Residential Energy Transition of Amsterdam Nieuw West neighbourhoods

Katerina Panteli 4516397

Reflection

The current report is a result of my graduation research during the Sustainable Design Graduation Studio, for the master in Building Technology within the faculty of Architecture of Delft University of Technology of TU-Delft. This project, aims at contributing in the European City-zen project which concerns the development of an energy transition urban planning methodology, for creating fully sustainable and energy (carbon) neutral smart cities in the future.

The main objective is the development of a stepped methodology, to define a roadmap that leads to the goal of the energy transition and CO2 emissions reduction of residential neighbourhoods in Amsterdam Nieuw West, through the suitable combinations of energy systems and retrofit measures on the timeline until 2050. Hence, the final expected result is a structured stepped methodology, including an energy transition roadmap for the definition of residential retrofit interventions on timeline, for neighbourhoods with different site energy conditions, referring to specific neighbourhood combinations inside Amsterdam Nieuw West district.

During this process leading to the final design a lot of knowledge is gained regarding the following topics:

Residential energy retrofit

- Residential building stock in the Netherlands and the expected reduced heat demand after retrofit of each typology is researched.
- The existing energy urban planning methodologies study is crucial in order to set the methodology steps for this project.
- The European energy goals for 2050 and Amsterdam Municipality's future energy goals contribute in setting the final energy goal to reach at the end of the timeline.
- There has been extended research on the energy systems to understand how they work and under which requirements they can be applied. The existing retrofit measures, beside the systems, were identified from papers and case studies, and were organised in a catalogue, according to their energy characteristic (reduce, reuse or produce), and their application scale (building, neighbourhood, district). The information of retrofit on all kinds of scales is useful to recognize the optimal solutions on neighbourhood scale as the aim of the project indicates, and since the other scales cannot be avoided.

Energy conditions of Amsterdam city

- The current energy demands in terms of electricity and gas were known from the research of Energy Atlas of Amsterdam. The current energy need for heating could be calculated then out of the gas use, and the 2050 goal for heat demand, when natural gas is eliminated, was determined as 60% as deep retrofit requires, including space heating and DHW.
- The energy potentials were also calculated and mapped in the same research. Knowing the potentials of heat sources contributed in forming a scenario for the availability of renewable sources until 2050. The sources were separated in low temperature heat, high temperature heat and electricity, because the amount of low temperature heat is needed to calculate the electricity for operating heat pumps for the relative energy systems, and make conclusions whether the energy needs can be covered fully by renewable sources that do not emit CO2.
- The existing proposed solutions for the systems application in the different districts of Amsterdam (District Heat Network, ATES heat and cold storage, transition to All electric and NOM, and green gas) combined with the sources potentials, helped in classifying the basic

energy systems that can be used for heating dwelling in the city, and in representing in percentages the systems in which district. For example, at this point, green gas is excluded from the basic energy systems, since the proportion of available biomass is so small though the years, that seems doubtful whether it can support an area. Thus, an assumption is that it could be used in transport. Consequently, this research will give solutions for the different neighbourhoods using four energy systems.

Context analysis of Slotermeer neighbourhoods of Amsterdam Nieuw West

- Existing typologies in the retrofit intervention area were identified, to figure out if there are groups of the same buildings in the neighbourhoods.
- The housing ownership condition is important for decision-making, since it is easier to convince one owner instead of multiple for the proposed solutions suitability.
- The energy demands of electricity and gas, and the calculated heat demand out of gas use is important to show later how it is reduced in steps of applying systems and retrofit measures until 2050.
- The potentials of local renewable sources are an extension of the process from the city scale to know how much energy can be provided to these neighbourhoods, and assume the systems that are going to be implemented expressed in percentages.

Roadmap design

For accomplishing the design phase of the roadmap 3 stages are required, 1) the selection of suitable energy systems for 2050 for each one of the selected neighbourhoods by applying the developed decision-making diagram [figure 1], 2) the description of the energy system and retrofit measures, and the corresponding changes in heat demand and CO2 emissions that are listed in templates, and 3) the definition of the interventions determined by the 2 previous sub-steps on timeline, starting from today and ending in 2050.

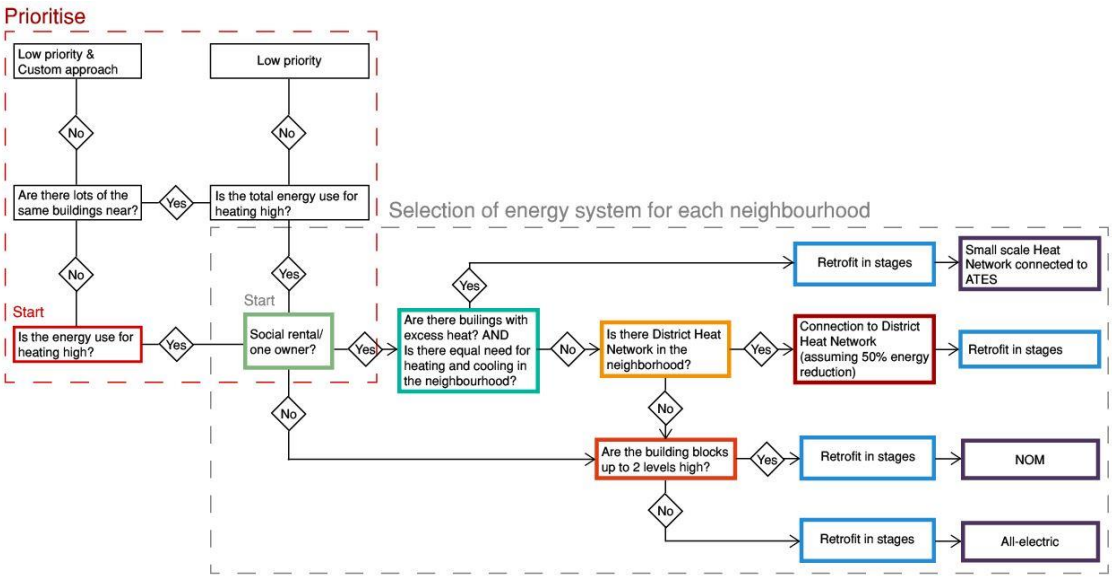

Fig. 1: Decision-making diagram for prioritising buildings before the selection of energy systems

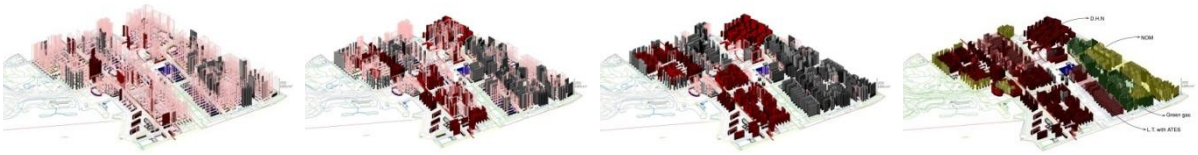

Fig. 2: Retrofit steps every 5 years starting from 2017 with building of average heat consumption over 300 kWh/m2

Difficulties faced and changes through the process

At the beginning of the project one of the sub-objectives was to categorize all neighbourhoods of Amsterdam Nieuw West in clusters with similar energy characteristics, for giving solutions that would cover the retrofit of the whole district. Due to the time limit of the project, the research was restricted in only 7 neighbourhoods for applying the basic energy systems. Also, another sub-objective was to quantify the energy reduction percentage of all energy systems and retrofit measures recorded on the catalogue of measures, but I couldn't figure out an accurate way to express that with generalised percentages. Thus, the retrofit stages for minor, moderate and deep retrofit interventions, and the resulting general reduction percentages have been used from the research Europe's Buildings under the microscope published by Buildings Performance Institute Europe (BPIE).

Another point realised through the process, is that I couldn't propose energy systems directly in the neighbourhoods in Amsterdam Nieuw West by looking only at their local energy demands and sustainable sources potentials, as I imagined in the beginning. It was important to understand the energy conditions and give solution for the whole city first, since the biggest amounts of energy would be provided from city scale.

The various existing solutions of energy systems made the process of applying them on-site too complex. Therefore, some basic solutions for the neighbourhood scale should be defined before entering the building scale. What was important, was the outline of five basic energy systems, meaning the use of the existing District Heat Network, the creation of Small-scale heat network connected to ATES, the transformation of existing dwellings in several areas to all electric, the transition to NOM (Zero-On-the-Meter), and the replacement of natural gas with green gas in other areas. The solution of using green gas was excluded later as already mentioned.

The intention then was to make a vision, based on the availability of the potential sources of these energy systems applied in percentages for each district of Amsterdam. The difficulty at this point is that I couldn't give an accurate percentage for each system, ending up in solutions for the districts of two general categories of heat systems [figure 3]. The High Temperature heat system of extending the District Heat Network, and the Low Temperature Heat systems, including Small-scale heat network connected to ATES, transition to NOM and to All-electric. The vision formed later for the neighbourhoods in Amsterdam Nieuw West is in more detailed, showing the systems in each neighbourhood [figure 4].

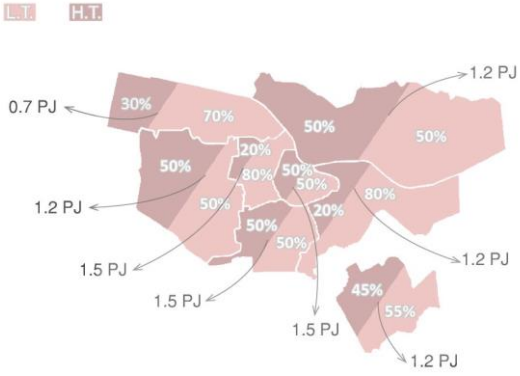

Fig. 3: High Temperature and Low temperature systems ratio per district

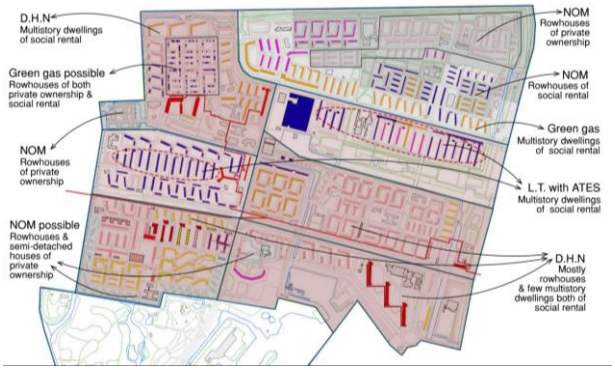

Fig. 4: Energy systems applied on intervention neighbourhoods

The design of the roadmap resulted a complex process, where I should deal with many variables and different approaches for the allocation of the energy systems, starting from the city scale to end up giving solutions in neighbourhood scale, and later apply the solutions in steps. To make the process simpler, I developed a decision-making diagram with variables that came out through the literature study of the application requirements of the energy systems, and the answers were given from the context analysis of the neighbourhoods. A main variable, the first question to answer in this diagram, that could not be examined accurately for this project was the human factor of the owners' decisions. Thus, the assumption made in order to go through the process was that if there is one owner, the possible systems to apply for a cluster of buildings is the District Heat Network and the Small-scale heat network with ATES. Otherwise, the possibilities are for individual solutions of transition to NOM or All-electric dwellings. The logic was that if you have to deal with only one administrator it is easier to convince for collective solutions, however the decisions of the owners cannot be predicted.

Another fact taken into consideration is that the results could not be illustrated as a specific blueprint. This happens not only because of the owners that might not agree in some points, but also because of the changes during time over a period of 33 years from today, as the technologies and the availability in sources change, and not everything can be predicted precisely. Thus, the solutions are shown in a diagrammatic way, that offers a possible methodology that could be followed to reach the goals of energy transition and CO2 emissions reduction for specific neighbourhoods of Amsterdam Nieuw West.

Further research and design improvement

Discussing the roadmap results, it is a fact that stakeholders play a dominant role on the decision-making for selecting systems, and further research is required, such as interviewing the owners and asking the energy suppliers about future plans, for giving more detailed and accurate solutions since their decisions would definitely affect the proposed results. Also, further research is needed regarding the time consumption of the retrofit stages, for improving the 3-dimensional visualisations that show the changes on heat demand of each building block through the years until 2050. Moreover, the final outcome of the whole process aims to give solutions of reducing the heating demand and the relative CO2 emissions, not really deepening at electricity reduction and decarbonisation solutions. The general result of the 4-step energy urban planning methodology results a promising approach for further implementations in other cities of the world, serving the targets of the largest society to decrease CO2 emissions and achieve the desired sustainable development. Nevertheless, several alterations are needed for using it in other places of different context and energy characteristics. These alterations can be based on different future energy goals of other cities, and on the local demands and potentials that must be collected. All this data will probably lead to the classification of different basic energy systems, guiding to different application variables for the decision-making process of selecting suitable energy systems for clusters of dwellings on the appropriate time.