Group project case: Energy Grid
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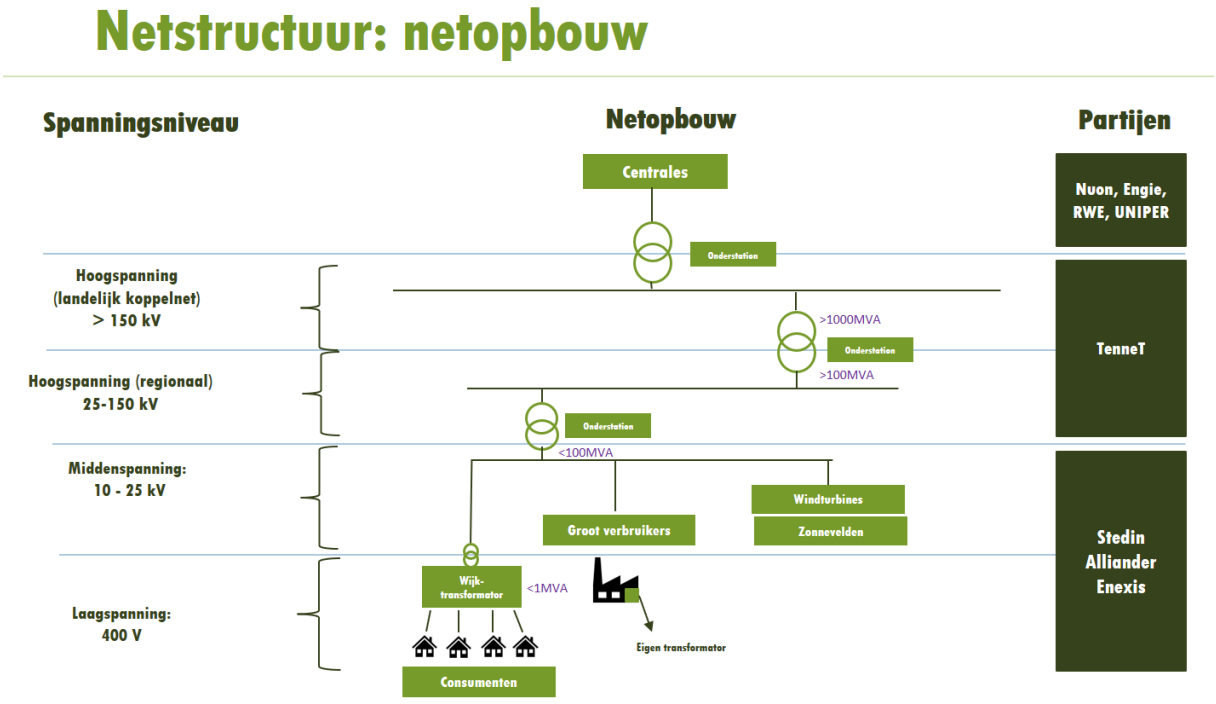
Update: January 30, 2022

The Dutch energy sector has a decoupling between utilities and electricity supply. While generation and retail of electricity in the Netherlands are liberalized, the transmission and distribution were and are still centralized and operated by the system operator and the utilities. The system operator, TenneT, is the only stakeholder responsible for managing the high-voltage grid (between a voltage of 110 kV to 380 kV) in the Netherlands. There are several utility companies that own the regional energy grids ("Netbeheerders").



(Picture from Infiniot)

With the transition to renewable energy and (large-scale) consumers becoming "producers" as well (with e.g. solar arrays, battery farms), these utility companies must be able to balance their grid: under-capacity can lead to black-outs (consumers/factories not getting electricity) and over-capacity can lead to grid failure (exploding power houses, burnt wires, etc.), each leading to fines and extra costs.

To be able to predict the future electricity market, the utility companies need to simulate different scenarios. E.g. based on (simulated or real) real-time weather conditions, location and time of day/year, supply and demand will change.

The utility companies measure (real-time) energy flows and power quality (keep the correct voltage and AC frequency), determine the price and create the energy market: long-term, day-ahead and interday/inbalance trade.

Take in account the following actors/stakeholders and determine their main requirements:

- Consumers (houses, schools, hospitals, etc.) / “Prosumer” (energy feedback to the grid)
- Large-scale consumers (chemical- or steel factories, greenhouses, datacenters, etc.)
- Utility companies (Stedin, Enexis, Liander, Enduris, …)
- Balance Responsible Party: BRP (TenneT)
- Producers: Power Plants (Nuclear, Coal, Bio, Gas, Solar, Wind, …)

Note: In the real world, the energy market is far more complex with extra “players”. For this case, we assume that the utility companies and the BRP control the energy market.

You need to be able to visualize the (national) electricity market, grid status and energy output and demand in real-time. Consumers would like to see their energy usage and production (by e.g. their solar array on their roof or batteries in their garage) in an app.

The International Association of Privacy Professionals (IAPP) has pointed out that personal data can under no circumstances be available to others than the customer him-/herself and employees who need access to this information. In other words, the whole system needs to be compliant with GDPR.

Your task is develop a distributed electricity (market) simulation system for one regional energy grid utility company taking into account the stakeholders' wishes as stated above. Users of the system(s) can choose between Dutch and English, and optionally a third language. You will prove that the system complies to all functional and non-functional requirements. In particular, you will develop monitoring tooling to prove that the system is available 24/7 and performance tests to prove that the system can handle the incoming messages from electricity meters, power- and price fluctuations. Also, you will demonstrate interoperability with systems from the other utility companies and the BRP.

References: (Most in Dutch)

- Why & how regulating the tariffs?
- International high voltage grid
- Long-term market
- Day-ahead market
- Intraday market
- Imbalance market