Final holistic assessment of potential X-ROTOR economic impact

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Abstract

This report aims to provide a regional economic impact analysis of the X-ROTOR technology in a comparison with traditional horizontal axis wind turbines (HAWTs). An assessment of the relationship between offshore wind levelized costs reductions undertaken by Devoy McAuliffe *et al.* (2023) in Deliverable 6.2, is used to provide input to a system-wide economic modelling framework. The I-JEDI model used in our analysis is an Input Output framework to measure regional economic impacts of renewable energy technologies. Three economic regions are studied, Ireland, UK, and Spain. We consider two market scenarios, one with deployment of 5GW of offshore wind in the three regions to compare X-Rotor and HWATs, and a second scenario with 100% deployment of X-Rotor offshore wind generation in the UK so that direct comparisons may be made with the computable general equilibrium (CGE) model in Deliverable 7.8 (Williamson and Allan, 2024). We find that X-Rotor requires fewer workers and that the impact on the local economy is greater for UK and Spain which have a tradition of heavy industry compared with Ireland which is stronger in the tech and high value sectors. There is agreement between the two models for the numbers employed but the CGE model captures more of the GDP growth due to the wide-ranging effect of lower electricity prices.

Introduction & Objectives

The assessment takes a case study in Europe, analysing the deployment of X-ROTOR and HAWTs in three countries, Ireland, United Kingdom, and Spain. The approach taken is a bottom-up analysis which involves analysing individual variables at the lowest possible level of detail and aggregating the estimates to arrive at the economic impacts' summary totals. This approach complements the CGE approach taken by our colleagues in the University of Strathclyde. To capture overall economic impacts, IO models have been widely used since their establishment by Leontief, (1936). The challenge is the huge amount of data required to create an up-to-date regional specific IO model. We use a the I-JEDI Input-Output methodology to assess the regional economic impact of deploying 5GW of wind farm capacity.

Methods

The I-JEDI model used here was first developed by the National Renewable Energy Laboratory (NREL) with support from the U.S. Agency for International Development, as a free tool for assessing the economic impacts of renewables around the world. The model estimates the gross domestic product, employment, earnings, and output from the construction and operation of renewable energy projects across the domestic supply chain and channels the results to other sectors like manufacturing and banking services.

The methodology used is similar to Darghouth et al., (2020) which analyses the economic impact of distributed photovoltaic cells in Indonesia, and to Woollacott et al., (2023) for renewable energy investment in Kenya. The scenario and data follow results from Deliverable 6.2 (Devoy McAuliffe et al., 2023). Deliverable 6.2 of the X-ROTOR project, provides input on the reductions in levelized costs of electricity from the X-ROTOR concept which informs this economic analysis.

The I-JEDI model has three custom regions with different IO matrices that can be edited to match different economic regions in the world. We adjust the model to fit the three countries, Ireland, UK and Spain, used in this report by using the current (2021) IO tables.

The regional analysis is customised by 37 sectors which capture direct, indirect, and induced effect from the project investment. Direct impacts represent the economic impacts that are directly linked to construction, operation, and decommissioning of the project for example employment on the construction site. Indirect effects are connected to the business in the value chain, and induced effects occur when workers involved in construction and operations of the wind project spend their money in other economic activities.

Results

Table 1 presents the number of jobs required for each technology in the three economic regions for a 5GW deployment. On average over the three countries there are 10% fewer jobs required to generate 5GW using X-Rotor technology compared with HAWTs. This is because X-ROTOR technology delivers energy more cheaply than traditional HAWTs. In Ireland there is a small increase in the number of jobs for the X-Rotor technology than for HAWTs, this small difference is due to more indirect jobs from X- ROTOR technology than for HAWTs, and the relatively fewer number of jobs in the Irish economy compared to UK or Spain.

	Effect	X-ROTOR		HAWTs	
		Jobs	Jobs to work force (%)	Jobs	Jobs to work force (%)
Ireland	Direct	395	0.0148	405	0.0152
	Indirect	2570	0.0963	2,507	0.0939
	Induced	-	-	-	0
	Total	**2,965**	**0.1111**	**2,912**	**0.1091**
UK	Direct	624	0.0018	660	0.0019
	Indirect	3702	0.0108	4,593	0.0134
	Induced	-	0	-	0
	Total	**4,326**	**0.0126**	**5,252**	**0.0153**
Spain	Direct	691	0.0029	731	0.0031
	Indirect	3,699	0.0156	4,137	0.0175
	Induced	-	0	-	0
	Total	**4,390**	**0.0185**	**4,868**	**0.0205**

Table 1

	Effect	X-ROTOR		HAWTs	
		Total Output Generated € m	GDP (%)	Total Output Generated € m	GDP (%)
Ireland	Direct	9,709	1.4914	9,617	1.4773
	Indirect	13,310	2.0446	13,088	2.0104
	Induced	9,227	1.4173	8,959	1.3764
	Total	**32,246**	**4.9533**	**31,664**	**4.8639**
UK	Direct	15,721	0.4303	16,526	0.4523
	Indirect	19,943	0.5458	22,830	0.6248
	Induced	15,594	0.4268	16,319	0.4466
	Total	**51,258**	**1.4028**	**61,822**	**1.5237**
Spain	Direct	13,866	0.6277	14,597	0.6608
	Indirect	24,566	1.1121	20,007	0.9057
	Induced	13,472	0.6099	14,098	0.6382
	Total	**51,904**	**2.3497**	**47,702**	**2.2047**

Table 2.

Table 2 presents total output generated in each region by each technology for a 5GW deployment. It is important to recall that, approximately €20 billion is being fed into each economy irrespective of the technology. The first thing to note is that the output is on average more than double this input for each region. However, depending on the total percentage of spending and manufacturing in each country, Spain and UK have the largest output of €52 billion. As with the number of jobs the effect on total output from X-ROTOR in Ireland is slightly larger, 0.0409% of GDP, than the effect from HAWTs. It is the reverse for Spain and the UK, and by larger margins of 0.1448% and 0.1209% respectively. Looking at the normalised results, the output generated as a percentage of GDP is very high for Ireland due to the fact that it's a smaller country than Spain, leaving UK with the largest GDP with the smallest normalised effect.

Conclusion

This report compares the effect of X-ROTOR deployment and the deployment of traditional HAWTs in Ireland, UK, and Spain. The principal areas of interest are the effect on jobs and GDP. The difference in job requirements between X-ROTOR deployment and that of traditional HAWTs, is that X- ROTOR requires about 10% fewer jobs averaged over Ireland, UK, and Spain. This is because X- ROTOR is a less expensive technology with a lower LCOE. These results depend heavily on the exact costs of the two technologies, the assumptions for local spending, and on the average gross salaries in each country. As X-ROTOR is more efficient, it requires a smaller investment, which has a smaller direct and indirect impact on local economies. The assumptions used in all of the calculations are based on the smaller size of the turbines and shorter blades of X- ROTOR compared with HAWTs, and hence the greater ease of manufacture with less need to import the components. The figures for salaries, though based on reliable sources (OECD, 2024), are without the effect of wage convergence which may happen in the offshore wind industry as workers move across borders, but speculation about such convergence is beyond the scope of this report.

There are clear differences between the three countries. There are fewer jobs projected to be created in Ireland. This is because of the lack of a tradition of heavy industry, shipbuilding, and mechanical engineering. There are more local jobs in Spain which has such industries and yet more in the UK which already has an offshore wind industry. The effect of offshore wind of either technology on GDP is largest for Ireland, less for Spain, and least for the UK. This is due to the relative sizes of the three economies.

The objective of this report was to examine the direct effects of X-ROTOR deployment in three European countries, Ireland, UK, and Spain. This report has used a "bottom up" approach using the I-JEDI model from NREL to calculate estimates for the effect of X-ROTOR and HAWTs on employment, earnings, GDP and total output. This approach is complementary to that of our colleagues Williamson and Allan (2023) who used a CGE method in Deliverable 7.8. Compared to the results in our colleagues' central scenario, where X-ROTOR alone is deployed in the UK, we find the I-JEDI model estimates slightly over 27,000 jobs compared with the CGE model which estimates 29,500 jobs. Regarding the effect on GDP, the I-JEDI model estimates an increase in GDP of 0.07% compared with an increase of 0.48% from the CGE model. This difference is the result of the CGE model taking into account the secondary effect of lower electricity prices for the whole UK economy in the event of a complete adoption of X-ROTOR instead of HAWTs. While this is unlikely to happen, the result nonetheless shows the difference between the two modelling systems, namely that a bottom-up model, such as presented here, does not examine the whole economy but focuses on the immediate effects. The results for the numbers of jobs from X-ROTOR shows that both models are in agreement carrying out their basic calculations. While the authors are more than aware of the estimated nature of the results in this report, it seems clear that X-ROTOR's greater efficiency means that it can produce power for a lower cost than HAWTs, and that the costs during the lifetime of an X-ROTOR wind farm will be lower than HAWTs.

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https://xrotor-project.eu

X-shaped Radical Offshore Wind Turbine for Overall Cost of Energy Reduction

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