Graduation Plan P2: Architecture

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Studio	
Theme	Architectural Engineering
Teachers	Annebregje Snijders and Tjalling Homans
Argumentation of choice of the studio	I wish to address renewable energy generation in the built environment in my graduation project. Also in general I am interested in technology. I feel these aspects are best addressed within the AE studio.
Theme	Renewable energy production in the built environment
Teachers	Arjan van Timmeren
Title	
Title of the graduation project	4FFerland

Product

Problem statement

In the near future we will become increasingly dependent on renewable energy sources. Because these sources have a lower energy density than fissile and fissile sources they will have a larger impact on our agricultural and urban environment. Integrating renewable energy production into these environments sustainably therefore becomes detrimental. Sustainable here means this production is integrated in such a manner that it does not compete with agriculture, biodiversity or recreation but rather complements these themes. The central question of my research and design project is therefore as follows:

How can the existing communal gardens in the Brettenzone (Amsterdam) be transformed into an energy producing landscape which complements the recreational and natural value of the area?

This question was divided into the following sub-questions:

1. *What strategies and methods can be used when designing for renewable energy production? What are the most important issues concerning (renewable) energy systems and what is the near future perspective of such systems?*

2. *What opportunities for renewable energy production can be found in Amsterdam's current energy system and within the industrial ecology of the Westpoort harbour area? What opportunities are offered by the city's natural energy potentials?*

3. *What techniques, fitted to the local potentials, can be used to harvest renewable energy and how should these be applied?*
   Emphasis: *How can technologies for biogas production from agricultural biomass be applied in the Brettenzone for renewable energy production?*

Goal

To design a landscape, stretching from the urban centre to the city's limits, which harvests energy from agricultural biomass and solar heat in a manner which is integrated in the industrial ecology of the area.
The landscape should simultaneously offer urban dwellers a recreational landscape that allows them to have a closer relationship to their production landscape.

N.B.: The architectural design assignment will be focussed on a group of greenhouses and buildings within this landscape where food and biomass are produced and where this is processed into biogas. Integrated symbiotically into this design will be a series of recreational functions such as communal gardens and a restaurant.

Process

Method description

The following research methods where / will be used in the research part of the project. These methods match the before mentioned sub-questions:

1. **Literature study:** on (renewable) energy systems, renewable energy production and their sustainable integration. (Timmeren 2006; Tester 2005) Also on analysis methods for designing such systems. (Dobbelsteen, Broersma, and Stremke 2011; Tester 2005) This part will also define the framework for my further research.

2. **Mapping:** the current energy system in Amsterdam. Mapping was done on the levels of the hydrocarbon energy system, the electrical energy system, the thermal energy or district heating system and the thermal energy or district cooling system. Also the links between these systems where analysed.

3. **Literature study:** on biogas production. The issues concerning bioenergy. The required technology and equipment for producing biogas from agricultural biomass. (Deublein and Steinhauser 2008; Gupta and Demirbas 2010; Giampietro and Mayumi 2009)
   Comparative literature study: analysing the potential of different biomass sources, that is: specific crops and manure.

For achieving the design goal the following design/analysis methods will/where used:

- **Computational solar irradiance study** of different configurations. This should lead to an optimization of the functions: solar energy harvesting, food production, biomass production and recreation.

- **(computational?) Mass balance.** This method should lead to an appropriate ratio between food crops, feed crops and livestock such that a closed cycle of food, feed, fuel and fertilizer is obtained. The goal is to obtain the highest yields for each of these productive aspects in their respective order.

- **Research by design.** Integration of research findings and design goals. Technical and architectural integration of the different functions and techniques. Research into an architecturally coherent expression.

Literature and general practical preference

1. **Literature study.** On renewable energy systems and methods / strategies for their design:
   (Timmeren 2006; Tester 2005; Dobbelsteen, Broersma, and Stremke 2011)
2. **Mapping.**
   Sources from governmental and private institutions, research papers and personal communication with casus specific researchers and experts.
3. **Literature study. On general issues:**
   (Giampietro and Mayumi 2009; Gupta and Demirbas 2010; Tester 2005; Deublein and Steinhauser 2008)

   Comparison of different biomass sources, their growth or husbandry requirements and biogas qualities:
   (numerical) Data from a multitude of experimental research papers and literature.

   On techniques and equipment:
   (Deublein and Steinhauser 2008)

Most important literature:

Deublein, Dieter, and Angelika Steinhauser. 2008. *Biogas from waste and renewable resources an introduction*. Weinheim: Wiley-VCH.

Dobbelsteen, Andy van den , Siebe Broersma, and Sven Stremke. 2011. "Energy potential mapping for energy-producing neighborhoods." *International Journal of Sustainable Building Technology and Urban Development* no. 2 (2):170-176.

Giampietro, Mario, and Kozo Mayumi. 2009. *The biofuel delusion the fallacy of large-scale agro-biofuel production*. London: Earthscan.

Gupta, Ram B., and Ayhan Demirbas. 2010. *Gasoline, diesel, and ethanol biofuels from grasses and plants*. Cambridge, UK: Cambridge University Press.

Tester, Jefferson W. 2005. *Sustainable energy choosing among options*. Cambridge: MIT Press.

Timmeren, Arjan van. 2006. *Autonomie en heteronomie integratie en verduurzaming van essentiële stromen in de gebouwde omgeving*. Delft: Eburon.

Reflection

Relevance

- Integration of renewable energy production into our built environment will become an increasingly important issue. Combining different functions with energy production and als its architectural expression are detrimental aspects which should be addressed.
- Considering the increasingly complex world and the unsure professional context of the architect it might be desirable for the architect to extend his expertise beyond his traditional domain. This could enable architects to become integrators of different scientific and societal domains rather than domain specific experts. Energy systems offer one possible subject with which the architect could extend his domain.

Time planning

Appendix A: Planning towards P4. Appendix B. Planning towards P2
N.B.: Planning B contains two topics (heat and coldharvesting technologies) which were dropped from the research paper. However literature was studied on these subjects. This research will be presented in a small report in September 2013.

Attention

The design will encompass greenhouses with different climatic conditions. Also it will contain a series of engineering structures and systems related to energy / food production and storage. Their technical design and integration will be the main issue in consultations with the BT teacher.

Deublein, Dieter, and Angelika Steinhauser. 2008. *Biogas from waste and renewable resources an introduction*. Weinheim: Wiley-VCH.

Dobbelsteen, Andy van den , Siebe Broersma, and Sven Stremke. 2011. "Energy potential mapping for energy-producing neighborhoods." *International Journal of Sustainable Building Technology and Urban Development* no. 2 (2):170-176.

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