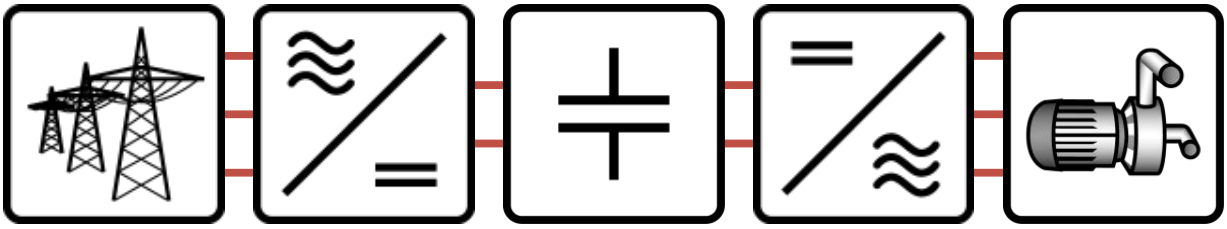

## Master's thesis on “GaN converters for heat pumps”

Heat pumps can play an important role in climate protection. They can be used to heat houses and buildings and provide hot water. Only around 1/3 of the heat energy provided has to be supplied to the heat pump in the form of electrical energy, the rest is absorbed from the environment, e.g. from the air in the case of air-to-water heat pumps. If a heat pump is operated with electricity from renewable energy sources, it generates heat in a completely CO2-neutral way. The heat pump is therefore an important piece of the puzzle on the way to CO2 neutrality.



Fraunhofer ISE wants to develop the power electronics for a heat pump as part of the InnoWP project. We want to use the wide-bandgap material gallium nitride (GaN) to convert the required electricity particularly efficiently. The first task of the power electronics is to rectify the alternating current from the grid and thereby also meet the requirements for the waveform quality of the current, imposed by grid codes. This includes, for example, limiting grid perturbations, but also issues such as power factor correction. It should also be possible to adjust the level of rectified voltage to the current demand. All these tasks are performed by the AC/DC converter, which is shown in the form of the second pictogram. In order to operate the electric motor of the heat pump, the DC voltage now generated must be converted back into a three-phase current with variable frequency. This requires a so-called drive converter, which is shown in the fourth pictogram. This enables the speed of rotation of the motor to be varied, which means that the output of the compressor stage can be adapted to the demand at the time, allowing the heat pump to be operated very efficiently.
During your Master's thesis, you will have the task of developing a prototype of the AC/DC converter on the mains side. You will approach the task with the help of simulation software. First, you will create a model of the converter stage. This will be followed by the development of the circuit diagram and layout. You will be able to familiarize yourself with the necessary software tools during your Master's thesis. You will then move on to assembly and commissioning. Finally, measurements will be carried out to determine the efficiency of the converter stage.

**Your tasks are:**

- You will familiarize yourself with the topic of AC/DC converters and wide bandgap components.
- You will develop a simulation model of the converter using the Plecs software from Plexim.
- You will create a circuit diagram and layout using Altium Designer software.
- You build your prototype, put it into operation and carry out an efficiency measurement
- You will document and present your work and results.

**What you bring along:**

- You are studying in the field of electrical engineering or similar.
- You are a team player and have a committed and independent way of working.
- You have a good knowledge of German and English.

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| **Main focus:** | Power electronics, simulation, circuit diagram and layout design, hardware commissioning |
| **Begin:** | November 2024 at the earliest |
| **Processing time:** | 6 months |
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