Hypothetical District Heating Use Case

The largest use of energy in Dutch homes is for heating, representing over half of energy consumption in the residential sector in 2018[1]. Natural gas is the primary source of energy used for heating homes in the Netherlands[2]. This has many drawbacks, including CO_2 emissions and reliance on sources outside of the country for energy supply. In order to meet government mandated targets for phasing out the use of natural gas and become both more sustainable and more resilient, Dutch municipalities will have to offer residents other methods for heating their homes. Unfortunately, many homes, especially older ones that are not well insulated, will be difficult to convert from natural gas to other heating mechanisms because of the ability of natural gas to create large amounts of heat in a short amount of time with relatively inexpensive equipment.

Accordingly, the transition away from natural gas will be complex and involve phasing in solutions by identifying "low hanging fruit" opportunities where the greatest amount of natural gas can be phased out quickly and prioritizing those projects first. This prioritization is fundamentally a mathematical problem that can be modeled using analytic techniques and special software.

In this specific *hypothetical* use case, the mythical city of Amstelmeerveen is looking to replace natural gas boilers in up to 4,750 homes in a high-density area with a combination of air and water-sourced heat pumps. An additional 2,700 homes that are in lower-density areas will be offered financial incentives to install their own single dwelling heat pumps. In order to determine which homes are eligible for connection to the new district heating system or financial incentives, many factors need to be considered including:

- capacity of the electric power grid,
- availability of property / locations to install the required infrastructure,
- access to either free flowing or open water sources,
- environmental impacts of removing heat from water, air and ground,
- ability to install additional insulation / isolation in homes planned for conversion,
- cost of equipment required to be installed within individual homes,
- current and future projected cost of electricity,
- capacity projections to ensure adequate heating can be made available on especially cold winter days, and
- what the impact of future technologies such as hydrogen and fusion power could have on any potential technology installed as a part of this project (the city wants the solution to be "future proof")
- … and many other factors.

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[1] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Share_of_final_energy_consumption_in_the_residential_sector_by_type_of_end-use,_2018_(%25).png

[2] Ministry of Economic Affairs and Climate Policy, 2016. *Energy Report: Transition to sustainable energy.* Available online at: https://www.government.nl/documents/reports/2016/01/01/energy-report-transition-to-sustainable-energy

Fortunately, Amstelmeerveen city managers have joined the CAC consortium and have full access to models that have been developed based on similar projects undertaken in Leiden, Den Haag, Groningen, and elsewhere in the world. Their journey starts with a consultation with a digital modeling expert at the CAC Foundation, a non -profit organization that curates and disseminates models for various types of climate change projects. During the consultation process, the CAC digital engineering expert identifies a model used in Edinburgh, UK that is very similar to the case in Amstelmeerveen and can be easily and quickly adapted to their needs.

Two additional models will be used to determine the best sources of heat, one based on a Norwegian installation where heat is pumped from local fjords to heat a city of 28,000 residents and another from the UK where heat is being extracted from a free-flowing river to heat a community of 32,500 residents.

After the models have been identified and adapted to the Amstelmeerveen use case, the city assembles a multidisciplinary team of policy makers, economists, city planners, scientists, engineers and members of the local community. This team meets once every two weeks in the CAC located in The Hague and – using digital engineering techniques – they explore various options for achieving the original goals approved by the Amstelmeerveen city council. The sessions are facilitated by a digital engineering expert hired from a partner company located in Leiden that is also a part of the CAC consortium.

In total, eight sessions are conducted after which the city has developed a plan that is determined to be feasible, affordable, low-risk, and one that is most likely to receive support from both the city council and also members of the community. As a part of this plan, the multidisciplinary team has also evaluated a new approach being proposed by TU Delft to create an underground "heat reservoir" that can act as a long-term heat buffer between summer and winter and can also solve the difficult problem of providing extra heat capacity on especially cold winter days. With this new knowledge, the existing models are updated and handed back to the CAC foundation so that other municipalities grappling with the same problems in the future will be able to quickly analyze the option of using the new TU Delft technology in their specific cases.

For the city of Amstelmeerveen, the CAC consortium has played a key role and the city has benefitted in the following ways:

Acceleration: The city was able to complete the feasibility study and early-stage design work in sixteen weeks what normally would have taken eight to twelve months. The resulting report was provided for public review and approval by the city council far ahead of the original schedule.

Cost optimization: By having access to previously validated models through the CAC Foundation, the city was able to "fast forward" their process and avoid undertaking duplicate work, thus saving both time and money.

Stakeholder engagement: Using Concurrent Design processes, the city was able to engage all key stakeholders simultaneously and evolve thinking on the project in parallel, ensuring the best possible solution was arrived at that would also receive acceptance by city residents.

Risk reduction: By taking advantage of models that have been used before, have been refined over time and that have been validated in other municipalities, city engineers were able to prepare a better specification of what was needed, leading to a better request for proposal to be released for public tender, and ultimately resulting in a better quality, more successful and lower cost project.

Overall, the assessment by the city was that running this complex project through the Climate Action Center resulted in numerous benefits and very few drawbacks; similar to the benefits achieved by the European Space Agency with Concurrent Design for over 20 years now including project acceleration, decreased costs, improved stakeholder alignment and improved project quality. As a result, the city has decided to use the CAC for planning of its next major project, a massive installation of solar panels in the vicinity of Schiphol airport.