Policy Brief

Risks & returns of technology opportunities in the energy transition

Our 2050

This is one of a series of policy briefs to summarize ongoing findings related to the research project, 'Our 2050 – Opportunities for Ireland in a Low Carbon Economy', which is on the economic and societal opportunities arising from the transition to a low carbon economy and the policies needed to achieve this transition.

MaREI Centre for Marine and Renewable Energy
EPMG Energy Policy & Modelling Group
IERG Intelligent Efficiency Research Group
eri Environmental Research Institute
UCC University College Cork, Ireland Coláiste na hOllscoile Corcaigh

The Our 2050 project is addressing four key questions:

1. What will Ireland's future energy use look like? In particular, how will we generate electricity? How will we heat our buildings? What modes of travel will we use?
2. What technologies are most likely to play leading roles in Ireland's transition to a low carbon economy?
3. What strengths can Ireland play to, and what opportunities can Irish-based firms avail of?
4. What policies are needed? What do government, firms, universities and individuals need to do, individually and collectively, to achieve the transition?

This policy brief addresses the challenges faced when answering the second & third questions.

Technology opportunities in transitioning energy systems – the challenge of uncertainty

In navigating the energy transition, policy makers, business executives and other stakeholders face new and complex decisions, without perfect information or knowledge of the future. To address this, we present an approach linking quantitative and qualitative methods to understand the opportunity and potential for different low carbon technologies in the energy transition, while at the same time, accounting for uncertainty and the unintended consequences that may arise.

Systemic visions and targets related to climate change are important as starting points for discussion and planning. However, identification of the actions required are not trivial. Although there are several prospective low carbon technologies, in light of the complex interconnected operation of the energy system, decisions and choices around technological alternatives can be challenging. Our approach accounts for uncertainty at two levels: i) systemic uncertainty and ii) uncertainty in stakeholder perception of the relative importance of different technology attributes.

This policy brief represents a contribution to effective engagement between users and providers of information that links climate change to decision making. We report our findings on linking low carbon pathways to diverse stakeholder perceptions in order to generate low carbon scenario ensembles that represent a wide range of uncertain outcomes for the energy system. We characterise this range and diversity by quantifying the risks and returns of different technologies.

The research employs a whole energy system optimization model (Irish TIMES model) to describe and develop pathways and scenarios of future energy use. Energy system optimization models such as the Irish TIMES model map the entire energy system from primary resources to end use. The model can then be used to project different future energy systems that account for preferences in system cost, carbon emissions, and renewable energy integration. To account for different stakeholder values we use multi-criteria assessment of technology. By including stakeholders outside our discipline, we adopt a transdisciplinary approach.

Transdisciplinary Assessment of Technology Opportunities

The following methodology characterizes technology opportunities in transitioning energy systems by quantifying the risks and returns of different low carbon technologies.

1. Identification: Scanning of the technology landscape as represented in the Irish TIMES energy system model to identify prominent technologies in 2050. It has been achieved by developing rank trajectories (Figure 1) for technologies, where rank is based on level of energy consumption. The level of energy consumption is considered part of the level of return in this analysis.

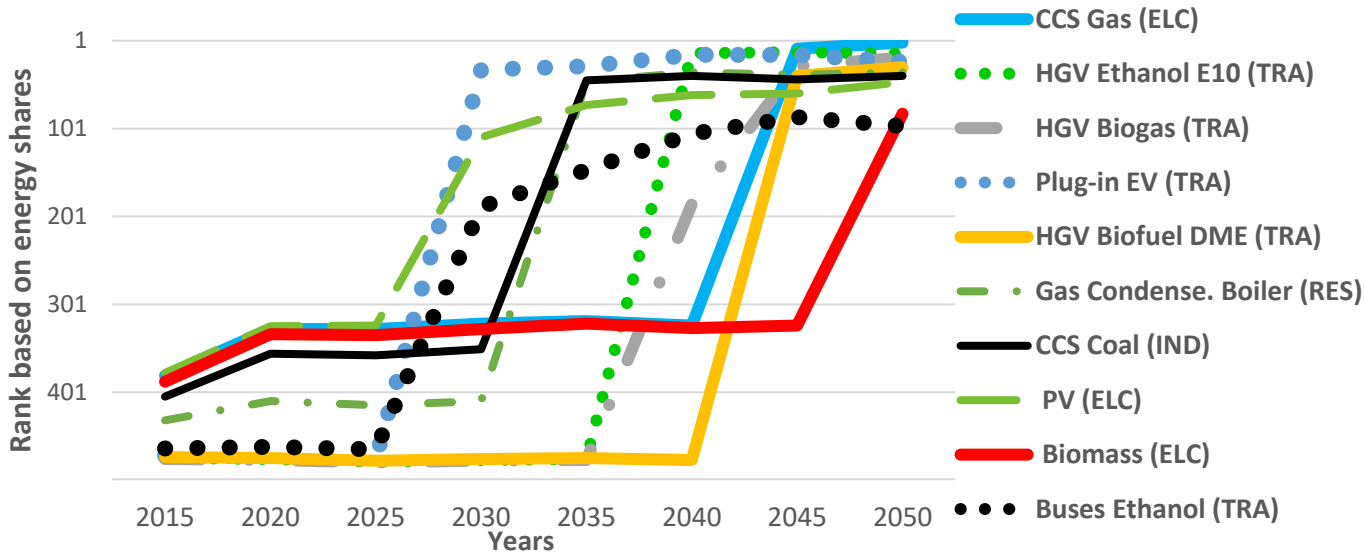

Figure 1: Rank trajectories for 10 prominent technologies in 2050 under 80% mitigation scenario.

2. Engagement: Stakeholder consultation to generate scenario ensembles by identifying systemic risk factors. These risk factors are used to generate scenario ensembles with hundreds of scenarios, which are then used to quantify the range of risk attributes of different technologies.

3. Characterization: Combined quantification of risk and return attributes for technology options. For this analysis we have considered six attributes as shown in Table 1. These criteria are weighted in various ways to obtain overall rankings for technology opportunities that account for risk attributes (as determined in step 2) and returns (as determined in step 1).

Table 1: Attributes captured from scenario ensemble.

Sl. No.	Attribute	Description
1	Market size	Captured by energy share of a technology in year 2050 in 80% mitigation scenario
2	Technology opportunity	Measured as energy gradient for technological option between year 2015 and 2050 in 80% mitigation scenario (corresponds approximately to a carbon budget of 994 mt for Ireland)
3	Carbon policy risk	Quantified as variance of energy consumption by technological options in the year 2050 as carbon budget varies from 366 mt to 1116 mt
4	Biomass imports risk	Captured as variance of energy consumption in the year 2050 as biomass imports are reduced to zero
5	CCS (Carbon Capture and Storage) development risk	Quantified as variance of energy consumption in 2050 with and without availability of CCS
6	Joint effect of carbon budget & BECCS development risk	Measured as variance of energy consumption in 2050 as BECCS's availability varies from year 2040 to 2052 while carbon budget varies from 366 mt to 1,116 mt

Findings

Importance of expectation setting and pragmatism in managing the energy transition cannot be ignored. Engaging diverse stakeholders and perspectives to evolve a shared understanding and expectation is challenging but has the potential to better harness the opportunities. Stakeholder engagement is important as it allows challenges and questioning of the assumptions and methodologies of quantitative models underlying policy targets which is crucial for bringing credibility to the outcomes of the analysis.

The risks and returns associated with technology opportunities have multiple dimensions. Transdisciplinary research integrating energy system optimization models with stakeholder engagement is a powerful methodology for profiling technology risk-return profiles. We observe substantial variations in risk–return profiles for technologies. Such analysis provides a useful starting point to take steps to mitigate the scenario-related risks. The analysis indicates to the crucial role of EU and the Irish government policy on carbon mitigation. At the same time, it captures implications of exogenous factors, e.g., availability of biomass imports for relative attractiveness of technology opportunities.

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Further Reading

1. *Sharma Tarun, Rogan F., Ó Gallachóir B.P. "A new hybrid approach for multi-criteria assessment of technology opportunities in transitioning energy systems", Environmental Innovation and Societal Transitions. In review.*
2. *Iyer, G., N. Hultman, J. Eom, H. McJeon, P. Patel and L. Clarke (2015). "Diffusion of low-carbon technologies and the feasibility of long-term climate targets." Technological Forecasting and Social Change 90: 103-118.*

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