system satisfactory (note that perfect efficiency is achieved only if we know exactly on a 24 hours ahead basis the amount of renewable energy produced and the residential user load, a feat which is unrealistic but used as an evaluation benchmark).

We have achieved this performance while also keeping the battery levels within the 20%-80% state of charge, thus extending its lifetime to 20 years and decreasing costs associated with battery usage. As such, both our objectives were reached. We intend to perform further evaluations in hardware for our system

Overall setup:



The project's team: