# Graduation project description

***Attention: This form has to be returned, via email, to the graduation agency (***[***graduation.ict-ct-emmen@nhlstenden.com***](mailto:graduation.ict-ct-emmen@nhlstenden.com)***).***

**Explanation:**

* The size of the graduation project description has to be 1-2 A4 and must contain the points mentioned here below. The format of the fields is not fixed and can be resized to fit.
* It must be clear why this graduation project is of sufficient level (think about the complexity).
* The research should serve the realisation (See phase 2 SDLC.)

**Name of student:**

Student: Robert Rachita **4859367**

**Institution/company where assignment will be carried out:**

Name: krumedia GmbH

Address: Fautenbruchstraße 46,

Town, post code: 76137 Karlsruhe

Department: Software development

Telephone: +49 721 9899180

Name of supervisor: Dr. Michael Krutwig

E-mail of supervisor: michael.krutwig@krumedia.com

Number of permanent employees: 35

**Does the company meet the requirements mentioned in the handbook graduation:**

*(Think about the requirement about company and placement supervisor.)* The company’s sole activity is ICT related, namely software development in the energy management field. The work is embedded in the company’s workflow, and it can facilitate the other requirements (workspace, computer, resources etc). The supervisor meets the requirements, having completed bachelor studies, master and doctorate in the ICT field and has more than 25 years of experience in the subject area, as the founder and owner of the company. He is also directly involved in this research project, that will constitute the basis for the realisation part.

**Are the required competencies achieved:**

*(See graduation project manual, appendix E.)* The final qualifications required to achieve bachelor in the field of Information Technology are sufficiently served by this project. Namely, the student will be in charge of creating and delivery all the process documentation (action plan, research report, results report, backlog, process models and any additionally related documents and sub-processes). Furthermore, through the means of this report, and in constant consultation and collaboration with the supervisor and other interested parties, advice concerning the software architecture (approach *and* availability, performance, and market needs) will be provided by the student.Lastly, a software component up the specified standards will be provided, including a solid test strategy for the targeted system*.*

**Introduction graduation project:**

*(Think about the context.)*

Context Overview: [enerchart](https://www.enerchart.com/en/) is a feature-rich Energy Management System (EMS), developed by [krumedia](https://www.krumedia.com/en/) for the past 10 years. Following the current energy industry trends, moving towards demand-based pricing and variable kilowatt rates for household consumers, it was proposed to expand enerchart's capabilities to incorporate smart load management.

*Demand-side management* is the planning, implementation, and coordination of activities on the consumer side of the electricity meter to modify the demand for electricity, whereas a *load management system* is a system that monitors and controls energy usage within buildings or industrial facilities. These systems can optimize energy consumption patterns and respond to signals from the grid, often through the use of techniques such as peak clipping, load shifting and valley filling.

The **goal** of this project is therefore to develop and integrate a Smart Load Management System within enerchart. This system will leverage time-of-use pricing and real-time market data, aiming to optimize energy consumption, reduce costs, and promote sustainability for consumers and organizations in the German electricity market. The company, krumedia, is currently involved in a multi-company research which includes this topic and hopes to achieve positive results with the aid of this graduation project. Information about the overall research project can be found by accessing the following link (German language only): <https://www.greenprod.de/>

**Description research:**

*(For example, on the basis of a main question and 3-5 sub-questions. Research must serve the realization . Clearly describe why it's an research.*

***When approving the assignment, we do not make substantive statements about the main and sub questions. So keep in mind that these still have to be adjusted during graduation and that the main and sub questions in this description are a first step towards****.)*

The research phase will look at the following aspects:

* Understanding Demand Side Management and Load Shifting
* Investigating the user interface requirements to ensure a seamless, user-friendly experience, evaluating factors such as device prioritisation and automation versus manual input.
* Research and create or select an appropriate load shifting algorithm that accommodates dynamic pricing structures and user needs.
* Current capabilities of enerchart

A possible main research question can therefore be defined as follows:

*"How can the development and integration of a smart load management system within enerchart, leveraging time-of-use pricing, contribute to optimizing energy consumption, reducing costs, and promoting sustainability for consumers and organizations in the German electricity market?”*

This research addresses a complex, highly relevant and new topic in the energy management sector. There is no such system available for industrial consumers readily available anywhere on the market. The research question involves multiple facets, each requiring in-depth exploration and analysis. The outcome of this research alone has the potential to provide practical solutions for consumers and organizations looking to optimize their energy consumption and costs. Lastly, the focus on German electricity market adds a geographical specificity and uniqueness to the research. Different regions may have unique challenges and regulatory frameworks and addressing them in the context of the German market adds depth and applicability.

**Description realization:**

*(What the student actually delivers.)*

In the realisation part, several software deliverables will be produces and shipped as part of the module integration of the Smart Load Management within enerchart. Primarily, the DSM system integration itself. In order to achieve this, it may be required to expand on the existing data collection mechanism within enerchart. The minimum viable product deliverable is to clearly define and develop the essential components, including features necessary for effective load management. The software should be thoroughly tested, well-documented, and ready for demonstration at the end of the project. This will include a user interface that is easy to use and in line with the current corporate design, used for interacting with the load management system, backend logic for optimization, and any necessary administrative tools.

Given that this project will expand on the current software infrastructure, the programming languages used will be primarily PHP 7.4/Laminas Framework, Typescript, NodeJS and MySQL. Should the data handling and other aspects of the algorithm required additional tools, languages or frameworks, the student can choose to use this, providing an explanation why it was required to do so.

**Description of complexity:**

*(What makes it that this assignment is suitable as a graduation assignment so that the student can achieve the final competences here.)*

The complexity of this project lies in the integration of a dynamic load management system into an existing web-based EMS (energy management system). Challenges include real-time data integration, algorithm development for efficient load shifting, and creating an intuitive user interface, besides understanding the current underlying software architecture and the in-depth task requirements. enerchart is a complex and extensive platform, and understanding the existing architecture and ensuring compatibility requires careful consideration, besides coding with PHP with Laminas, TS, and the other technologies. Researching, creating, or selecting an appropriate load shifting algorithm also introduces complexity. The algorithm must accommodate dynamic pricing structures and user needs, requiring an adequate understanding of energy management principles and optimization techniques.

Overall, the complexity should be enough for a prospective Bachelor of Information Technology. Given the time duration of 90 days, the workflow should be manageable and spread across evenly.

**Date completed: 07/12/2023.**