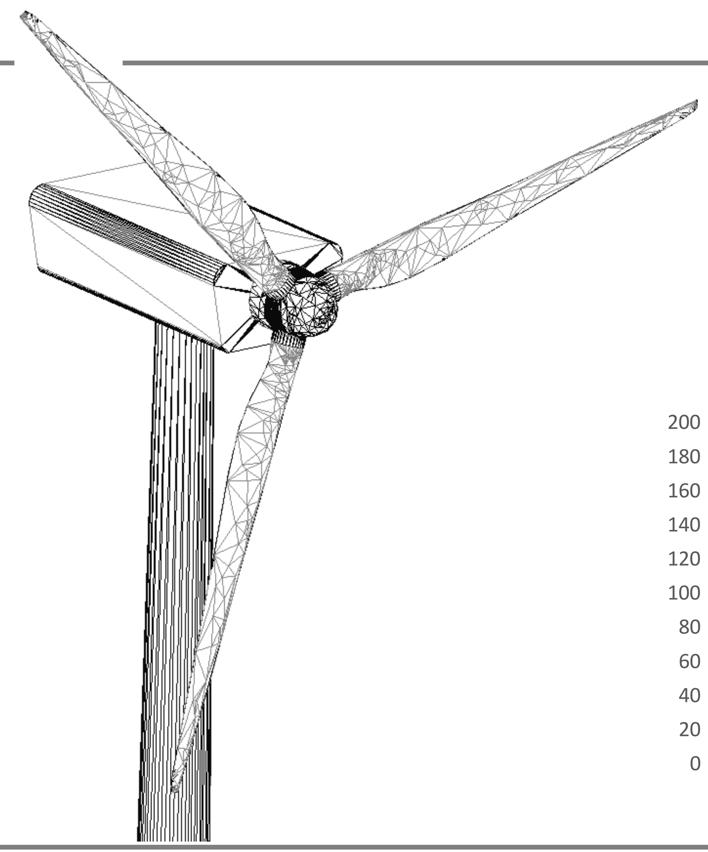
INSTITUTE OF MANAGEMENT SCIENCE

A COMPONENT-BASED SELECTION MODEL FOR END-OF-LIFE OPTIONS OF ON-SHORE WIND TURBINES

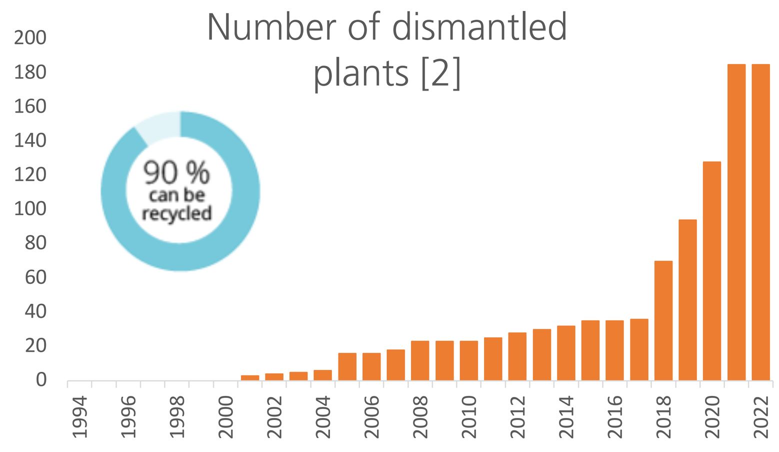
Dipl.-Ing. Stefanie Eisl, BSc.; Supervisor: Univ.-Prof. Dr.-Ing. Sebastian Schlund

Initial Situation



Material recovery opportunities by 2030 [1]

4.75 million tons
of concrete, metals and composites



Stefanie Eisl

Education & Experience

- Mechanical Engineering | TU Wien
- Economics | Universität Wien

Interests

- Circular Economy & Sustainability
- Human-Machine Interaction

Contact: stefanie.eisl@tuwien.ac.at

Motivation & Problem Statement

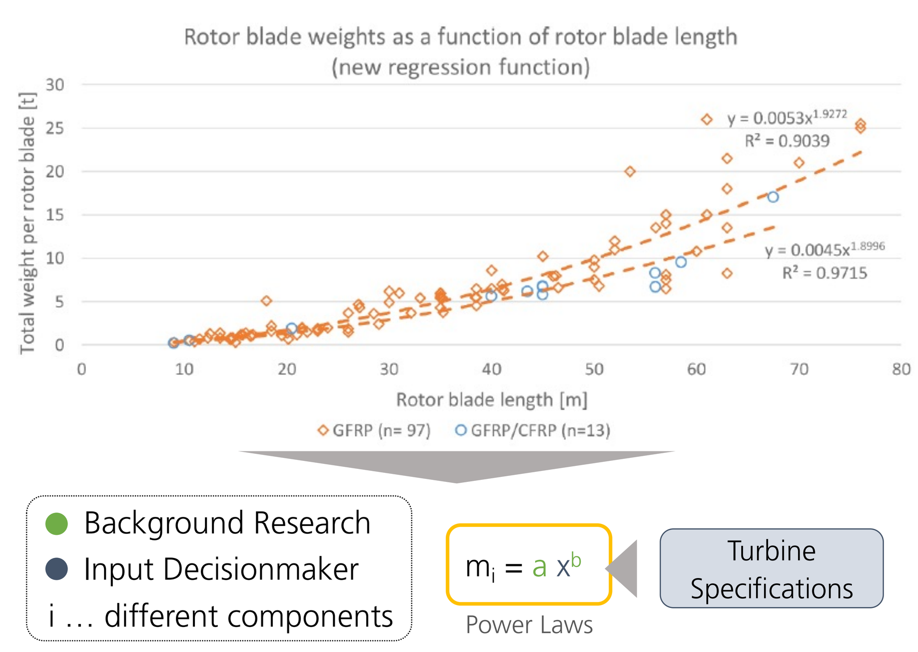
As 75% of EU greenhouse gas emissions come from energy use and production, the decarbonization of the energy sector is a crucial step towards a climate-neutral EU [3,4] . However, decarbonization is associated with high resource pressure, especially within the wind energy sector, since the large structures have significantly higher material costs than other renewable energy sources. Accelerated by the rapid development of wind energy technology, the dismantling rate of wind turbines (WTs) will continue to increase in the next years [2,5], unveiling a pressing challenge tied to the End-of-Life (EoL) management of the WTs [6, 7]. At the same time, the correct EoL management of the plants offers significant potential to meet the increasing resource requirements of renewable energy sources and thus further boost the decarbonization of the energy sector. According to the European Environmental Agency, the wind energy sector alone holds a material recovery potential of 4.75 million tons annually by 2023 [1].

Methodology

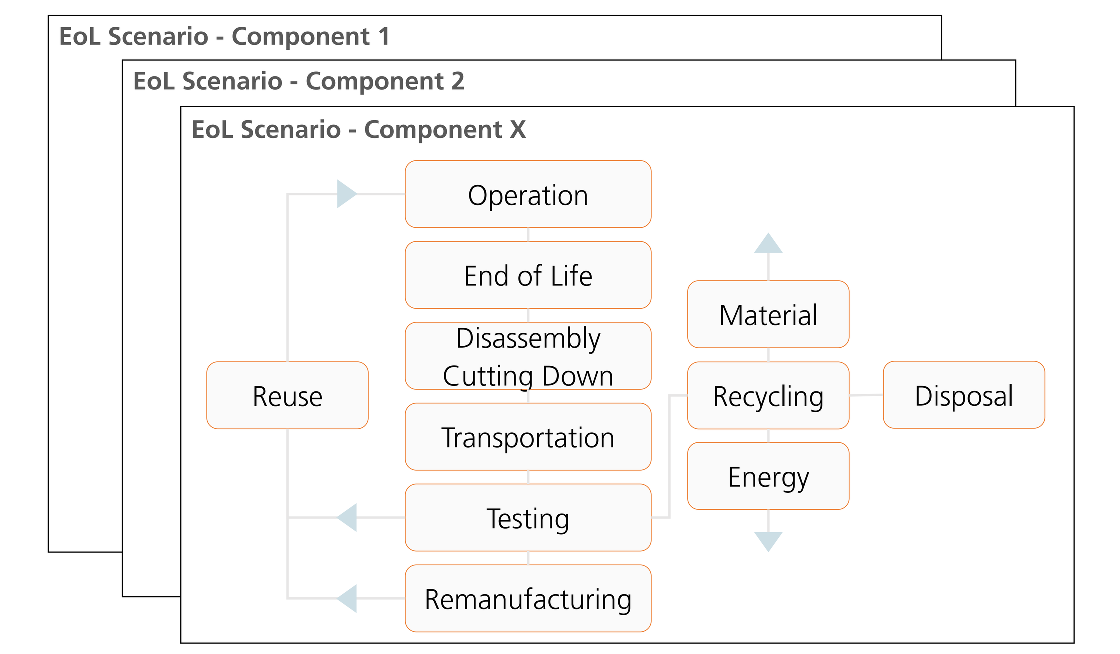
Material Relations

System Component	Component Index	Component Name	Material
SC1 Foundation	SC1	Foundation	Concrete, Gravel
SC2 Tower	SC2	Tower	Steel, Concrete
SC3 Nacelle	C1	Cover	GFRP
	C2	Gearbox	Steel, cast iron
	C3	Generator	Steel, cast iron, Cu
	C4	Magnet	Nd/Fe/B
	C5	Yaw Control	
SC4 Rotor	C6	Rotor Blade	GFRP & CFRP
	C7	Rotor Hub	GFRP & CFRP

Regression Model

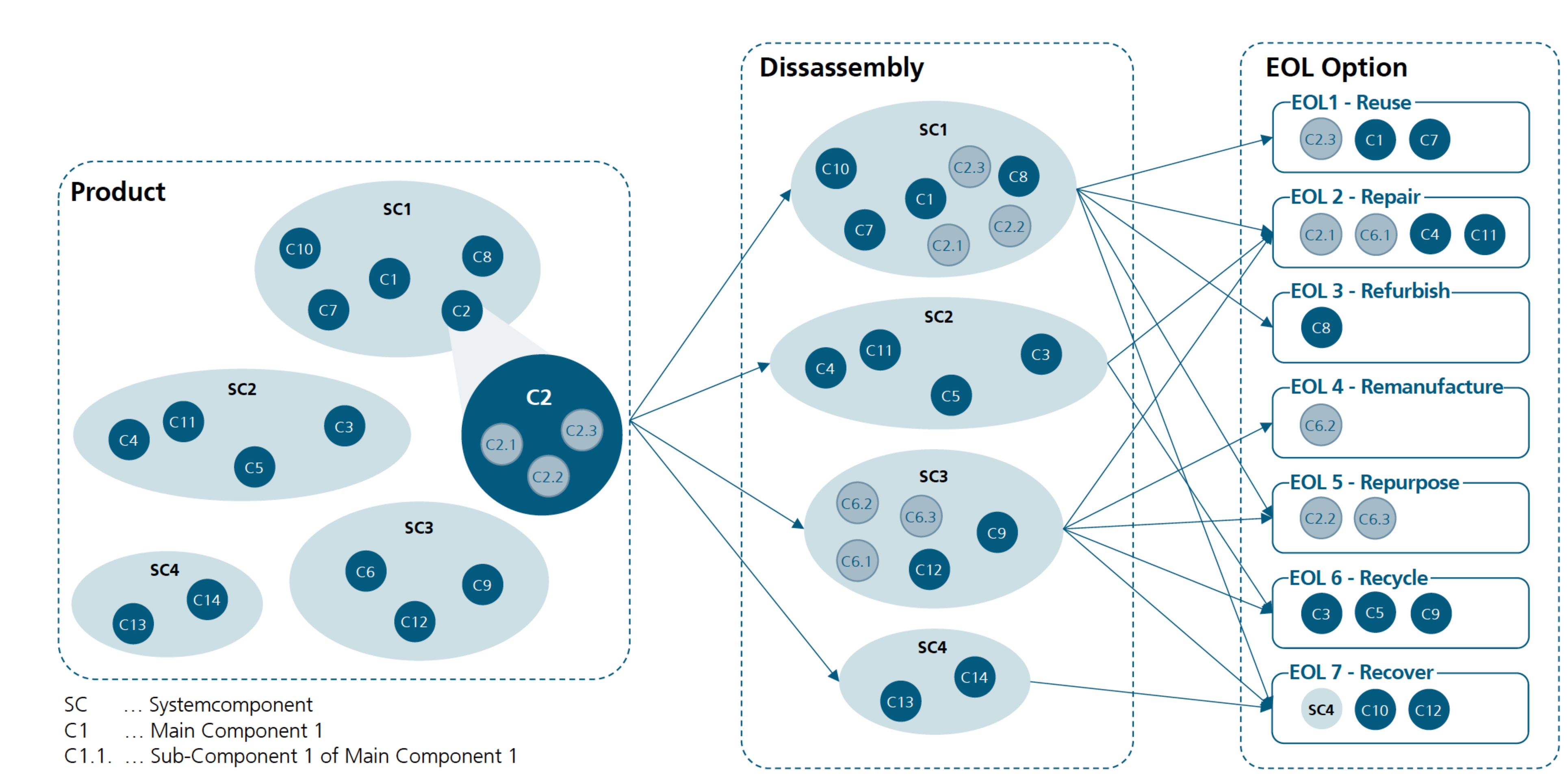


Process Analysis of feasible EoL Options



Expected Result

EoL Selection Model



- Development of a generic model for onshore wind turbines based on the material composition of different wind turbine (WT) components and regression analyses.
- Identification, analysis & categorization of potential End-of-Life (EoL) options for the distinct WT components aligning with the "R" framework of the circular economy.
- Quantification of the ecological effects of different End-of-Life options for each identified WT component through the development of a streamlined Circular Life Cycle Assessment (CE-LCA) model.
- Development of a **component-based selection model for feasible EoL option of on-shore WT components** using optimization techniques to reduce the resource pressure on the wind energy sector

References

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