Graduation Plan

Master of Science Architecture, Urbanism & Building Sciences

Graduation Plan: All tracks

Submit your Graduation Plan to the Board of Examiners (Examencommissie-BK@tudelft.nl), Mentors and Delegate of the Board of Examiners one week before P2 at the latest.

The graduation plan consists of at least the following data/segments:

Personal information	
Name	Fruzsina Kovács
Student number	5675316

Studio		
Name / Theme	Metropolitan Ecologies of Places	
Main mentor	Alexander Wandl	Environmental Technology & Design
Second mentor	Ir. Francesca Rizzetto	Urban Design
Argumentation of choice of the studio	The starting point of this thesis was the rapid development of the critical raw materials-based battery industry in the country of Hungary. The project looks at this phenomenon from a systemic perspective, focusing on the severely impacted North-East Hungarian territory. The thesis identifies, and takes a stance against the ongoing uncontextual and unsustainable industrial electrification transition, and proposes a transformability-based spatial exploration towards a sustainable, socio-economic transformation, aligning with the goals and values of the Metropolitan Ecologies of Places studio. The project also combines theory with exploration, and investigates both the problems and the proposed solutions on multiple scales. Moreover, the thesis is at the intersection of the three trajectories of design, planning and technology, supported by the interdisciplinary nature of the studio.	

Graduation project	
Title of the graduation project	Towards a *Transformative* Battery Territory Subtitle: A spatial exploration of transformability for a sustainable, resilient, and circular North-East Hungary
Goal	
Location:	Hungary, North-East Hungary
The posed problem,	Hungary is currently experiencing a rapid (re)industrialisation process under the banner of sector electrification, pushed by the economic vision of the government. Resulting in uncontextual development patterns both spatially and socially, the process can be described as an 'unsustainable sustainability transition'. Despite promises of growth and the industrial boom of the future, Hungary only serves as a stepping stone between East-Asian and Western-European companies in a system of friend-shoring (the Economist, 2024). In this arrangement, the country itself gains minimal economic benefits from the presence of the factories, while bearing the burden of increasing pollution and hazardous waste (Czirfusz, 2022). This parallel process contradicts the ambitions of the European Union as well, which strives to build its own independent supply chain based on critical raw materials (Draghi, 2024). The uncontextual nature of this development disproportionately impacts the inhabitants of North-East Hungary, one of the country's most vulnerable and least engaged regions. The sole concentration on manufacturing without

	Research and Development diminishes economic opportunities for local communities, while scarce energy and water resources are redirected for industrial use, worsening existing spatial, social and environmental challenges. It also affects the ecology of the region due to soil, water and air pollution caused by the industrial activities (Előd, 2023). The loose system of regulations and policies regarding the social and environmental impact of the industrial transition is a possible root of the problem, enabled by a centralised, populist government. Moreover, the lack of an integrated vision or participative planning and design strategies has resulted in profit-driven developments that disregard local spatial and social characteristics (Czirfusz, 2022; Weiler, 2023). To ensure a sustainable, resilient and circular future for North-East Hungary, a fundamental shift from the current practices is needed. It is crucial to build on local characteristics, offer alternatives for integrating battery manufacturing into the spatial and social fabric of the region, and explore transformative solutions to address the currently untenable transition.
research questions and	How could the processes of the **industrial electrification transition** in **North-East Hungary** be **transformed** to promote **resilient, circular and just spatial territorial development**? **Q1:** What are the spatial, social and economic dimensions of industrial development in the region and how did it evolve through time? How does the industrial electrification transition relate to it? **Q2:** What is transformability on a territorial scale, and how could one identify the transformative potential of the region of North-East Hungary? **Q3:** How could the future of the region be envisioned in 50 years based on transformability, and what kind of alternative futures can be explored to test this vision? **Q4:** How could alternative futures be evaluated and translated to a long-term transformative, circular and just spatial framework and development strategy for North-East Hungary?
design assignment in which these result.	A design exploration on the spatial aspect of transformability towards a sustainable, resilient and circular battery territory.

<u>To answer the research questions, the design outcomes include</u>:

- **Identity and innovation maps**: identity is the synthesis map of the static (low frequency of change) elements of the region (connected to the 'Remember' loop of the panarchy), while innovation is the synthesis map of the dynamic (high frequency of change) elements of the region. These two maps are the outcome of the Understanding (analysis) phase, answering the 1st and 2nd research questions.

- **Vision of a 'Transformative Battery Territory', 2075**: a manifesto-like vision towards a 'Transformative Battery Territory' in 50 years, identifying future goals for the synergy of battery development and the region based on current trends and the transformative potential.

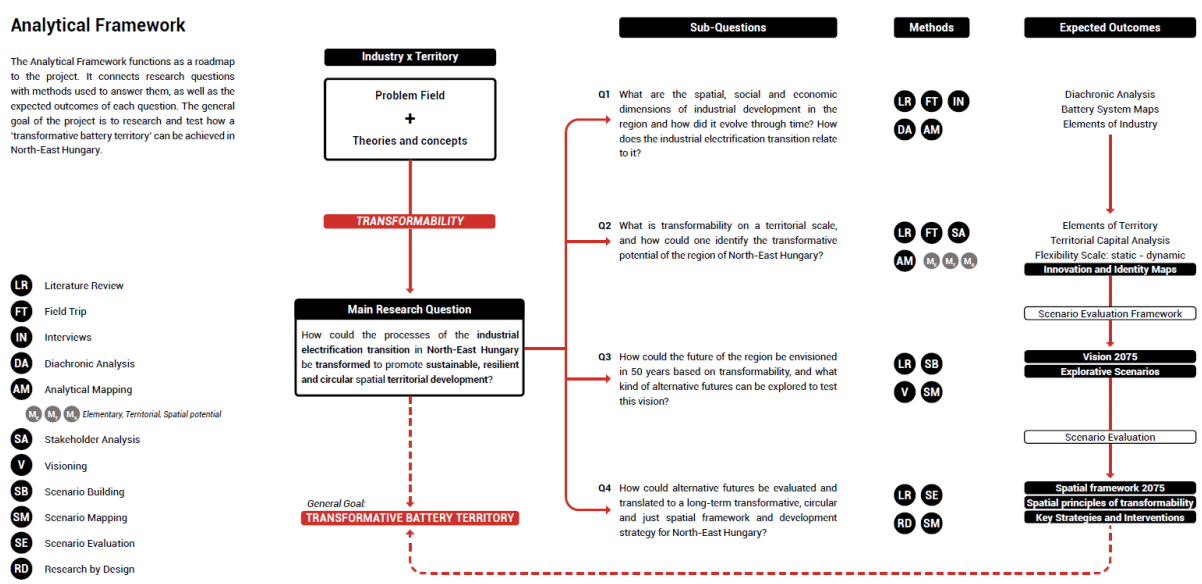
- **Explorative scenarios**: a set of alternative futures designed to test the vision, exploring the uncertainty of battery production in the future, in relation to the transformative potential of the region (identity, innovation), based on the outcome of the Understanding (analysis) phase. The vision combined with the scenarios answer the 3rd research question, as part of the Exploration phase of the project.

- **A spatial framework and strategies**: after evaluating the scenarios, they can be translated into a spatial framework for the territory, connected to the goals of the vision. This framework can be visualised through a set of maps, sections and spatial principles, highlighting the sustainable, resilient and circular principles of the new relationship of battery industry and territory as key strategies that allow for a 'Transformative Battery Territory'.

- **Key design interventions**: these key projects are meant to show concrete examples on how the spatial framework and strategies work in the existing context, depicting the impact of the transformation through multiple scales (from the house, through the street, neighbourhood and city to the territory), through a series of illustrations (from a human perspective) and smaller-scale design interventions (axonometric drawings).

Process

Method description



Literature Review:

Reading and reviewing literature (scientific articles and reports, newspaper articles, studies, relevant books, ...).

Aim: To create an understanding of industrial electrification transition, battery manufacturing, regional processes and the relation of industry and territory, as well as to develop a theoretical and conceptual framework based on transformability and to research scenario-building and possible future strategies.

Connects to: Q1, Q2, Q3, Q4

Field trip

Visiting the region of North-East Hungary and the battery factories.

Aim: To observe and better understand the spatial conditions and consequences of battery-related developments, as well as to explore the spatial and social dimensions of the regional context of North-East Hungary in order to identify morphological elements and territorial capitals.

Connects to: Q1, Q2

Interviews

Conducting interviews with experts in the field of battery development in Hungary and spatial planning, as well as the relation of industry and regional development.

Aim: To further understand the main effect of the rapid development of battery manufacturing on the Hungarian spatial (and social) fabric, and to see what are the feasible future pathways to integrate this industry on a regional scale, with an emphasis on flexibility and transformability.

Connects to: Q1

Diachronic Analysis

Comprehensive analysis of the evolution of the relationship of industry and the region from the late 19th century until today by combining elements of both history and case study (Widdersheim, 2018).

Aim: To identify reoccurring characteristics, spatial, social, and economic relations between industrial elements and the region of North-East Hungary through time, and to observe how battery manufacturing fits into this context, whether its patterns relate to or differ from those of previous industrial eras.

Connects to: Q1

Analytical Mapping

Mapping out trends, tangible and intangible elements, territorial capitals, spatial structures and potential.

Aim: To analyse and synthetise observations, research and spatial elements while representing them in a visually understandable way, uncovering patterns and interrelations between different topics and structures. Analytical mapping is used on multiple scales. There are special types of mapping used in this thesis, including:

1. *Elementary mapping:* to map out the tangible (morphological) elements of battery industry and territory and potentially overlay them, in order to uncover hidden spatial relations, based on the concept introduced by Paola Vigano (1999), detailed in the 'Theories and Concepts' and 'Analysis' chapters.
2. *Territorial Capital mapping:* to map out the intangible layers of the territory, and to synthetise the elements of industry and territory (tangible layers) with the mapped intangible layers, sorted into groups of territorial capital. This method is based on Camagni (2017) and Orsi et al. (2014), and is detailed in the 'Theories and Concepts' and 'Analysis' chapters.
3. *Spatial potential mapping*: to map out and grade the spatial potential of the tangible and intangible elements grouped into territorial capital layers, based on the flexibility and frequency of change of these elements, and is detailed in the 'Theories and Concepts' and 'Analysis' chapters.

Connects to: Q1, Q2

Stakeholder analysis

Identifying crucial stakeholders related to battery manufacturing and the territory, as well as analysing their intentions and goals, relations, power and interest, and distribution in space.

Aim: To understand the complex system and relations of actors connected to the topic, in order to see their goals, react to their needs or make them seen with proposed strategies, as well as to uncover hidden influences or relations between them.

Connects to: Q2

Visioning

Envisioning North-East Hungary in 2075 by identifying future sustainability goals based on current trends and the transformative potential of the region.

Aim: To formulate a vision for the territory reacting to the current rapid battery industry development, thus providing goals and a now lacking spatial agenda for the future.

Connects to: Q3

Scenario building

Constructing scenarios based on possible future scales of the battery industry and the two extremes of transformability in the region.

Aim: To test alternative futures while incorporating possible uncertainties and changes in supply and demand of the battery industry, as well as the extremes of transformative potential in the region (innovation versus identity). It is informed by, thus incorporates a trend analysis and is influenced by the outcome of analytical mapping.

Connects to: Q3

Scenario Mapping

Mapping out scenarios, possible strategies and design interventions.

Aim: To visualise and relate the proposed scenarios, strategies and design interventions to the regional context. Scenario mapping is used on multiple scales to get a holistic view of the researched and designed themes.

Connects to: Q3, Q4

Scenario Evaluation

Analysing and comparing the scenario outcomes in a systemic manner, based on a previously defined scenario evaluation framework built on specific criteria.

Aim: To discover the strengths and weaknesses of each scenario, in order to be able to derive strategies from them and come to a spatial framework. The evaluation framework is based on the project values (economic, social, environmental) and the degree of transformability.

Connects to: Q4

Research by Design

Projecting possible strategies and design interventions on the regional context while examining how they interact with each other and the territory.

Aim: To test and visualise how the design interventions and strategies can be implemented, whether there are conflicts or synergies between them or the region. Research by design therefore helps understanding the consequences of a design in a given context, providing valuable insight.

Connects to: Q4

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Reflection

1. What is the relation between your graduation (project) topic, the studio topic (if applicable), your master track (A,U,BT,LA,MBE), and your master programme (MSc AUBS)?

My thesis, titled "Towards a Transformative Battery Territory: A spatial exploration of transformability for a sustainable, resilient, and circular North-East Hungary", investigates a rather peripheral topic in the field of urbanism, yet the way of interpretation clearly connects to the studio topic and the master program. Dealing with spatial, territorial issues regarding the battery industry might seem unexpected from an urbanism graduation project, yet I believe it is a phenomenon that will radically shape all aspects of Hungary – including economy, society, environment and space - in the upcoming decades. Battery development lacks spatial considerations or strategies at the moment, therefore a spatial exploration is needed. This issue requires a transformative, systemic approach, combining technology, planning and design, which are fundamental to the "Metropolitan Ecologies of Place" studio. The relation between the graduation project and the studio is further explained in the "Argumentation of studio choice" section.

The main focus of the thesis is regional design, combined with spatial planning, systems-thinking and urban design, as it is part of the Urbanism track. Proposing sustainable, resilient and circular solutions on a territorial scale using transformability as a core concept requires social, environmental and economic perspectives, while the nature of the Hungarian governance makes it unavoidable to take a political stance in this question. This integrated approach aligns well with the goals of the Urbanism track.

The relation between this project and the overall master programme - MSc Architecture, Urbanism and Building Sciences – lies in the fact that I set out to explore and advocate for a more sustainable, resilient and circular built environment, by offering a new way of looking at the territory through transformability. The territorial lens requires an interdisciplinary approach, combining urbanism, industrial technology and design, as well as regional planning.

2. What is the relevance of your graduation work in the larger social, professional and scientific framework.

[societal relevance]
Globally, the project aims to improve the well-being of humans and ecosystems, by shifting the paradigm to a sustainability transformation, instead of the current, unsustainable electrification transition in Hungary. This leads to the three values of the thesis, adapted from Folke (2016), which are:
1. Just society,
2. Development within planetary boundaries, and
3. A resilient biosphere for humanity and ecosystems.
These three values also connect to the Sustainable Development Goals of the United Nations (2015).

Even though industrial electrification and the Lithium-ion supply chain are global phenomena, they have very local consequences spatially and socially. The government of Hungary disregards local communities and makes spatial decisions in a centralised, authoritarian way, without participatory processes (Czirfusz, 2022). Moreover, the chosen region of North-East Hungary is one of the most left-behind areas of the country, with issues of shrinking population, poverty and high unemployment rates, as well as climate vulnerability threats. The project addresses these challenges by providing a vision, and creating a spatial framework and strategies for the region based on local characteristics offering a just, sustainable and resilient future for the area that enables transformative change.

[scientific and professional relevance]
As global critical raw materials (CRM) based supply chains are defining the economy of the 21th century, it is crucial to research their spatial and environmental consequences in order to uphold sustainability goals. This project delves into the disparities between the North-East Hungarian territory and the CRM-based battery industry, by connecting sustainability, resilience and circularity. While territorialising circularity (Furlan et al., 2022) somewhat lacks research, the intersection of resilience and circular economy is a significant knowledge gap (Suárez-Eiora et

al., 2021). Consequently, this thesis investigates how to design a sustainable, resilient and circular battery territory that can transform in face of crisis.

As the battery industry is a rapidly evolving and relatively novel sector, almost no spatial studies have been done on this topic. In order to offer a sustainable solution, the project aims to explore the spatial dimension of transformability - or transformative resilience - on a territorial scale, which is a highly unexplored field of research. In this sense, the thesis tests a novel understanding of space, based on the flexibility and the frequency of change of industrial and territorial elements.