UCD Engineering - PhD Opportunities
Electricity Research Centre (ERC) / School of Mechanical & Materials Engineering
Demand Response Strategies – Commercial Buildings and Home Area Networks

As an essential of modern life, electricity is different from other commodities. It cannot be stored economically, and the supply of and demand for electricity must be balanced in real time. Mismatches in supply and demand can threaten grid integrity within seconds. Grid conditions can change significantly from day to day or hour to hour especially with the introduction of Renewable Energy Sources (mainly wind) in the electricity generation fuel mix. Demand levels also can change quite rapidly and unexpectedly. Increasing grid capacity to maintain reserve margins sufficient for demand is possible, but is not a good solution because the electric system is highly capital-intensive, and both generation and transmission system investments have long lead times. Whereas the cost of electric power varies on a short time scale, customers generally face retail electricity rates that are fixed for months or years at a time, representing the average costs of electricity production (including transmission and distribution). This disconnect between costs of short-term marginal electricity production and the fixed retail rates paid by consumers leads to an inefficient use of resources. By contrast, Demand Response (DR) generally induces demand shedding, shifting or limiting during times when the electric grid is near its capacity, or when electric wholesale prices are high. Under conditions of tight electricity supply, DR can significantly reduce peak price and, in general, electricity price volatility. Given that building energy demand accounts for up to a third of primary energy consumption globally (40% in the EU), and an increasing associated electricity footprint within buildings, buildings will therefore be central to a scaling up of demand response to levels that significantly reduce costs, mitigate environmental impacts, increase reliability and balance intermittent resources of an electric grid that is changing quickly.

Two PhD opportunities now exist at the Electricity Research Centre, UCD in collaboration with the School of Mechanical and Materials Engineering, that will focus on examining how buildings can be incorporated as an integral component as part of a Demand Response solution with the electricity grid.

PhD 1 Automated demand response algorithms in the commercial building sector as a mechanism to address electricity supply demand synchronisation in a distributed flexible grid

This PhD will focus on the development of Auto-Demand Response algorithms for application in commercial buildings, thereby demonstrating the application of Auto-DR strategies in such environments. Using one or more UCD campus buildings as demonstration sites, this project will investigate the feasibility of Automated Demand Response (Auto-DR) in commercial buildings. More specifically, the project objectives are as follows:

- Identify representative ‘commercial-like’ buildings on the UCD campus.
- Investigate the automation capabilities of the different Demand Response (DR) programmes identifying the most viable.
- Develop building simulation models using EnergyPlus to assess space, occupant comfort, weather profiling of the building to different DR strategies and to examine and optimise the most suitable DR strategies.
- Identify, develop, optimise and implement effective Auto-DR control and load shedding algorithms on categorised buildings - firstly in the building simulation model then using existing appropriately modified building energy management systems (BEMS).
- Perform comprehensive feasibility studies which will:
    - Evaluate the effectiveness of the designed Auto-DR control systems.
    - Evaluate the effect of Auto-DR control strategies on building and occupant comfort and determine how building/facility managers/owners will respond to this form of automation.
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The main outcome of this research is likely to result in the development of technically feasible, scalable, effective robust Auto-DR algorithms for commercial buildings that can respond to utility operator requirements.

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PhD 2 Demand response algorithms for Home Area Networks (HAN) utilising forecasted meteorological data and utility demand-supply profiles

This PhD project will analyse the integration of domestic energy equipment, thermal storage solutions subject to utility demand constraints, so as to optimise both utility demand expectations and building occupier comfort requirements. The project objectives are as follows:

- Identify an appropriate domestic building(s). The ideal building(s) should have a range of thermal energy storage systems (e.g., hot water tank, high thermal mass, thermal storage heaters, phase change materials, etc), preferably both electrical and gas/oil fuelled HVAC equipment (e.g. electric resistance heaters, heat pumps, boilers) or electricity generation equipment (e.g. microCHP, PV).
- Audit and install metering equipment in the building(s) to record its energy behaviour. Model the building using EnergyPlus and calibrate/validate the model.
- Subject to weather predictions / expected occupancy patterns & profiles, as well as utility pricing data - examine dwelling sensitivity response (energy use, energy cost, thermal comfort) to different Demand Response schemes.
- Develop algorithms (subject to user modes and profiles) and incorporate these within an integrated Energy Management System in the dwelling that will automatically implement DR schemes.
- Test the Energy Management System in the house and assess its performance (i.e., energy use, energy cost, thermal comfort, occupant response).

The main outcome of this research is likely to be control algorithms implementable on residential energy management systems that can respond to utility demand scenarios so as to shift domestic thermal loads without unduly compromising occupier comfort.

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For either PhD position, the successful candidate is likely to have a background in Electrical or Mechanical Engineering and will be expected to work with the ERC project team. Liaison with the collaborating industrial partners, preparation of technical reports, presentation at international conferences and publication of research findings in peer-reviewed journals will be expected. Candidates will be supervised by Drs. Roisin Duignan, Donal Finn and Simeon Oxizidis.

Applications should include a CV and covering letter outlining why they think they are suitable for the position and be sent to any of the above (roisin.duignan@ucd.ie, donal.finn@ud.ie simeon.oxizidis@ucd.ie). Although applications will be accepted until the positions are filled, early submission of interest is encouraged.