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:

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The posed problem,

1. **Impacts of climate change**
   Climate change becomes more serious today. The climate factors change dramatically which has greatly influenced eco-system, social-economy and health of human and animals. The temperature of both land and sea continues to rise which directly caused Antarctic collapse and the rise of sea level. Different areas suffer differently. Climate change may be beneficial for some regions or sectors, while most of the effects are adverse, for example the floods, storms, extreme events and shifting land which has a large environment, economic and human cost. Moreover, changes in climate parameters like temperature and precipitation will result in social and economic vulnerability.

2. **Higher demand and lower emission in the transitional energy system**
   To control the increase of the global warming, UN climate summit in Paris in 2015 proposed that all the members should take actions. This is a challenge for the energy system which is mainly responsible for the climate warming. Carbon-based economy and the emission of CO2 needs to be decreased in order to achieve carbon neutral by 2050. It becomes necessary to use new and clean energy to instead of conventional energy. But this transformation needs not only the space but also the time. Also, geography and region to some extent influence the transition of product and speed. Meanwhile, the demand for energy will correspondingly to increase according to the increasing population all over the world. Only under the circumstances that the quantity demanded for energy are met and the price are affordable can society become thriving and prosperous.

3. **Energy infrastructure and urban systems at risk**
   Since the climate change is becoming more severely, there are more potential risks of damage to energy infrastructure. More like the ‘central nervous system of our economy’ (European Commission 011), the local energy disruption will have global ramifications (Kopytko and Perkins, 2011),
for example the disruption of supply chains (Emmerson and Stevens, 2012) and temporary rise in prices (Hoffman and Bryan, 2013). Also, as energy facilities usually have long design lives, high set-up costs (Wilby et al. 2011), prospection on future climate change and environment conditions is essential in the design.

Furthermore, the combination effect of climate change impact and transitional energy policy threatens the whole urban system on its operation and function. The economy depends on the energy system will collapse and the energy structure and urban structure needs reconstructing. The people in the changing urban system also suffered from this impact. Especially, the vulnerable groups are harder to adapt to the environment. Considering the trend in the increase of population and the ageing effect, more people will be the victims under the climate change impact.

research questions and

Which integrated resilience strategies can be applied in the coastal system of Norway assessing the climate change impact within the process of energy transition goals?
1. How does the transition of energy systems contribute to climate change?
2. Which are the effects of climate change impacts in coastal region?
3. How does climate change affect coastal energy system?
4. How the urban system and the urban structure are affected by climate change effects and the energy transition?
5. Which systems are at risk in the coastal region?
6. How to mitigate the climate change impact and how to adapt to this effects through time?
7. What kinds of resilience measures can be applied and which governance bodies need to be aligned to do so?

| design assignment in which these result. | A revised perspective for the coastal development in Norway will be proposed as the expected outcomes for the graduation project, which considering the interrelation of energy system and other urban systems. And, by defining concrete adaptive guidelines for delta urbanism and forming into local adaptation strategies, this project aims to improve the urban structure and increase capacity of resilience to existing climate vulnerability considering climate change effects integrating with the potentiality of the requested energy transition. |

**Process**

**Method description**

**Literature review** on stock of contemporary delta urbanism theories and practice, climate change vulnerability assessment, coastal adaptive strategic and spatial planning to climate change, the documents and government reports of energy transition towards less emission energy, case studies of other energy infrastructure system in coastal regions, achievements in low-emission energy and renewable energy source, transformation of redundancy.

**Theory essay** serves as a tool research on the meaning of climate change to coastal energy infrastructure system, to assess the vulnerability and identify the key factors to adaptive measures in terms of spatial strategies in coastal region.

**Working with layers, times, scales** (Courtesy of TU Delft – Nijhuis, Pouderoijen) is a way to analyze complex delta through different layers, periods and scales. Back to the essence of urbanism, the layers can be summarized as the ‘substratum’ system with nature and water, the networks of infrastructures, and the occupation of urban patterns and agriculture (H. Meyer, 2016). The spatial form evolved with its own dynamics and speed through time on different scales. The analysis way of decomposing the delta into separately changing layers serves better for understanding of the problems, challenges and opportunities.

**Drawing the Delta** is not only used to represent the nature structure, topography, geomorphology, urban patterns, resources, elements of Norway but also as an instrument to connect generic context based on research and potential spatial interventions developed on intrinsic qualities of space.

**Exploratory scenarios** for development opportunities due to several uncertainties of future climate change, impacts of climate change, future demographic, economic and urban development and lack of specific strategies on energy profile for both short-term and long-term.
Design as a way of research can not only propose possible spatial interventions but also provide strategic framework of potential future planning and reframe current approaches.

The methodology is supplemented by Delta Urbanism Methods which is grounded on series of lectures, seminars, workshops and also a field trip across the North Sea to expand understanding of dynamic nature system and urbanism environment.
Theoretical framework is structured to support the whole research-based design, mainly by five main topics:

1. **Vulnerability and risk** theories and relevance to climate change. One of the primary purposes is to identify the climate change impact on energy infrastructure, energy system and complex urban system in the coastal region. The vulnerability theory provides the knowledge to learn further how and to what extent does the climate change impact threats these systems. Combining the assessment of vulnerability and hazards, the risk might happen in the short-term and long-term future can be estimated, which can provide a comprehensive understanding of emerging risks. The research on vulnerability and predication of risks is the precondition to resilience strategy by helping understand and build up undesirable conditions.


2. **Transformability** including transition theory, serves as part of the resilience thinking. It related with the adaptive capacity by change the fundamental attributes in a system to shift the direction of urban development. By defining and evaluating the time and resource, transformation happens in social, economic, environment system, embedded in the complex urban system. Thus, transformability goes together with complexity theory. In terms of energy system, transformability provides both the knowledge for energy resources to mitigate climate change impact and energy infrastructure for example the drilling platform offshore and petroleum plants onshore. The constantly updated knowledge of transformability helps to prepare and adapt in case of the change in city.

   - Burkett, V. (2011), Global climate change implications for coastal and offshore oil and gas development, U.S. Geological Survey, USGS Chief Scientist for Climate and Land Use Change, 540 North Courthouse Street, Many, LA 71449, USA
3. **Delta urbanism** theories are new approaches to plan urban environment for spatial plans and management while respecting the dynamics of the ecosystems. Due to the particular features of deltaic region, the interventions are quite different from the ones for the landlocked cities. Emphasis is put on the relation between natural and human system. Although Norway is not a delta region, by means of delta urbanism theories, the basic principles of dealing with the nature environment and urban development in a harmony way can be developed, which is the headstone of integrated strategies for resilient cities in coastal regions.


4. **Complex urban system** theories provide comprehensive understanding of the influence when facing the transition. Understanding the composition, the operation and function of urban system is the preliminary for risk assessment. And meanwhile, the new equilibrium of the subsystems in the complex urban system is the evaluation of the resilient city after a critical transition.


5. **Resilience** is an extended concept of mitigation, adaptation towards sustainable development. Adaptation as an adjustment in both natural and human systems, provides the basic knowledge to respond the expected climatic impact in order to acclimatise the changing impact and moderates the disaster. Mitigation affords the strategies to reduce the anthropogenic pressure in the climate change, including reducing the greenhouse gas emission. Resilience persists in a harmony relationship between natural and human system and puts focus on the synergies and interactions of social-ecological, environmental, spatial, ecology systems, which provides a more advanced thinking for sustainable development.


**Reflection**

**Relevance**

- **Societal relevance**

Nowadays, climate change mitigation is a global topic. In 2015, 195 countries adopted the first and universal binding climate agreement at 2015 Paris Climate Conference (COP21), with the ambition to keep the increased temperature below 2 degree centigrade.

The energy transition was regarded as an opportunity for the countries to great extents to reduce greenhouse gas and contribute to climate change mitigation. However, the dependence of renewable energy on weather and environment makes the green energy more vulnerable. Given the increasingly serious climate change and incremental energy demand due to population growth, how to keep the continuous of the energy system especially in the transition is essential and urgent to the society.
In Norway, the public finances are greatly boosted by petroleum sector, and nearly 30% employment is provided by energy system and related service system (Statistics Norway, 2017), which will be greatly influence by the change of coastal energy system. Meanwhile, it will also challenge the other water related or coast based economy for example fish breeding sectors. This also encourages us to think about the future lifestyle, will our daily demand of energy be satisfied, how will the delta environment be according to the climate change and what is the impact on the way of development of delta urbanism.

On the other hand, as a main production and export country for energy, Norway has already devoted himself to low-carbon energy. New tech-knowledge and new now are applied to energy generation for example using electricity exclusive hydropower to generate energy and access to new energy like wind power and flexible hydropower. Norway has a good beginning in the production and usage of energy in the new field, comparing with average consumption in the world which has a relatively low rate. Furthermore, 90% of energy in Norway is exported to European country. If Norway can play his strength in clean energy as the only provider in European, the supply is promised and CO2 emission of energy system will be lower, also shorter distance to transport and lower the carbon tax. In this aspect, Norway can serves as a paragon that other countries can copy the success on resilience energy system under climate change.

• Scientific relevance

The graduation project tries to find out some adaption and mitigation measures of coastal energy system under climate change, especially in the progressively transition from carbon-based energy to green energy, which is rarely studied till now. Although there is a lot of academic paper discuss about the meaning of resilience in terms of the whole urban system, and the vulnerability of energy system in the engineering domain, few has studied on the combination of both two. The knowledge transferred in the research of case study could be applied to other relevant question. Furthermore, this kind of interdisciplinary methodology can be applied to other fields.

Although the one-year master thesis is quite plain, it can still contribute to existing state of knowledge on pathways to develop coastal adaptive design on energy system. Also, more relevant questions are aroused, how to deal with coastal energy infrastructure after redundancy, how to keep prosperous and achieve sustainable economic transitions of cities that lost their economy pillar like petroleum sector. The challenge that urban designers are facing is not only to find a solution to protect specific infrastructure or system in order to make our city safe, but also to make it better, more resilient, more sustainable. This graduation project may serves as motivator to assemble designers and researches to thinking for a better future for our regeneration.

Time planning
- A new vision for the Norway coastal area to reach better resilience level by adapting the coastal urban system considering climate change effects integrating with the possibility of the requested energy transition.

Reflection