ZF Team #40

ZF Energy Generation

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Objective

To become more sustainable, ZF is exploring alternative energy sources, focusing on wind and solar power. The Lafayette Plant roof is being considered for solar panels, while the feasibility of wind turbines, inspired by a nearby company, is also under review. The team will be divided into two sub-teams—one for solar and one for wind. These teams will work together to create three design plans to be compared.

CUSTOMER PROBLEM AND BACKGROUND

ZF, in its efforts to become a net-zero company by 2030, is seeking to integrate alternative energy sources to reduce dependence on its current energy supply. The company is particularly interested in solar and wind power solutions that provide a return on investment (ROI) of five years or less. The Lafayette Plant has been identified as a potential site for solar panel installation, while the feasibility of implementing small-scale wind turbines is also under consideration.

The primary challenge lies in identifying cost-effective and efficient renewable energy solutions that align with ZF's sustainability goals. Current barriers include high upfront costs, space constraints, and the need for seamless integration with existing infrastructure. Additionally, ZF is exploring small-scale solar applications for oil tank evaporation, aiming to reduce energy consumption and operational costs related to oil disposal.

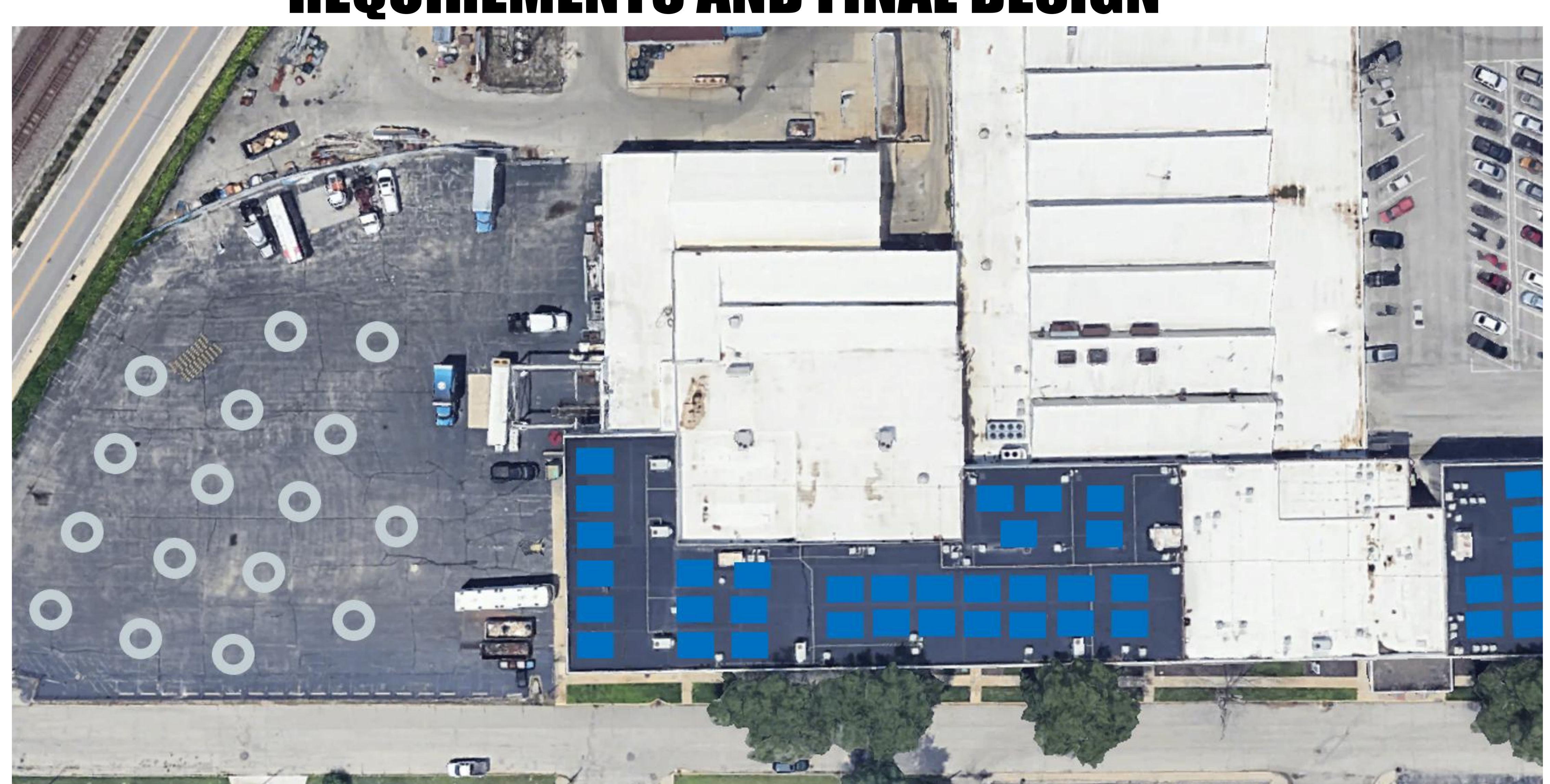
The end-customer impacted by this project includes ZF's sustainability team, facility managers, and financial decision-makers, who require a feasible, data-driven approach to implementing renewable energy solutions. Inefficient planning or investment in suboptimal technologies could lead to financial losses, operational disruptions, and failure to meet sustainability targets. Therefore, the project must ensure that proposed energy solutions are viable, scalable, and aligned with ZF's economic and environmental objectives.

CONCEPTS AND RESEARCH

Wind turbine selection starts with site assessment, analyzing wind speed profiles, turbulence, and directional stability. Engineers match these conditions with turbine specifications such as rated capacity, cut-in/out speeds, power curves, and hub height. LCOE modeling incorporates capital and operational costs, energy yield, and lifecycle projections. Final selection balances performance with transport, installation, and grid integration constraints.

Solar PV selection involves evaluating irradiance, shading, and mounting area. Modules are assessed for efficiency, temperature coefficient, degradation rate, and performance under varied light. Technologies—monocrystalline, polycrystalline, thin-film, bifacial—are compared based on energy yield and cost-effectiveness. Durability, certifications, warranty, and compatibility with inverters and racking systems inform the final decision.

REQUIREMENTS AND FINAL DESIGN



The following comparison is of the three different designs/plans that the team created. The three energy generation plans include a solar panel only design, a vertical axis wind turbine only design, and a hybrid design that includes both forms of energy generation. An explanation for our final decision is below the comparison, which details our final design.

Comparison

Payback Period:

Solar Only = 6 years
Cost per kW = $1253.77

Wind Only = 11 years
Cost per kW = $5866.70

Solar + Wind Hybrid = 9 years
Our hybrid configuration is going to consist mostly of solar generation.(0.75:0.25)

CONCLUSION AND RECOMMENDATIONS

The three design plans give ZF options when it comes to developing energy generation on-site. However, the team recommends that ZF focus on and develop based on the Solar + Wind Hybrid plan. The solar-only plan has a payback period of 6 years, the wind-only plan has a payback period of 11 years, and the hybrid plan has a payback period of 9 years. While the solar-only plan has a shorter payback period, the hybrid plan allows for a more reliable option. This is due to the plan having two different forms of energy generation. The wind turbines can generate energy during the downtime of the solar panels (night or cloudy days), and the solar panels can generate energy during the wind turbine downtime (little to no wind). Thus, the team believes the hybrid plan to be the most reliable and efficient design for ZF's future energy generation.