# PROJECT TWO: MILESTONE 2 – COVER PAGE

Team Number: TUES-24

Please list full names and MacID's of all *present* Team Members

| Full Name: | MacID: |
|---|---|
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# MILESTONE 2 (STAGE 1) – REFINED PROBLEM STATEMENT FOR A WIND TURBINE

Team Number: TUES-24

The Title of The Assigned Engineering Scenario

A Pioneer in Clean Energy

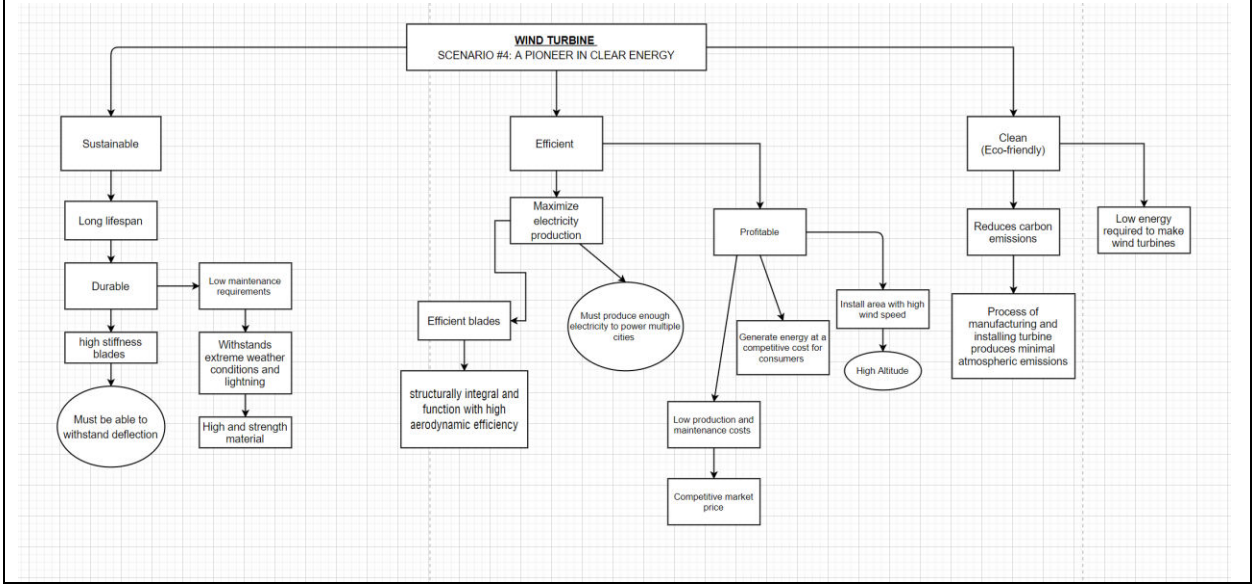
Write the Initial Problem Statement Below

→ This is a *copy-and-paste* submission of what you submitted for Milestone 1

During project one, our team will be designing a wind turbine blade component for one of the four assignment scenarios: renewable energy for a large population, engineers without border humanitarian aid mission, a roof generator, pioneer in clean energy. Our wind turbine blades must fulfill the design requirements associated with our assigned scenario. Generally, the wind turbine blades must be structurally integral and function with high aerodynamic efficiency, with regard to local wind speeds and air densities, to maximize power output whilst withstanding potential issues such as deflection, leading-edge erosion, and lighting strikes.

Finalized Objective Tree of Wind Turbine for Your Assigned Engineering Scenario

→ Please have a copy of your finalized team objective tree of wind turbine for your assigned engineering scenario.



Refined Problem Statement:

→ Write the refined problem statement for the design of wind turbine based on your assigned scenario.

During project 1, our team will be designing wind turbines alongside the Sweden Wind Energy Association, to help fulfill Sweden's plan of reducing net emissions of greenhouse gases to zero by 2045. Our reasoning behind working on such an issue is non-renewable electricity generation is a major contributor to the global carbon dioxide and greenhouse gas emissions, which significantly contribute to global warming. In regard to specifications, the wind turbines must be installed in a location with high wind speeds at high altitudes and in an area large enough to facilitate a wind farm. Also, the wind turbines must be able to efficiently generate a sufficient amount of power to provide electricity to multiple cities. We must minimize costs of manufacturing and installation of our wind turbines to ensure they are low-cost option for electricity generation thus, causing reductions in the energy bills of consumers.

# MILESTONE 2 (STAGE 2) – DESIGN REQUIREMENTS FOR A TURBINE *BLADE*

Team Number: Tues-24

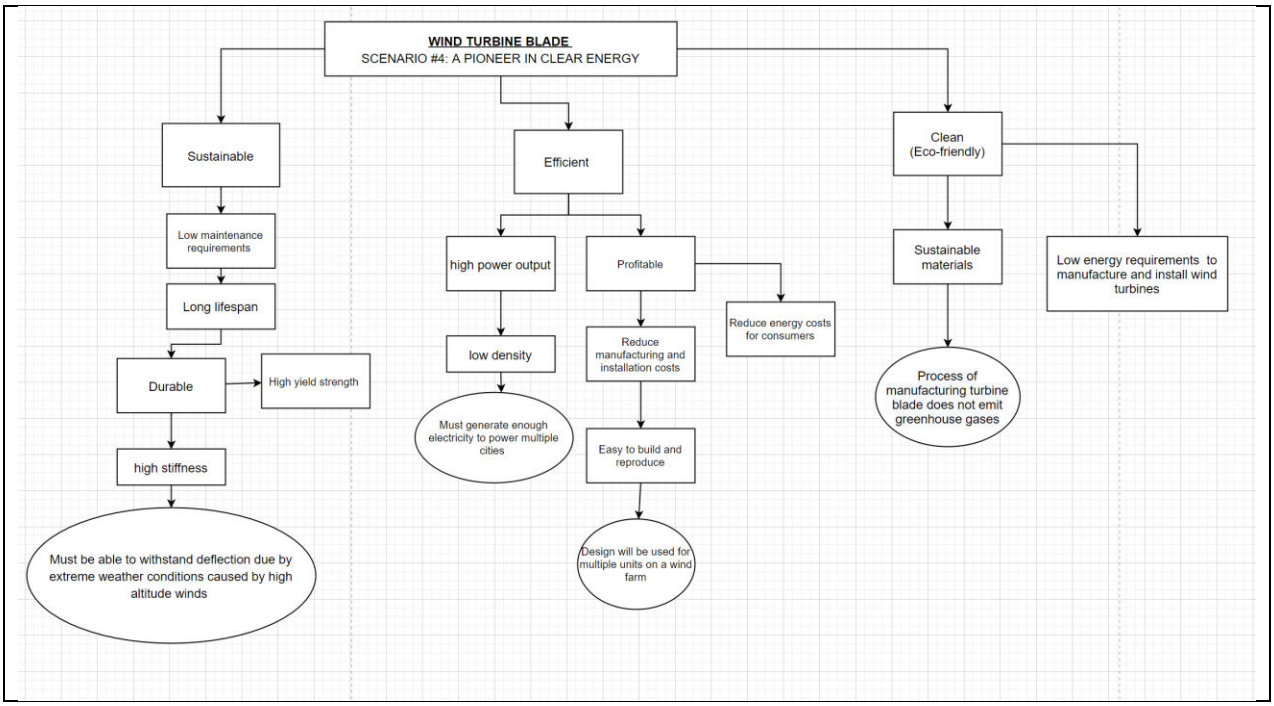
Turbine Blade Problem Statement:

→ Write a complete problem statement for the design of turbine *blade* based on your assigned engineering scenario.

Project 1 will specifically entail designing wind turbines blade component which will be used by the Sweden Wind Energy Association for multiple units for a new wind farm. We will be working on this project to aid Sweden in fulfilling its plan of reducing net emissions of greenhouse gases to zero by 2045. Regarding specifications, the blade component must be able to withstand potential issues such as deflection, leading-edge erosion, and lightning strikes that result from installing wind turbines at high altitudes. This is because our wind turbine blade must be durable as we aim to maximize the lifetime of wind turbines in an effort to reduce service and maintenance costs during operation. Also, we must minimize the mass of the blade component to achieve high rotor efficiency, which would maximize power output. Additionally, by reducing the blade mass, we reduce its cost. By doing so, this simultaneously reduces the initial capital cost of the wind farm project and as a result, electricity costs for consumers.

Objective Tree of turbine blade for assigned engineering Scenario

→ Please have a copy of your team objective tree for the design of turbine blade of your assigned engineering scenario.




# MILESTONE 2 (STAGE 3) – SELECTION OF TOP OBJECTIVES FOR A TURBINE BLADE

Team Number: Tues-24

List the top three objectives of a turbine blade for your assigned engineering scenario

1: Low blade cost
2: Optimized blade wall thickness
3: Minimized blade mass

Include a rationale for selecting each of these objectives

→ Write *maximum* 100 words for each objective

Objective 1: Blade cost

Rationale:

Since many units of this turbine are required, and the project has a large scale, production and installation of wind turbines for the wind farm will be highly expensive. Taking an incremental approach to making the process as cost-efficient as possible means that the cost of the blade itself relative to the cost that it offsets through energy production will need to be minimized.

Objective 2: Mass

Rationale:

With heavier blades, more wind is needed to turn the rotor, therefore lighter blades are easier to turn, and hence more efficient in capturing energy. Reductions in mass also lead to reductions in fatigue loads for large wind turbines, which increases the lifespan and reduces maintenance requirements of a wind turbine.

Objective 3: Blade Wall Thickness

Rationale: In order to maximize the energy collected from the wind turbines, the blade wall thickness must be one that is small enough to allow the turbine to collect optimal amounts of kinetic energy from the wind. The thickness of the blades would depend on the wind speeds. Cannot be too thin as turbines would get damaged easily in extreme wind conditions.

# MILESTONE 2 (STAGE 4) – METRICS

Team Number: Tues-24

For your selected top three objectives fill out the table below with associated metrics (including units) for each objective.

| Objective 1: | Minimize Blade Cost |
|---|---|
| Unit/Metric:<br>Dollars ($) | Metric: Price of production of one blade (Range from 0-10, in which 0 is worst and 10 is the best)<br><br>Units: Approximate price of one blade<br>• Cost - ≤100,000 CAD (10 points)<br>• $100,001CAD-$140,000CAD ( 9 points)<br>• $140,001CAD-$160,000CAD ( 5 points)<br>• $160,001CAD-$200,000CAD (3 points)<br>• Cost - ≥$200,001 CAD 0 points |

| Objective 2: | Minimize Blade Mass |
|---|---|
| Unit/Metric:<br>Mass (Kg) | Metric: Mass of one blade (Range from 0-10, in which 0 is worst and 10 is the best)<br>Units: Approximate mass of one blade<br>• Mass - ≤ 10,000kg (10 points)<br>• 10,001kg-12,000kg (8 points)<br>• 12,0001kg-14,000kg (6 points)<br>• 14,001kg-16,000kg (4 points)<br>• 16,001kg-18,000kg (2 points)<br>• 18,001kg-20,000kg (1 points)<br>• Cost - ≥20,001kg CAD (0 points) |

| Objective 3: | Minimize Blade wall thickness (mm) |
|---|---|
| Unit/Metric:<br>Blade Wall Thickness (mm) | Metric: Blade wall thickness (Range from 0-10, in which 0 is worst and 10 is the best)<br>Units<br>• ≤20mm (10 points)<br>• 21-25mm (8 points)<br>• 26-30mm (5 points)<br>• 31-35mm (2 points)<br>• 36-45mm (1 points)<br>• ≥45mm (0 points) |