PROJECT TITLE: Wind Turbine Project (or something catchier…)

BACKGROUND: This is meant as an introductory-level engineering project (i.e. for students with little to no experience with the engineering design process). It focuses on physics content involved with energy transfer and energy transformations.

NEXT GENERATION SCIENCE STANDARDS ADDRESSED:
Disciplinary Core Idea: Conservation of Energy and Energy Transfer
HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

Project Phase	Lesson Plans
PHASE 1: PROBLEM DEFINITION Define boundaries of problem: ● Refine problem statement ● Identify constraints & criteria	Link to entry document Link to project packet - focus of phase 1 is on *diagram*, *problem identification*, *constraints*, *criteria* sections Anticipated time: 20-30 minutes Overview of lesson: ● Teacher introduces students to the scenario. ● Students identify relevant and irrelevant information as they define the problem and activate content knowledge. ● Teacher introduces the concepts of *constraints* and *criteria.* ● Students identify constraints and prioritize criteria. ● Students build consensus around key elements of problem identification. Link to exemplar student responses Expandable Link - show more for differentiation strategies
PHASE 2: DESIGN EXPLORATION Generate design alternatives: ● Brainstorm ● Select preliminary design	Link to project packet - the focus is on *brainstorming* section Anticipated time: 20 minutes Overview of lesson: ● Teacher reiterates the objective of the wind turbine and asks whole class, “What factors could possibly affect the energy output the turbine could generate?” ● Students work in small groups to identify various factors that could influence the work done by the wind turbine.

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	• Student groups share out their lists of factors. The teacher leads a whole-class discussion, identifying the merits of each variable. • Students are divided into groups to study the effect of the identified variables. It is recommended that at least two groups study each variable so that the teacher can control the quality of data presented to other students during student whiteboard presentations. Expandable Link - show more for differentiation strategies
PHASE 3: DESIGN OPTIMIZATION Develop and optimize selected design: • Build, test, verify, & refine prototype • Evaluate in light of tradeoffs	Link to project packet - focus on *parameter data* section Anticipated time: Overview of lesson: • Students work in groups to iteratively test the effect of one of the four parameters. • Students generate graphs that clearly illustrate the relationship between their tested parameter and the maximum work/energy output. • Students to share their findings: describe their experimental setup, display their graph and point out key features (axes, intercepts, trends), and share their interpretation of what implications the data have on the wind turbine design. • Students use the data shared at the board meeting to develop an initial prototype with blade angle, blade shape, surface area, and number of blades optimized. • Students identify an additional parameter to iteratively test and collect data on its effect. • Students develop their final optimized design based on their findings. Link to sample student data Link to sample student graphs Link to video of board meeting? Expandable Link - show more for differentiation strategies
PHASE 4: COMMUNICATE SOLUTION Communicate final design to audience: • Relate design details & rationale • Justify tradeoffs • Reflect on process	Link to project packet - focus on *expense report*, *rationale* sections Anticipated time: Overview of lesson: • Students reflect upon their process and conclusions supported by the data collected in Phase 3. • Students document their final wind turbine design, as well as the data collected that lead them to settle on this particular design.

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	● Students prepare a report or presentation tailored for stakeholders. Link to sample student expense report Link to sample student rationale Expandable Link - show more for differentiation strategies

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