Characterizing Relatedness of Offshore and Onshore Wind Energy Using Patent Analysis

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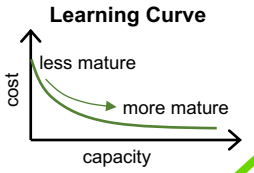
Introduction



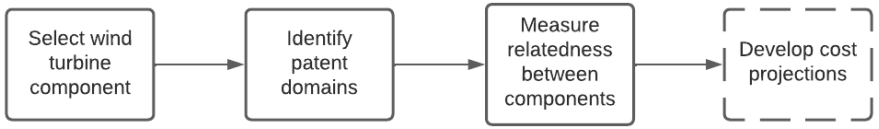
- The prospects for a clean technology depend crucially on costs [1]. Offshore wind energy as a novel technology is **more efficient but less cost effective** than onshore wind energy.
- Cost reductions can be achieved as experience accumulates. We want to know **how novel offshore wind energy is** because **novel technologies learn faster** than mature ones.
- The relatedness of offshore wind to onshore wind energy affects the modeling of **accumulative capacity** of offshore wind energy.

Methods

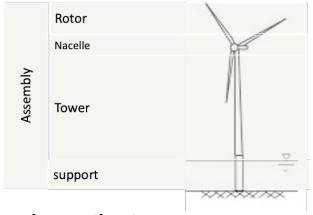
European Patent Office's Spring 2020 Patent Statistical Database:

Hierarchical classification system: patents are divided into nine sections, which are sub-divided into classes, sub-classes, groups and sub-groups.
Text-based information in titles and abstract: patent documents are required to be specific and descriptive.

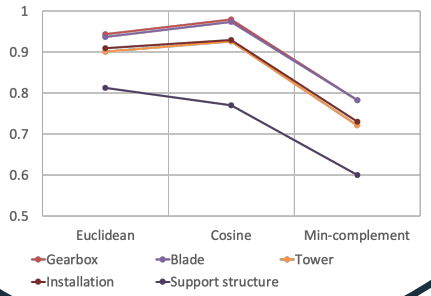
	codes	keywords
offshore	F03D 13/25%, Y02E 10/727% …	Offshore, ocean, lake, marine…
onshore	F03D 9/48, Y02E 10/728%	Onshore, tree, mountain, land…



Research Highlights



All three methods show that:
"above the water" components (gearbox, blade, tower and installation) have higher relatedness while the **"below the water"** part (supporting structure) has lower relatedness.



Define portfolio vector *P* for patent domain *d* :

$$P_d = (c_1, c_2, c_3, \dots, c_k)$$

where $c_k = \frac{n_k}{N}, \sum c_k = 1$

k – codes in domain d
n_k – number of patents with code k
N – sum of n_k

Degree of similarity[3]:

$$\text{Euclidean}(P_{off}, P_{on}) = \sqrt{\sum_{k=1}^{n} (c_{off,k} - c_{on,k})^2}$$

$$\text{Cosine}(P_{off}, P_{on}) = \frac{\sum_{k=1}^{n} c_{off,k} c_{on,k}}{\sqrt{(\sum_{k=1}^{n} c_{off,k}^2)(\sum_{k=1}^{n} c_{on,k}^2)}}$$

$$\text{MinComplement}(P_{off}, P_{on}) = \sum_{k=1}^{n} \min\{c_{off,k}, c_{on,k}\}$$

Empirical patenting data	→	Technology innovation
Classification code frequency	→	Technology characteristics
Distance between points in a technology space	→	Similarity between technologies

Conclusion

Offshore and onshore wind energy technologies have different levels of similarity across components. There is a high similarity in blades, gearboxes, towers and installation, but a smaller similarity in supporting structures.

- The difference implies the experience from onshore to offshore wind energy is more transferable for rotors, nacelles, towers and assembly.
- Technologies related to supporting structure are less mature but are more likely to learn faster and contribute to cost reductions.

Reference

[1] Jouvet, P., & Schumacher, I. (2012). Learning-by-doing and the Costs of a Backstop for Energy Transition and Sustainability. Ecological Economics, 73, 122-132.
[2] "Experience curves and the relatedness of technologies: Offshore and onshore" by Chris G. Hernandez-Negron, Erin Baker et al. *Under Review*.
[3] Bar, T., & Leiponen, A. (2012). A measure of technological distance. Economics Letters, 116(3), 457-459.