

UCD EMPower outputs for Climate Action Modelling Group

Title	Publication	Summary	Date
Backbone—An Adaptable Energy Systems Modelling Framework	Journal Paper	Backbone represents a highly adaptable energy systems modelling framework, which can be utilised to create models for studying the design and operation of energy systems, both from investment planning and scheduling perspectives. doi	02-Sep-19
The role of power-to-gas in the future energy system: Market and portfolio effects	Journal Paper	This paper considers the potential of power-to-gas to provide flexibility and enhance system integration of renewables. Firms with renewable generation benefit from investing in power-to-gas. While the technology itself is loss-making, power-to-gas particularly increases demand and hence prices in low-load hours. doi	15-Oct-19
A Social cost-benefit analysis of the Irish Vehicle Tax Reform	Report	This paper presents the results of an ex-post evaluation of the impacts of the 2008 vehicle tax reform in Ireland. We carry out a full social cost-benefit analysis of a vehicle tax reform that began in Ireland in 2008 and show that whilst successful in improving the fuel economy of new passenger cars, it may also have caused unintended effects, such as increased proliferation of diesel vehicles in the passenger car fleet. These outcomes have mitigated the overall benefits. In addition to quantifying the scale of the various effects and outcomes, this paper demonstrates the importance of broad-scope policy design. doi	20-Dec-19
Factors influencing early battery electric vehicle adoption in Ireland	Journal Paper	Factors that influence battery electric vehicle (BEV) uptake amongst early adopters are examined. We provide new evidence for Ireland on the key determinants of uptake in the early phase of technology diffusion by combining Irish census and BEV uptake data at a granular spatial scale for the first time. doi	01-Feb-20
The resilient decentralised control of inverter-interfaced distributed energy sources in low-voltage distribution grids	Journal Paper	This study identifies the relationship between the voltage at the terminals of an inverter-interfaced renewable energy source (RES) and its optimal reactive power support. This relationship, known as volt-Var curve (VVC), enables the decentralised operation of RES for active voltage management (AVM). By updating the VVCs according to the system configuration and components' availability, the objective functions will be significantly improved and the AVM method remains resilient against network changes. doi	11-Feb-20
Addressing technical challenges in 100% variable inverter-based renewable energy power systems	Journal Paper	This article provides a review of the status of power systems throughout the world with increased integration of renewable generation. It reviews the implications of this, focusing on rising challenges, and provides an overview and technology-readiness classifications of some proposed mitigation strategies. doi	27-May-20

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Uncertainty management in decision-making in power system operation (Book Chapter)	Book Chapter	Due to the penetration of renewable energy resources and load deviation, uncertainty handling is one of the main challenges for power systems; therefore the need for accurate decision-making in a power system under the penetration of uncertainties is essential. In this chapter, some of the uncertainty modelling methods in power system studies are analyzed. doi	01-Jun-20
COVID-19 and EU Climate Targets: Can We Now Go Further?	Journal Paper	This paper examines the implications of the COVID-19 crisis on the 2030 EU CO2 emissions target, considering a range of economic growth scenarios. Our analysis highlights that although existing climate policy measures will likely reduce emissions more than 40% by 2030 in the wake of the pandemic, they will not be enough to meet the Paris agreement. More stringent measures, such as those proposed under the Green New Deal, will still be needed and may be less costly than previously estimated. doi	04-Aug-20
Impact of Wide-Scale Data Centre Growth on Power System Operation with Large Share of Renewables	Conference Paper	The potential of data centres to contribute to demand flexibility in a day-ahead electricity market is examined in this study. Several factors are examined to demonstrate how large-scale data centre growth can affect a system's ability to meet its renewable obligations. doi	16-Sep-20
System impact studies for near 100% renewable energy systems dominated by inverter-based variable generation	Journal Paper	This paper examines the implications of the move to near 100% renewable energy systems concerning planning, operation and system stability, also addressing the need for integration with other energy vectors, including heat, transport and Power-to-X. link	30-Oct-20
The network limits on residential heat pump capacity as an enabling technology towards renewables integration	Conference Paper	Heat pumps will increase the demand from domestic customers and reduce the natural diversification of loads in low voltage (LV) networks, with implications, at certain times, for the loading levels of network assets, and voltage drops at the extremes of the LV feeders. This paper assesses the volume restrictions that LV feeders are likely to require on the widespread installation of heat pumps for different domestic settings. link	01-Mar-21
Analysing wind and solar power integration with a multi-carrier energy system model of Ireland	Conference Paper	This article analyses the costs and benefits of several sector-coupling measures using an energy system model with hourly scheduling of the whole energy system. The results indicate the potential importance of electricity-based heating in the industrial sector, smart charging of electric vehicles, batteries and power-to-ammonia, as part of achieving future targets. doi	01-Mar-21
Plug-In Hybrid Electric Vehicles	Report to DTTAS	The aim of this report was twofold – (i) to carry out a review of current subsidies and grants for PHEVs and plans for their phase-out in European countries; (ii) to simulate the PHEV and BEV fleet in Ireland and model the impact of grant phase-out timing on the fleet under two techno-economic scenarios.	01-Mar-21

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Power system stability in the transition to a low carbon grid: A techno-economic perspective on challenges and opportunities	Journal Paper	This article provides a comprehensive overview of emerging power system stability challenges posed by power electronic converter-interfaced renewable energy sources (RES) and distributed energy sources (DERs), particularly related to low inertia and low system strength conditions. This paper also introduces new technologies that can help tackle these challenges and discusses the need for suitable techno-economic considerations to integrate them into system and market operations. doi	05-Apr-21
Report on Higher Climate Ambition Energy Research	Report to DECC	This report presents the findings from UCD research on the implications of Ireland's decarbonisation strategy under the levels of higher ambition outlined in the new Climate bill. The analysis focuses on three areas: the predicted uptake of new technologies by households under various policy scenarios, e.g. heat pumps, EVs, and solar PV; the impact on the distribution network of increased electrification; and the feasibility of very high shares of renewable electricity in terms of the reliability and adequacy of the power system and the potential for flexibility.	13-May-21
Green hydrogen: A new flexibility source for security-constrained scheduling of power systems with renewable energies	Journal Paper	Green hydrogen, i.e. the hydrogen generated from renewable energy sources (RES) may contribute to a successful energy transition. This paper develops a model to investigate the possible impacts on generation scheduling and power system security on the introduction of green hydrogen to the electricity network. doi	28-May-21
Enhanced Transmission and Distribution Network Coordination to Host More Electric Vehicles and PV	Journal Paper	The focus of this paper is on investigating and managing the impacts of Electric Vehicle (EV) charging and Photo-Voltaic cells considering TSO-DSO interaction constraints. The aim is to optimally utilise the existing assets and flexibilities to have more EV and Photo-voltaic (PV) units at the distribution level without causing technical problems at the transmission level. Policymakers could readily use the proposed model to design and implement proper time-of-use tariffs to better handle the increasing EV demand and PV units in emerging distribution networks. link	19-Jul-21
Multi-sectoral flexibility measures to facilitate wind and solar power integration	Journal Paper	In this paper, the impact of a range of flexibility measures is assessed for the island system of Ireland, with a high share of renewable energy, particularly wind and solar. Flexibility measures studied include hybrid heating in domestic and industrial processes, smart charging of electric vehicles, renewable hydrogen, power to ammonia, peak shaving demand response and batteries. doi	24-Jan-22

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The state of play in electric vehicle charging services – A review of infrastructure provision, players, and policies	Journal Paper	EV charging infrastructure can be viewed either as a public good or a private asset. This paper considers the issues of the location of future chargers, the deployment models needed to develop, operate and own charging infrastructure, and finally the policy context for the development of charging infrastructure. We find that clear roles should be assigned to the individual public and private actors and funders, in order to achieve efficient development of the required infrastructure for large-scale EV deployment. doi	01-Feb-22
Heterogeneity in preferences for renewable home heating systems among Irish households	Journal Paper	This paper aims to understand heterogeneity in preferences for renewable home heating systems such as heat pump systems, using a combination of psychological construct statements and a discrete choice experiment. The findings of this study should provide useful information to policymakers and companies on end-user profiles, heterogeneity in preferences, and willingness to pay estimates for new home heating alternatives. doi	01-Feb-22
Demand response and curtailment in an isolated system with up to 80% renewables	Conference Paper	The latest 2030 target aims for up to 80% of electricity consumed on the island to be provided by renewable sources, predominantly wind power. The objective of this conference paper is to investigate the role of flexible demand in reducing curtailment, improving operational security, and the economic implications for electricity generators and consumers. link	01-Mar-22
C-E (curtailment – Energy share) map An objective and quantitative measure to evaluate wind and solar curtailment	Journal Paper	This paper evaluates and compares curtailment situations in selected countries using an objective and quantitative evaluation tool named the “C-E map” (curtailment-energy share map). The C-E map is a correlation map between curtailment ratios i.e. mean curtailed wind (or solar) energy per available energy and energy shares of wind (or solar). doi	01-May-22
Flexibility From the Electrification of Energy: How Heating, Transport, and Industries Can Support a 100% Sustainable Energy System	Journal Paper	This article examines the technology status and implementation timeline for the electrification of various end-use sectors and their potential to offer flexibility. Key technologies include heat pumps, which are already commercially available for space heating; EVs, which are currently expanding rapidly in transport; and a growing number of industrial processes with the potential to replace fuels with electricity. The main barriers to achieving greater flexibility are discussed, be they technological, economic, regulatory, social, and/or behavioral. link	22-Jun-22
Decarbonising Passenger Cars	Report to DECC/DTTAS	This report is based on agent-based modelling of future passenger vehicle choices by Irish drivers in the light of policy and technology cost assumptions. The implications for fleet composition, supply and demand in the second-hand market, exchequer revenue and inequality are considered quantitatively in a scenario where the climate action plan ambition is achieved in 2030. This requires a path to low electricity prices and high pump prices in 2030.	01-Jul-22

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Clean energy technology adoption – policy analysis for a cleaner future	Policy Brief	Barriers to the adoption of low-carbon technologies (heat pumps, electric vehicles, photovoltaics) by Irish households are reviewed. Agent-based-modelling tools developed at UCD can assist policymakers in evaluating the effectiveness of measures to overcome these barriers and achieve climate targets. link	01-Nov-22
Adoption of Renewable Home Heating Systems: An Agent-Based Model of Heat Pump Systems in Ireland	Journal Paper	An agent-based model is developed and used to analyze the adoption process of heat pump systems in Ireland. Underlying psychological factors and social networks influence the adoption and diffusion of heat pump systems. Agent-based modelling is of interest to policymakers, as the impact of various policies on technology adoption rates can be tested explicitly. doi	01-Nov-22
Enhancing the unbalanced distribution network's hosting capacity for DERs	Journal Paper	Maximizing the distribution systems' hosting capacity for distributed energy resources (DERs) is an integral part of the efforts to decarbonise the energy system. Using a novel three-stage optimization model, this paper shows how the network's HC for DERs can be enhanced, taking technical constraints such as voltage unbalance caused by the high share of DERs into account. doi	01-Dec-22
Distributed flexibility to maintain security margin through decentralised TSO–DSO coordination	Journal Paper	A decentralised scheme for the coordination of transmission and distribution networks while maintaining the voltage security of the whole integrated system, is proposed. This decentralised optimisation scheme preserves the system security with minimum information exchange between operators, as well as minimum physical load curtailment. The distributed flexibilities of all DSOs are utilised to meet the required security margin of the whole system. doi	01-Mar-23
Temperature neutrality and Irish methane policy	Journal Paper	Temperature neutrality is a natural way to frame climate policy in countries with significant agricultural methane emissions. It provides one way to align national policy with Article 2.a of the Paris Agreement. doi	20-Apr-23
Strategies to increase grid flexibility for an isolated system with over 80% renewable electricity in 2030	Conference Paper	This conference paper summarises the unit commitment modelling results from UCD for the 80% RES-E 2030 power system in 2030 described in CAP2023. Flexibility is key to reducing curtailment, especially on an island system. The impact of the different sources of flexibility, including synchronous condensers, is assessed. link	06-Jun-23
A review of policies for the rollout of solar PV in Ireland	Report to CCAC	The report reviews policies used to incentivise rooftop solar PV internationally and the potential for Ireland. Modelling gives insights into the impact of policy support on the future uptake of solar PV and battery storage by Irish households.	01-Nov-23