Data Science semester project :

Goal: Find optimal PPU mix across Switzerland and locations with respective storage sizes considering grid infrastructure.

The project would design an optimization framework to identify the cost-optimal mix of Power Plant Units (PPUs) for Switzerland. Each unit type (hydro storage, PV-hydrogen, biomass, nuclear, etc.) has specific costs, efficiencies, and land or storage needs, all of which must be respected. The model would also consider regional siting constraints, like hydro availability in the Alps or rooftop PV in urban centers. By coupling capacity expansion decisions with grid infrastructure limits, the tool could reveal bottlenecks and the cost of required reinforcements. Seasonal and day-night storage would be sized endogenously, ensuring that supply always matches demand under realistic Swiss load profiles. The optimization would include redundancy rules (e.g. 6 active + 2 backup PPUs) to guarantee resilience.

Outputs:  
- the technology mix  
- storage requirements  
- expected LCOE  
- regional distribution

Goal: Risk adjusted cost and security of supply analysis to identify price shockers

This project focuses on quantifying the risks of relying on imported energy carriers like hydrogen or synthetic fuels. Using stochastic modeling, we would represent geopolitical disruptions, price shocks, and supply chain delays as probabilistic events affecting import availability and cost. A storage-inventory module (e.g. three-month hydrogen buffer) would be included to simulate resilience strategies. The model would compute risk-adjusted costs of electricity generation, accounting not only for expected costs but also for volatility and tail-risk events. Scenarios would compare pathways such as domestic PV-hydrogen vs. imported hydrogen or palm-oil-based fuels, highlighting the trade-offs between cost efficiency and supply security.

Output:

-probability distributions of system cost  
- expected unserved energy   
- required buffer sizes.

Review of Prof. Züttel works and model optimizing measures

1. No regards for the CO2 emission impact over the entire life cycle -> lithium batteries are also 0 emissions but only because they delecolize the problem
2. Natural decay of infrastructure in efficiency -> Some parts of the PPU need to be renewed every 10 years, if these are the most polluting ones of the bunch then the entire enterprise is problematic

Semester project proposition

**Goal:** Optimal investment PPU-portfolio repartition over 80 years to ensure the CO2-neutral energy mix while safeguarding national independence.

Make a timeline

Part 1 – Integrate the spot price of electricity and meteorology (sun & wind) in python with the constructed model. Using this information find the optimal mix of PPU to maximize energy supply. We will suppose we have the spot price curve of last year and that demand will grow as per the paper proposed whereas the price of components will grow with the inflation.

Part 2 – optimize the current model by incorporating more elements for each component of the PPU

Part 3 – Build a sensitivity analysis by constructing tolerances around the input factors