(JABA note: I can help with filling this in, at this stage it would be good to get some inputs from you on some aspects, and then build up the description further)

Project Heading:

## Background/Motivation:

I want to put the knowledge gained during my wind farms master into practice, in a way that I can use in my career in the industry. I chose my master initially because I wanted to contribute to the energy transition and make an impact. I believe improving efficiency can make a significant impact if a change in lay out causes an increase in energy yield.

In many different projects it excited me to optimize processes. In smaller things in life but also in jobs or university projects. So, that would align with the project. I am really motivated to have no unnecessary losses in a project so even more for a impactful project like a wind farm.

During sailing across the north sea we come across wind farms often. It required good planning to sail around them for a lot of people, so they better yield the maximum amount of energy to make optimal use of the space. So this is another reason why I am motivated to work on their optimization.

Aspects of wind farms I want to try to optimize are the layout, so shape of the farm and distance between turbines, and distance between different windfarms within clusters. Different heights of rows of turbines could possibly also investigated. These aspects could be analyzed by looking at data from existing wind farms over the world or from simulated data.

## Objective:

**Main objective:**

Finding the most efficient offshore wind farm by optimizing its layout.

Hypothesis options:

* Power curves. Different wind farms, then see which layout fits best for which location:  
  A wind farm lay out can not be optimized for a general case but is location depended  
  *Method*: Compare multiple wind farms with different layouts placed in various locations and analyze their performance to determine which configurations are optimal under different wind regimes (so different locations).
* **Optimizing wind farm layouts by simulation and analysis**  
  *Method*: Develop and simulate several layout strategies (different spacing between clusters/ cluster arrangement/ orientations) using wind farm simulation software. Analyze their effectiveness (AEP/ wake losses/ efficiency) under certain atmospheric stability conditions and wind profiles for 1 (offshore) location.  
  1. Create several layout strategies, which 1 basic design and then differing on aspects like density/ cluster arrangement, orientation/ heights.  
  2. Simulations for all scenarios. Combine the optimal design for each varied aspect and simulate this.  
  3. Analyse result and compare with existing wind farms.  
  4. Recommendation for wind farms in these conditions/ location.
* **What is the optimal spacing between wind farms in a cluster under varying turbine densities.**  
  Determine the optimal spacing between multiple wind farms within a cluster, considering different **turbine densities**, wind conditions, and wake interactions, using the example of a to-be planned wind farm south of India.  
  *Method*:   
  1. Scenario development: create mulitple spacing configurations between wind farms and vary turbine densities within each wind farm to see influence on wake interactions.  
  2. Simulating the different spacing scenarios for different densities of turbines for the planned wind farm area. Input realistic wind profiles for the specific region. Maybe one winter and a summer variation.  
  3. Analyzing their impact on total energy output and efficiency. Identify threshold where extra spacing does no longer significantly improves the efficiency. Compare the results to theoretical/ earlier models.  
  4. outcome is a recommendation for the wind farm on this specific location. Maybe include what it saves in cost/ delivers extra energy.
* **Individual optimal vs complete cluster optimum in wind farm layouts.**  
  The most efficient wind farm cluster layout is not necessarily the sum of individually optimized wind farms, but rather an arrangement that maximizes the collective efficiency of the entire cluster.  
  Method:  
  1. Scenario development: create indiviually optimized wind farm layouts based on practices/ other research and create cluster-optimized layouts considering wake interactions between wind farms and regional wind.  
  2. Simulation different layouts. Find total wake loss in both cases.  
  3. Analysis: compare AEP in total/ wakelosses/ efficiency of the two cases  
  4: outcome recommandation for newbuilt clusters on local and total efficiency.
* **Determining the required downwind distance to avoid wake effects from an upwind wind farm**  
  How far must the downwind windfarm be to have no wake effects from the nearest upwind windfarm under a certain condition or location.  
  Method:   
  1. Create scenarios with multiple distances between upwind and downwind farm/ take existing cases. Consider different atmospheric stability conditions or only take stable since these wakes will last the longest.  
  2. Simulations to analyze the wake propagations at various distances, including the seasonal variations.  
  3. Determine threshold under which wake effects become negligible for a downwind windfarm. Compare with threshold in other research.  
  4. Give recommendation for minimum spacing requirement under these certain conditions. Maybe trade-off with AEP loss/ easier to build because of depth.
* Giving a complete wind farm planning design for a possible location

**Specific objective:**

* Simulating impact of changing layout aspects: spacing, maybe also other aspects
* Advice an existing wind farm or planned wind farm on more efficient layout
* Learn skills useful (for the industry), eg PyWake.
* …
* …

(JABA note: please include above objectives that align with competences you want to develop during the project, it could be data analysis, programming, software, knowledge around a particular wind energy issue, etc)

## Data Collection:

From existing wind farms, simulated, maybe from a company/ windfarm. Dutch lidar data

## Methodology:

Data analysis for different layouts for same wind conditions. Looking at energy gained/ AEP/ wind speed decreases.

## Tools:

Python, pywake,

…

## Brief Time schedule

Start Date: 20-1-2025

End Date: +- 01-07-2025

Defense Date:

(JABA note: for 30 ECTS duration is 5 months, defense should be with 10 working days of submission)

Month 1: literature research, set up plan

Month 2: background information

Month 3: create different scenarios by varying aspects in layout

Month 4: data analysis/ simulations

Month 5:

## Supervision

(JABA note: it’s good to state here format for supervisory meetings, frequency, location, online and in person etc. Can also be filled out as part of a dialogue.)

Bi-weekly meeting at Riso, then also working that day at Riso campus. If needed extra online or working more often at Riso.

UOL: Martin dornkamper?