Exploring futures of summer comfort in Dutch households


Photo by Angeline Swinkels

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Abstract: This article describes the results of a qualitative study into cultural aspects of summer comfort in Dutch households. Results show that two main ways of preventing overheating – shading and summer night ventilation – compete with active cooling. Moreover, it identifies potential for technologies, policies and procedures to support adaptation to higher temperatures.

Keywords: Summer comfort, Netherlands, cultural change, qualitative study, dwellings, energy.

Introduction

The Dutch Meteorological Institute (KNMI) defines a heatwave as a period of at least five consecutive days with daily maximum temperatures exceeding 25°C, with at least three of the five days reaching maximum temperatures above 30°C. In the coming decades, heatwaves are expected to become longer, warmer, and more frequent [1]. On top of this, dwellings in the Netherlands have long been built with a focus on keeping warm during winter, resulting in high levels of insulation and airtightness that increase the risk of overheating. Other factors contributing to risks of overheating are large windows, urbanisation, and an ageing society.

Dutch households are beginning to adjust their lives and homes to these new circumstances. For those who can afford it, mitigating discomforts and health risks of hot weather are within reach, but tend to require high amounts of energy. Essent, one of the main energy providers in the Netherlands reported a 30% increase in energy demand during the August 2020 heatwave [2], and a 2021 study by research institute TNO [3] showed that 20% of Dutch households already have a form of active cooling, while 26% is considering to get it.

At this point in time, Dutch responses to global warming can still go in many directions, some of which are undesirable from health, inclusivity, and environmental points of view. Therefore, it is important to try and anticipate, and where possible redirect these pathways. Actions in the present, such as building policies, proposing standards (e.g. EN ISO 52000-1, EN ISO 52016-1), designing infrastructure, building technologies, and passing on instructions have an effect on shaping futures of summer comfort in Dutch households. These actions, in turn, are informed by visions, assumptions and expectations of what futures are possible, desirable and likely to come about. However, insight into these futures from a Dutch household perspective is so far limited.

This raises questions like: To what extent are mainstream Dutch households equipped and able to equip themselves to deal with longer, warmer, and more frequent heatwaves? Which strategies do households apply and aspire to achieve comfort in times of hot weather, and which currently not? What are possible consequences of these strategies for levels and patterns of energy demand, and general well-being? What are developments outside of these households that may affect these strategies?

This article summarizes a selection of findings from a qualitative exploration of the future of domestic summer comfort in the Netherlands. A full version of the study results is available in an open access stakeholder report [4]. While the focus of the study is on the Netherlands, its outcomes may be relevant beyond this context, particularly in countries where active cooling is currently on the rise due to global warming.

Method

The study consisted of a set of interrelated research activities, primarily involving 21 household interviews and 10 domain expert interviews.

The household interviews were designed to capture the main daily domestic activities that are relevant to summer comfort. These were: (1) cooking and eating, (2) personal care and clothing, (3) laundering and cleaning, (4) home working, (5) free time, (6) sleeping, and (7) ventilating, shading and cooling.

The interviews were conducted around a heat wave in August 2020 (**Figure 1**). No actual measurements of indoor temperatures were made, so conclusions regarding temperatures are based on self-reported values, which tend to be less reliable. The use of workbooks with daily exercises, which primed participants to notice their indoor temperature values in the week before the interview, partly compensated for this.

The domain experts included HVAC, sleep, physiology, fashion, architecture, building standards, social housing and domestic shading. These interviews and additional sources, such as trade fairs and observations were used to identify and extrapolate current cultural, demographic and technological trends in domestic summer comfort.

Findings

Overall, the study confirms the expectation that the use of active cooling in Dutch dwellings is likely to increase in the future. This is reflected in growing sales figures of cooling systems, but also in actual and experienced overheating in dwellings, as well as frictions with emerging practices of shading and ventilation. The latter, along with embodied acclimatisation, have potential to contribute to summer comfort in a low-energy manner. However, their establishment is hampered by existing infrastructures, historically shaped cultural values and habits, and competition between different activities. The sections below elaborate on these points.

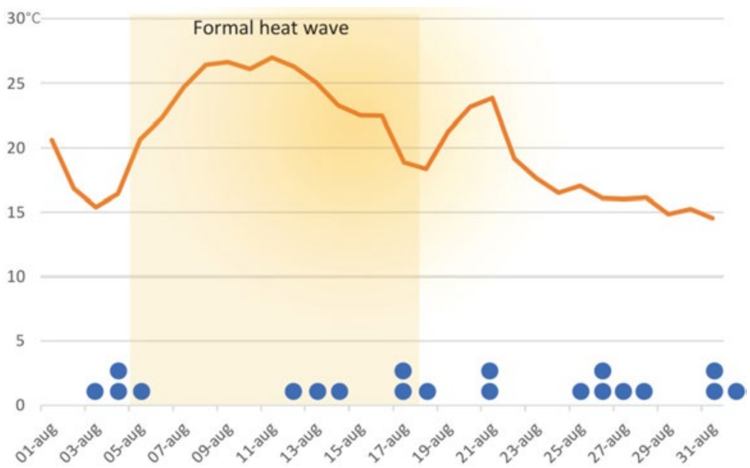

Figure 1. Timing of household interviews in relation to the August 2020 heatwave. Graph shows average temperatures measured at De Bilt weather station obtained from KNMI.nl. [4]

Actual and experienced overheating

Overheating is already an issue in Dutch households. From the perspective of the NZEB (Net Zero Energy Buildings) standards, several dwellings in the study (all apartments) exceed the threshold of 450 WHOs (the Weighted Overheating Hours), which in the Dutch TO_{juli} -indicator start counting above 27°C. Overall, reported indoor daytime temperatures during the heat wave ranged from 24°C to 45°C for dwellings without cooling. The dwellings that reported temperatures over 30°C in their main living areas were all rented city apartments.

Stories of residents confirm that these dwellings become practically unliveable during a heat wave. Moreover, most households in the study considered their dwelling to be overheated well below the formal overheating threshold. Indoor temperatures above 25°C were considered too high by all but four participants, particularly for working and sleeping. These higher temperatures inhibited their freedom of movement and capability to go about their daily business, such as focusing on work, sleeping well, and performing housework.

These issues were absent for households with active cooling, but they were inhibited in other ways, particularly, in being outdoors. The data indicated that households with active cooling have a stronger tendency to take the car instead of walk or cycle, because stepping outside from a cooled space felt like 'hitting a wall'. In other words, spending time in cooled spaces reduced their willingness and ability to tolerate the higher outdoor temperatures.

With climate change, these overheating issues are expected to grow. The next sections go deeper into the strategies that households currently apply and aspire to deal with these issues.

Acclimatizing

Participants that were able to enjoy or accept the heat and modify their daily schedules around it were most capable of getting through the heatwave without too much discomfort. For example, families that had their summer holidays during the heat wave or a young person practicing mindfulness. However, the freedom to adjust one's daily schedule is not accessible for everyone, especially if heatwaves are to occur more often outside of summer holidays. Moreover, not all bodies are equally capable of dealing with heat and these capabilities decrease with age [5,6].

However, the study shows that common knowledge among the general public on bodily responses to heat show a gap with state-of-the-art research, particularly regarding the role of sweat in dealing with heat (it is mostly seen as something negative) and the capability of bodies to adjust to higher temperatures over time. While research shows that people can adapt to heat by as much as 1°C per day as confirmed by the physiology expert, none of the participants referred to concepts of bodily adjustment to heat over time. This finding indicates that adjustments in knowledge, available products, skills, and attitudes to acclimatize could reduce people's experiences of being locked into their homes and bodies, and contribute to well-being in a low-energy manner. Put more strongly, the adverse mental and physical effects of reduced physical activity in hot weather might be partly mitigated if people (are facilitated to) acclimatize.

Cultural frictions with shading, ventilation and cooling

A seemingly embedded friction that arose from the interviews is the relationship that 'the Dutch' have with warm weather. Warm and sunny weather is associated with being outdoors and enjoying the light and warmth of the sun. In the spring, when days get longer and warmer, people open doors and windows to let fresh air in, extending their living spaces onto balconies and into gardens. Fluctuating temperatures mean that Dutch summers can have relatively cool spells that precede heatwaves. When temperatures go up, the sun is initially welcomed into the home. But when temperatures rise, this behaviour leads to overheating, which is then difficult to correct.

Proper, disciplined outdoor shading and summer night ventilation routines could reduce the extent to which indoor spaces heat up [7], but adopting these routines requires more than new equipment and behaviours. Viewing the sun as an 'enemy' instead of a 'friend' for part of the year requires a cultural shift. The Dutch friendship with the sun is deeply embedded in customs (opening doors, curtains and windows to enjoy light, views and fresh air), the built environment (ample, sun facing windows) and related professional practices such as architecture (disliking and sometimes prohibiting outdoor shading). For most of the year, the sun is and will remain a friend, helping to light and warm dwellings, and keep people healthy and cheerful. Learning to occasionally 'cool' this friendship requires a cultural shift that is necessary for the potential of shading and ventilation practices to develop (**Figure 2**).

Active cooling is more explicitly approached with reservation. Participants without active cooling are familiar with air conditioning, but find it too energy-consuming, noisy, expensive, and uncomfortable. However, even highly committed, knowledgeable residents in modern homes, equipped with the latest shading and ventilation technologies, had trouble maintaining a comfortable indoor climate without the use of active cooling. Many anticipated getting some form of active cooling in the future. Those who already had cooling were mostly content with their systems (except for mobile air conditioners). Although there are cultural and practical frictions to integrate active cooling into Dutch households, they seem easier to overcome than those related to shading and ventilating. Added to this lower barrier to uptake is the risk that active cooling creates a further threat for shading and ventilation practices to reach their potential because they compete.

Shading, ventilating and cooling compete

Shading and active cooling can complement each other in dwellings, but the study illustrates how they compete in the market. Both active cooling and outdoor shading require considerable investment.

Figure 2. Examples of inconsistent Dutch practices of shading and ventilating during hot weather (28°C). [Lenneke Kuijer, August 2022]

If households have an opportunity to only invest in one, then cooling has the better position in terms of low-effort comfort. This competition is also visible in the current NZEB requirements, where adding a form of active cooling eliminates incentives for other, low-energy measures against overheating such as shading.

Cooling and summer night ventilation compete directly in the dwelling. While the cooling system is on, windows and doors need to be closed to retain the microclimate. This effect is even stronger for mobile air conditioners, used in three participating households, because securing the hose in the window can further hamper the opening of windows when the device is not in use. During the day, the hose in the window necessitates a (partly) open window enabling hot outside air to enter the dwelling (**Figure 3**).

In general, active cooling, when properly designed and installed, can secure comfortable temperatures in the dwelling regardless of other measures such as shading or ventilation. Shading and ventilation require the active involvement of residents. With active cooling in place, the incentive to invest money, time, and effort in them is reduced. Mobile air conditioners have a particularly problematic position in this respect because of their relatively low threshold, and energy-efficiency. While they can be life-savers on the scale of individual users, in the broader picture these appliances form undesirable symptoms of overheating in Dutch dwellings that contribute to the problem of climate change and heat islands [8].

Smart automation

These insights can be used to design measures that might slow down or prevent Dutch households from becoming dependent on energy intensive cooling equipment that could hamper the development of other strategies to deal with a warming climate.

Automation can play a role here. For example, when shading responds automatically to levels of solar gain, rain and wind, and ventilation to temperature and humidity differences inside and outside the dwelling. However, the role of residents cannot be ignored. Not only their autonomy in deciding whether to have these systems at all, but also in the ways they are used. The study revealed a wide array of circumstances in which people might disable automated shading, such as feeling locked-in, wanting more light, annoyance with repeated movement, wanting to open windows, etc. For ventilation systems, it became clear that their automated responses to CO_2 or humidity levels can conflict with summer comfort by drawing in hot outside air during the day, while summer night ventilation, in most homes, requires residents to open and close windows while they are sleeping. Further research is needed into this direction.

Pathways for active cooling

So far, active cooling is discussed as one practice, but in fact, different forms of active cooling are currently developing in parallel. Main pathways are radiant cooling and air-conditioning. Radiant cooling, mainly in underfloor settings powered by heat pumps or district cooling are relatively slow systems that cool the building mass. Such systems are likely to run continuously during hot weather. An advantage of these systems is that for ground source heat pumps, cooling can be provided on low-energy demand, or even energy-positive manners when heat is stored for use in winter (**Figure 4**).

Figure 3. (Mobile) air-conditioners interfere with ventilating practices. [Lenneke Kuijer, August 2022]

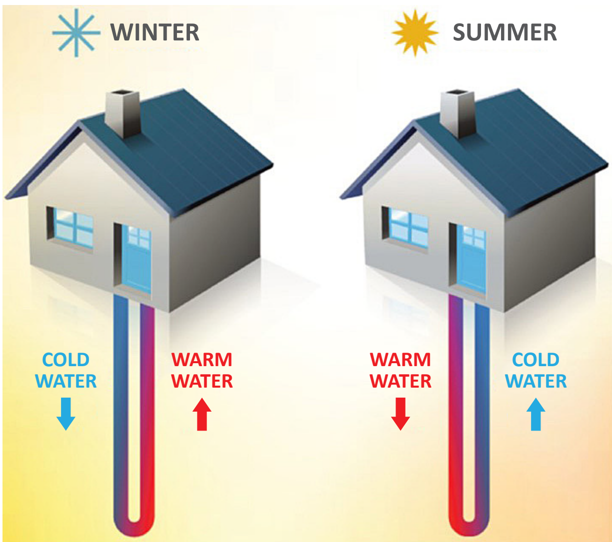

Figure 4. Storing summer heat in a ground source for use in winter. [4]

Air-conditioners work more quickly by directly cooling the indoor air and are more likely to be used based on occupancy and direct demand. Spaces also heat up again relatively quickly when they are off. Mobile air-conditioners allow for even more directed, person-oriented, albeit fleeting forms of cooling. Apart from their efficiency, these different patterns of use are likely to affect their overall energy demand.

Moreover, levels of energy demand for active cooling do not only depend on the type of systems and when it is used, but also on the set-temperature. At present, the temperatures to which households will set their cooling systems has not been settled or stabilised, but it is likely that norms around acceptable and normal temperature ranges will develop in the coming years and decades. With heating, for example, Dutch households presently tend to set their thermostat somewhere between 18 and 22°C. This normalised temperature range has formed and changed over a long time period [9], and varies per cultural context [10].

As illustrated in the introduction, building norms, standards and system design can play an important role in shaping these norms. Considering that technologies co-shape practices, it makes a huge difference for the way in which summer comfort practices will develop whether default settings, promotion materials, media and installer instructions for cooling systems recommend setting the system to 18°C or 27°C, introduce some other metric like a combined humidity/temperature value, or are designed to offer a variable temperature that moves with the outdoor temperature and slowly increases over time to support acclimatisation.

Additional effects of warming on everyday life

The use of active cooling in the home seems to lead to a dependence on cooled spaces that extends beyond the dwelling. The examples in the study indicate a trend towards spending more time indoors, and the car becoming preferred over other means of transportation. Beside increases in CO_2 emissions and energy costs that accompany the increased use of most forms of active cooling, these trends indicate undesirable health effects resulting from lower activity levels and lower natural vitamin D intake.

Other areas in which increases in energy demand are likely to arise according to our finding are in increased capacity for cold food storage, showering and laundering. Several households reported that fruits and vegetables that are normally kept in dry storage are moved to refrigerators during hot weather, where they compete for space with more cooled drinks (**Figure 5**).

Photo by New Africa / Shutterstock

Figure 5. Demand for cold food storage increases in hot weather, but fridges and freezers heat up indoor spaces.

This leads to an increased demand for (larger) fridges and freezers—appliances which, in turn, directly contribute to overheating in dwellings due to the heat they produce.

The study also indicated that shower frequencies increase during hot spells. The main reason for more showers within the sample was not to cool down, but to rinse off sweat. This requires water, as well as energy to heat it. With a trend towards better insulated homes, these secondary effects could become significant.


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Different consequences for different types of households and dwellings

While it is difficult to draw a strict line, some of the dwellings in the study were clearly overheated. These examples represent a larger group of households for which homes become unliveable for part of the year. Smaller, well-insulated dwellings, with higher window-to-content ratios, high sun exposure (e.g. in high-rise), little shading and ventilation opportunities, located in cities (heat islands) heat up quickly. Such dwellings are more likely to be occupied by lower-income households and are more often rented than owned. This might also mean that the potentially higher amount of time spent at home by the residents due to lower levels of employment could add to the overheating issues.

Also judging from recently introduced building standards in the Netherlands and elsewhere [11], overheating is slowly starting to be acknowledged as an issue, and social housing providers and landlords are beginning to contemplate on how to intervene. The study indicates that the costs of installing and maintaining outdoor shading on non-ground floor windows plays a role in hampering tenants and owners to act. Moreover, explicit demand for shading and cooling seems low among social housing tenants. This could have all kinds of causes such as other more pressing issues on the tenants' minds, a fear of unmanageable rises in rent, unfamiliarity with the effects of shading and ventilation on overheating, or better skills of acclimatizing. Despite various efforts to involve low-incomes households, they were only present indirectly in the study through stories of higher income tenants, experts and observations during fieldwork. More research is needed into the specific issues, wishes and strategies of this group.

Conclusions

This study set out to gain more in-depth insight into the ways in which Dutch households are likely to deal with hot weather in their dwellings. Several opportunities were identified that might direct Dutch domestic practices of summer comfort onto more inclusive, healthy, and less energy-intensive pathways.

A range of opportunities present themselves around acclimatisation, i.e., modifying bodily relations with hot weather. There seems to be a gap between state-of-the-art physiological research on how bodies deal with heat and everyday knowledge among the households. The benefits of sweating (when combined with drinking enough water) as an effective way to deal with heat is not fully acknowledged. Moreover, none of the participants talked about bodily adjustment to heat over time, while experts confirm that this effect can be as strong as 1°C per day.

Outdoor shading during the day and ventilation during the night can reduce or prevent overheating in low-energy ways. The study shows that active cooling, while spreading quickly, reduces residents' acceptance of the experienced downsides of shading (including the costs) and lowers incentives and opportunities to utilise cooler night air. ■

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References

Please find the full list of references in the original article at: https://proceedings.open.tudelft.nl/clima2022/article/view/388