# Graduation Plan

Master of Science Architecture, Urbanism & Building Sciences

Tolga Özdemir 4843959

| Personal information | |
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| Name | Tolga Özdemir |
| Student number | 4843959 |

| Studio | | |
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| Name / Theme | AR3B025 Sustainable Design Graduation Studio | |
| Main mentor | Pirouz Nourian | Design Informatics |
| Second mentor | Annebregje Snijders | Architectural Engineering |
| Argumentation of choice of the studio | Many projects are being developed to promote renewable energy usage but few of them can be realised due to cost related challenges. The motivation of this study is to contribute finding cost-effective BIPV solutions to apply in areas where renewable energy generation is less popular. | |

| Graduation project | |
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| Title of the graduation project | Computational allocation and orientation optimisation of BIPV panels on an existing concrete-façade hospital building |
| Goal | |
| Location: | Amsterdam Academic Medical Centre (AMC), Amsterdam, Netherlands |
| The posed problem, | There is a need of adopting renewable energy generation strategies in urban settlements. A relatively simple way of doing so is replacing the façade claddings with BIPV panels when improving the insulation properties of buildings. In urban settlements it is not always easy to have PV panels optimally oriented to the South with a 37° tilt. The yield can be increased by minor rotations of the panels. However, this would increase the production costs and thus initial investment costs. Evolutionary algorithms can be used to find a balance between energy yield and added production costs by locating the right panel in the right place on a limited budget. |
| research questions and | How can the cost-effectivity of an early-stage BIPV design be assessed and optimised computationally within the frame of the AMC case?<br>• Which measures can be taken to improve the energy performance of the AMC Amsterdam's external walls and what is the solar electricity potential of the building?<br>• Which façade systems can be used for BIPV retrofit to the AMC's concrete external walls, in combination with other cladding options?<br>• What may be the energy yield benefit compared to the added costs of custom-made BIPV-panels?<br>• What is the financial aspect of BIPV usage in combination with other façade materials, such as façades with vegetation?<br>• To what extent can the proposed computational design methodology maximise the profits on a limited budget? |

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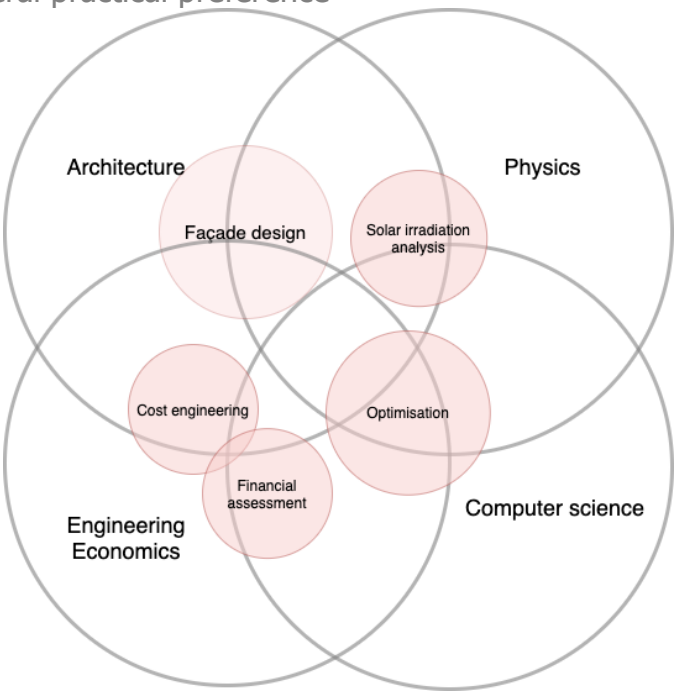
| design assignment in which these result. | The main objective of this thesis is to deliver a computational toolkit for assessing and optimising BIPV systems financially on a retrofitted concrete building to reach a cost-effective and applicable solution. |

## Process

### Method description

- Designing a BIPV panel concept
- Applying the design to an existing old building
- Optimising the allocation and orientation of the BIPV-panels for maximum benefit, considering a maximum investment cost with the created toolkit
- Testing the toolkit for different scenarios
- Evaluating the results to answer the research questions

### Literature and general practical preference




EuroPHit. (n.d.). Window / Façade Integrated PV. Retrieved January 30, 2020, from https://europhit.eu/products-focus

Van den Dobbelsteen, A. (2018). Routekaart Amsterdam. *16-03-2018*, 1–12. Retrieved from https://www.delta.tudelft.nl/sites/default/files/images/180315 - Routekaart Amsterdam v1.8_6pp.pdf

DGMR Bouw. (2016). *Academisch Medisch Centrum Amsterdam gevelrenovatie fase 2 – scenario's*.

"Engineering economics" textbooks, especially Engineering Economic Analysis (Newnan et al., 2004) from Oxford University Press, were consulted for a better understanding of the application.

### Reflection

The proposed method is involving both design and engineering aspects. Optimising the allocation and orientation of BIPV façade cladding thus fits the scope of the programme. Furthermore, research on how to integrate solar energy in the urban context in a cost-effective way encourages stakeholders to adopt this technology for outdated and new buildings.