ENERGISE

EUROPEAN NETWORK FOR RESEARCH, GOOD PRACTICE AND INNOVATION FOR SUSTAINABLE ENERGY

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ENERGISE LIVING LAB COUNTRY REPORT

Table of contents

Contents

SUMMARY PAGE

ENERGISE Living Labs (ELLs) employ practice-based approaches to reduce energy use in households while co-creating knowledge on why energy-intensive practices are performed and how they depend on the context in which they are performed. Altogether 16 living labs were implemented in eight European countries in 2018.

The Dutch ELLs were led by the ENERGISE team from Maastricht University, in Maastricht in the Netherlands. The ENERGISE Living Labs were implemented in the Southern most province in the Netherlands, Limburg – in two municipalities. Maastricht for ELL1 and Roermond for ELL2, the community-based ELL. Participants were recruited with the help of a local implementation partner Op het Zuiden.

Most participants accepted the common laundry challenge of reducing the weekly number of cycles by 50%, as well as the common heating challenge of lowering the indoor temperature to 18 degrees Celcius. Households were able to reduce their number of laundry cycles by approximately 30%, and reduce their indoor temperature by 0,9 degrees Celcius, on average. Participants made use of alternative methods to keep clothing clean or to reduce the need for indoor heating. Many simply wore clothing for a longer period of time between laundry cycles, while others removed stains by hand or aired out clothes that were not visibly dirty. With regard to heating, several participants reported that they made use of blankets and slippers to stay warm even before the challenge period. However, there was an increase in the use of alternative practices, and participants stated that they made use of warm beverages as well as sweaters to feel more comfortable at a lower indoor temperature. Some participants reported that the temperature of 18 degrees Celsius as set by the challenge was too low for their comfort, while others stated that they hardly noted the difference, and that adapting to the new temperature was effortless.

The implementation team did also encounter difficulties during the challenges. The participants in ELL2, living in apartment buildings, were not able to reduce their indoor temperatures much because of the heat leakage from adjoining apartments. Many older participants stated their health as a reason for accepting a personalized heating challenge with a temperature target above 18 degrees Celcius. With regard to laundry several participants noted that they were already at their limit before the reduction. Households with small children in particular had difficulties making a significant reduction in their number of laundry cycles, due to the regular need for washing reusable diapers or washcloths, for example. Several participants also stated that they feel uncomfortable washing their clothes at lower temperatures or using shorter cycles. Moreover, a number of participants reported allergies that require washing specific items at higher temperature settings and therefore were unable to save more energy.

Many participants reported that they had discussed the ENERGISE project with their friends and colleagues at work, and some had also posted about the project on social media. However, on the basis of the interviews, it was sometimes easier to discuss about heating than about laundry, which was considered by some to be private and somewhat embarrassing. This norm especially translated to the reluctance for participants to engage in meaningful discussions with friends or colleagues about their specific laundry behavior and potential changes.

Participants were happy to join the project and the challenges, and on the basis of a follow-up survey which was sent to them three months after the end of the challenges, some of the new habits of keeping warm and avoiding excessive laundry had remained. While some participants had stated that they were only able to make marginal changes to their routines, many did report a continued and increased awareness of their laundry and heating habits. This reveals the potential impact of this project on the energy related behavior among participating households.

1. ELL DESCRIPTION

The Dutch ELLs were located in two separate sites that should reflect typical practices related to thermal comfort and home heating in the Netherlands. ELL1 took place in Maastricht, a small city in the south of the Netherlands, and ELL2 in Roermond, predominantly in high-rise settings. Households were recruited by collaboration with local stakeholders. The recruitment was started in June 2018 and completed in August 2018. A total of 32 responses were obtained to the recruitment questionnaire (though not everyone responded to each question, so the number of responses is presented in each table). There were some dropouts and late additions due to changes in living situation, or disengagement of participants. The final number of participants completing the ELL challenge in the Netherlands is 35.

This section first presents the socioeconomic and demographic characteristics of the Dutch ELL participants. As follows, the characteristics of their homes and living environments are presented, and finally, their prior engagement with (similar) energy-related initiatives. The data below are based on a survey used when recruiting participants (n=32) and complemented with observations made during the household visits.

1.1 SOCIODEMOGRAPHIC AND SOCIOECONOMIC CHARACTERISTICS OF THE ELL PARTICIPANTS

Households were selected to reflect, as far as possible, the sociodemographic and socioeconomic composition of the Dutch population. The population for the Dutch living labs was rather balanced, with significant participation from one-person (22%), two-person (38%), and larger households (Table 1). Thus, all relevant household types are included among participants, though their shares are somewhat different from the distribution of the Dutch population (CBS, 2019).

The second characteristic displayed in Table 1 is the age of the contact person, which in the case of families, was usually close to the age of the other spouse. Households where our primary contact was between the age of 30-49 make up 38% of our participants, 47% are aged 50-69, and 16% of participants was aged 70 or over. In this respect, the participants reflect the Dutch population fairly well, though elderly households are slightly underrepresented.

In terms of employment status (Table 1), our ELLs participants are primarily full-time employed or entrepreneurs (63%), but we also engaged those who worked part-time (37%). While we did engage retirees, these participants did not respond to this question in the recruitment survey. We did not engage any students or people who are unemployed. In terms of education (Table 1), our participants include a larger share of people with tertiary education (university or polytechnic) than the population as a whole (84% vs. 29% in the population), and no people with only primary education (vs. 1% in the population). However, not all participants responded to this question on the recruitment survey.

Table 1. Sociodemographic and socioeconomic characteristics of participating households. Source: recruitment survey.

Household size (n= 32)	**1 member**	**2 members**	**3 members**	**4 members or more**
%	22	38	6	34
Age of contact person (n=32)	**29 or younger**	**30-49**	**50-69**	**70 or older**
%	0	38	47	16
Employment status of contact person (n=8)	**Full-time employed or entrepreneurs**	**Part-time**	**Student//Unemployed**	**Retired**
%	63	37	0	0
Educational level of contact person (n=25)	**Tertiary**	**Secondary/vocational**	**Primary**	**Other or unknown**
%	84	16	0	0

1.2 REASONS FOR PARTICIPATING AND PRIOR EXPERIENCE OF ENERGY INITIATIVES

Our primary method for getting people involved was via local implementation partners. While we have not explicitly asked for participants' reasons for getting involved in the ENERGISE project, several participants volunteered that they were interested in experimentation or were curious about the project and its potential impact for their daily life. Many ELL2 participants decided to participate since others in their social environment were participating. In both ELL1 and ELL2, a reason to get involved was also because ENERGISE was seen as a potential learning experience, and a way to save on energy and utility expenses.

It appears that the method of recruitment, as well as offering incentives for participation helped to obtain a group of participants that includes people who are not regularly involved in energy or environmental initiatives (Table 2). Only a small share of households reported that they had been involved in initiatives related to energy use and efficiency. A few participants, however, did report that they had been involved in some other type of project. Overall, participants were not 'the usual suspects'; rather, most of them were rather new to this kind of energy initiative.

Table 2. Share of participants having prior experience of energy initiatives (n=32). Source: recruitment survey.

	At home, %	**At work, %**	**At school, %**
Information campaign, tips for saving energy	0	-	-
Incentive to buy efficient appliances (including light bulbs)	-	-	-

Incentives to invest in renewable energy	-	-	-
Incentives or support for energy efficiency	3	-	-
Challenge/discussion to change habits and everyday routines	0	0	-
Other	6	6	6

1.3 BUILDING CHARACTERISTICS OF ELL PARTICIPANTS

The most important criterion for selecting households for the two ELL challenges was an effort to illustrate typical Dutch practices, which are rather different in apartment buildings and single-family homes. Our collective ELL2 was located in an area in Roermond that consists of mainly apartment buildings. Another criterion for selecting this district was its high residential activism, with two active local associations as well as several active Facebook groups. These two features facilitated the collective elements of the challenge: meetings among people living close together and interacting regularly, as well as online communication between meetings. Our individual ELL1 was located in Maastricht, a small city, and its surroundings. This offered the opportunity to recruit single-family homeowners without a strong socioeconomic bias.

Table 3 displays the main characteristics of the ELL participants' dwellings. There is a moderate distribution of dwelling types and sizes among our group of participants; while the majority of the homes was constructed in the mid-20th century, with the remainder constructed before the millennium. Among our participants, only two responded to the question whether they were home-owners or renters. Both were home-owners. Due to our recruitment strategy, most of the participating households living in detached homes are located in Maastricht and are therefore part of ELL1, whereas the majority of the households from Roermond (part of ELL2) live in apartment buildings. This balance is partly reflected in the distribution of the size of dwellings, with apartments typically being smaller than detached houses.

Table 3. Characteristics of the participants' dwellings. Source: recruitment survey.

Type of dwelling (n=32)	**apartment**	**terraced/semi-detached**	**Detached**	**other**
%	22	53	13	13
Size of dwelling (n=28)	**<60 m2**	**60-100 m2**	**101-140 m2**	**>140 m2**
%	79	21	0	0
Age of dwelling, built (n=14)	**before 1920**	**1920s-1970s**	**1980s-2000s**	**After 2000**
%	0	92	8	0

Respondents to the recruitment and baseline surveys did not report their primary heating sources, and therefore we do not have data on this particular fact for the Netherlands. From interviews we have obtained information that gas is the primary source of heating, with one exception – this household primarily makes use of a wood-burning fireplace.

The ability to adjust one's room temperature was one of the criteria for recruitment. Most of the ELL participants 6% were able to control heating for both individual rooms and the entire dwelling, whereas (40%) were able to control temperature settings by room only, while a few could only control temperature at the level of the entire dwelling.

One of the recruitment criteria was that participants should own a washing machine, however, common use of a laundry room is uncommon in (these parts of) the Netherlands, and therefore this did not affect our recruitment. However, some of our participants had both their own laundry machine and access to a common laundry room or reported that they would be interested in a common laundry space. Sixty-one percent of the households had a separate tumble-dryer or drying cabinet. A large share (66%) also reported having an energy-saving or eco-programme in their washing machine, and thirty-four percent reported owning an A++ rated washing machine.

Table 4. Laundry equipment owned or used by the households (n=35). Source: recruitment survey and baseline survey[1].

	Households with this equipment, feature or service, %
Tumble dryer or drying cabinet (n=33)	61
A++ rated washing machine (n=35)	34
Washing machine with eco-programme(n=35)	66
Regular use of shared laundry room (n=32)	0

1.4 TOOLS AND APPROACHES USED FOR ELL1 AND ELL2 OUTREACH AND COMMUNICATION

The Dutch ELLs made use of challenge kits, which included information, tips and tools to enable households to engage with and meet the challenges set within the project. Households received their challenge kits during the first round of in-home interviews but were instructed not to open them until the start of the related challenge. Overall participants reported that opening the challenge kits and discovering the tips and tools inside was an engaging experience. The contents of each challenge kits were met with relative approval. Some items were redundant because participants already owned a similar item (e.g. an apron), or did not fit (e.g. slippers), but they were effective in challenging the habits and routines of participants. Since the end of the baseline period and inception of the challenge period were marked with the opening of challenge kits, this reintroduced the participants to the project and therefore may have intensified their commitment to the ELL challenges.

2. PRACTICES BEFORE THE CHALLENGE (FROM THE DELIBERATION PHASE)

This section examines the practices existing in the households before the challenge. It is based on a survey sent to participants and on qualitative interviews (ELL1) or focus group discussions (ELL2) conducted before the start of the challenge. These datasets are complemented, where necessary, with observations made during home visits. In the following, we first discuss practices related to thermal comfort, and following, we report on practices surrounding laundry patterns in the participating ELL households.

[1] AA+ rated washing machine and washing machine with eco-programme are from the baseline survey

2.1 PRACTICES RELATED TO THERMAL COMFORT

Home heating is often viewed as a gendered practice, where control of home heating systems is often ascribed as a male activity (e.g. Offenberger and Nentwich 2013). Among the Dutch ELL participants, however, the male household member looked after the temperature settings in only 31% of the households, whereas 54% of households reported that an adult female household member controls indoor heating.

The ELL participants' perceptions of desirable winter-time indoor temperatures were rather typical for usual Dutch indoor temperatures, with people on average preferring about 20°C in the living area, and a bit lower in the bedroom; albeit with quite some variation (Table 5).

Table 5. ELL participants' perceptions of desirable temperatures in the winter during daytime before taking part in the ENERGISE challenges (n=35). Source: baseline survey

	Average	Highest	Lowest
Living area, °C	20.2	23	18
Bedroom, °C	15.4	19	10
Child's bedroom, °C	16.7	20.5	12

Participants were rather satisfied with their current indoor temperatures: and around 60% also felt that other household members had the same view on the indoor temperature as the respondent did. Open-ended comments suggested that spouses might feel colder than respondents did. This last fact was reflected in the response to the challenges, where many participants did not want to commit to the heating challenge without conferring with their spouse. Participants commonly reported that they do not frequently adjust the indoor temperature, and that they had found a comfortable level of heating that suits their routines and level of comfort.

Home heating practices are different in different countries, and also depend on the heating system, i.e., whether it can be easily adjusted. A large majority of Dutch ELL participants turned down their heating for the night, when not at home, as well as in unused rooms (Table 6). Airing of rooms by keeping windows open is fairly common among our ELL participants; those who commonly aired out their homes tended to turn down heating while airing. From in-home interviews, this practice appears to have relevance to a Dutch cultural preference for conservative use of heating and other home resources.

Table 6. Frequency of various heating-related practices among the ELL participants in winter-time before participating in the ENERGISE challenges (n=39). Source: baseline survey.

	Share of households, %
Turn down heating for the night	80
Turn down heating when not at home	80
Turn down heating in unused rooms	80
Has program to automatically turn down heating at certain times	34
Air rooms for more than a few minutes per day	46

Turn down heating when airing rooms	49

Some (older) participants reported that in their childhood the indoor temperature was often lower, or that only the main living space was heated in their home. They often reported that this informed their current temperature preferences and heating practices.

Few participants reported adjusting their cooking habits for the purposes of thermal comfort, while many reported the frequent use of blankets and slippers to feel comfortable indoors. However, older participants stated that the use of blankets was not an option, because they feel that they should feel comfortable in their living space without the use of blankets.

Many participants stated that there are areas in their homes that are less easily heated to a comfortable temperature, while there was an overall satisfaction with the ease of control and access to the heating system. Overall participants were in agreement that the airing out of living spaces is important for health reasons, while they were unaware of the potential heating benefits.

Our ELL participants did not report many ways of keeping warm without changes to the heating system before the start of the challenge. The most common ways were using extra blankets in the living room, which was reported by multiple participants in the deliberation interviews, as well as, to a lesser extent, the use of wood-burning fireplaces. Still, many participants reported that they have a strong opinion about 'overheating' and that they try to avoid using the heaters unnecessarily.

2.2 PRACTICES RELATED TO LAUNDRY

Laundry appeared to be a rather gendered practice among our ELL participants, as is the case more widely in the Netherlands. In 74% of Dutch ELL households, women mainly take care of the laundry; while in 17% of the households a male household member is responsible.

Participants generally had similar laundry practices, with their differences mainly relating to frequency of laundry and preferred temperature settings. Some households separate all clothing types and colors for laundry, whereas others wash all colored items together while separating only whites. Many households prefer washing towels and bedsheets separately, and on higher temperature settings. The use of the clothes dryer also differs between households, with some participants using the dryer for all clothing, and others using it only for large items that do not dry easily using air drying. Participants report that towels in particular are tumble-dried, since the resulting softness and freshness is important when washing towels and bedsheets.

Most of the Dutch ELL participants determined when items need to be washed on the basis of length of wear (49%), although smell (26%) or stains (20%) were also common criteria.

The number of weekly laundry cycles washed by households varied from 1 to 10, with an average of 4.2 cycles per week, depending largely on the number of household members (Table 8). However, regular use of the clothes dryer and ironing (for at least less than half of all laundry) were less closely connected to household size, with larger households actually ironing a relatively smaller share of their laundry. Very few households reported ironing frequently, and the use of the clothes dryer varied mostly between two extremes – using it for all laundry, or (a preference for) not using the dryer at all.

Table 8. Laundry practices in different types of households before participating in the ENERGISE challenges (n=32). Source: baseline survey.

Average laundry cycles/week	**4.2**
Share using clothes dryer regularly,%	43
Share ironing regularly, %	66

Households most commonly washed their clothing at 40°C and bedlinen at 60°C. However, there was a large variation (Table 9). Many households mainly used only one or a few of the existing programs in their washing machine, and few frequently used the 'energy saving' setting on their machines.

The most common reason for households to wash many items on higher temperatures is that they were informed by their parents or others that this is important for hygiene. This does not only related to the perception of clean clothes, but also the level of comfort with wearing clothes washed at lower temperatures. Older participants appeared to report this sentiment more frequently than younger participants.

Table 9 Washing temperatures among the ELL participants before participating in the ENERGISE challenges (n=32). Source: baseline survey.

	Mode	**Mean**	**Lowest**	**Highest**
Dark clothing, °C	40	38	30	60
White clothing, °C	40	46	30	60
Bedlinen, °C	60	51	30	95

Before the start of our laundry challenge, many households reported to have employed various ways to keep clothes clean, apart from using the washing machine. The most common ways were airing out clothes (71% of respondents did this), washing out stains (31%), preventing stains by protecting clothing (51%) and brushing out stains (9%). In our interviews, several participants mentioned changing out of their work-clothing when arriving home, and having separate clothing for "dirty" activities (gardening, repairs). Others, especially those with young children, reported that they wear old clothes inside their home, since it is hard to keep them clean around the children. However, one-fifth (20%) of our respondents did not use any particular ways to avoid the need to wash items.

From our interviews we found that participants tend to place worn clothes on a chair in the bedroom or on a special shelf in their closet, to separate them from freshly-washed laundry, as well as to be able to wear these items more than one day between laundry cycles. Participants report using the eco-setting occasionally, but a common concern among our ELL households was that the eco-settings on many washing machines have a longer cycle duration, and this makes it impractical for regular use. Some participants, however, stated that they use timed programs to save energy by running laundry cycles at night, when electricity is cheaper.

Participants generally did not report that laundry was a time-consuming practice in their experience, but they did find that it was sometimes overwhelming, especially in households with more than two household members. Participants were divided with regard to their concern for color. Some participants mentioned that they feel more comfortable in sparkling clean, and bright-colored clothing, whereas others reported that they simply accept that colors get duller after a number of laundry cycles.

3. PRACTICES DURING AND DIRECTLY AFTER THE CHALLENGES (FROM WEEKLY AND EXIT PHASE)

This section describes the changes that occurred in the households participating in the ELLs during and directly after the two times four-week challenges. These challenges were to reduce indoor temperatures to 18°C, or if deemed impossible, determine an individual challenge, as well as to cut the number of laundry cycles by half, or if this was not feasible, to determine an individual laundry challenge. Table 10 shows the share of households signing up to the common challenge, and provides examples of individually defined challenges.

Table 10. Share of households signing up for common or/and individual challenges Source: interviews and closing survey

	Common challenge, % households signing up	**Individual challenge, % of households selecting an individual challenge**	**Examples of individual challenges**
Laundry challenge	ELL1: 50% ELL2: >60%	ELL1: 50% ELL2: <40%	Smaller reduction in weekly cycles (e.g. work clothes) Reducing energy used for laundering in other ways (eco-program)
Heating challenge	ELL1: 60% ELL2: >75%	ELL1: 40% ELL2: <25%	Leaving some rooms outside the challenge Smaller reductions (e.g. 19°C)

In the following, we first discuss the changes in heating practices, and then turn to discussing changes in laundry practices. The data for this section is derived from a weekly survey sent to households, a concluding survey directly sent after the end of the challenges, as well as a closing interview (ELL1) or focus group discussion (ELL2). Moreover, indoor temperatures were monitored with a temperature logger and electricity use for laundry machines (washing machine and dryer, if used) with a power meter.

3.1 CHANGES IN HEATING PRACTICES

The heating challenge started on November 12 in the Dutch ELL households. Figure 1 presents differences in indoor temperatures, based on temperature logger data from the participants' living rooms, during the baseline period (September 10 to November 12) and during the challenge period (November 12 to December 14). The changes are greater in ELL1 (about 0,8°C), where participants have greater control over indoor temperatures, than in ELL2 (about 0,7°C), where it was difficult for participants to adjust their temperatures even though they tried to do so. Due to heat transfer from adjacent apartments, the heating for participants living in large apartment blocks was more difficult to adjust, and several ELL2 participants turned off their thermostats completely but still experienced very little change in indoor temperature.

The average reduction for the entire sample of participants was 0,8 °C. While we are aware that in some cases, indoor temperatures might drop in response to changes in outdoor temperatures, in the Dutch case, most of the reduction is due to actions taken by our participants. Outlier 31*C NL37 ELL1

Among ELL1 participants there was an outlier on November 3, when for a few hours the temperature registered on a particular logger reached 31,4 degrees. Removing this outlier did not significantly impact the overall trend or averages in the data.

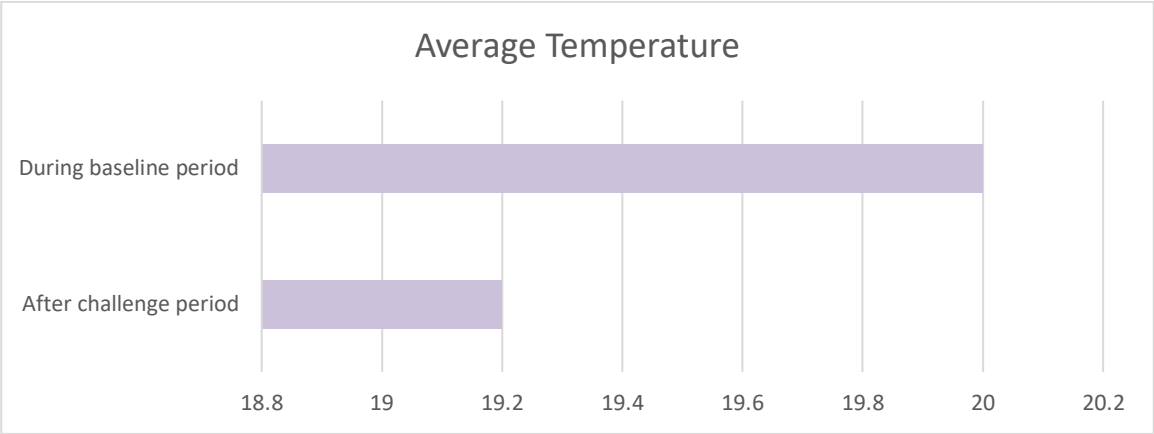


Figure 1. Changes in indoor temperatures before and after the heating challenge (starting November 12).

Not all households found it easy to live with 18 degrees. Some attempted to lower their temperature but found limits to the level of comfort or discomfort they were willing to accept. Some older participants, and participants suffering from arthritis or other conditions were unable to significantly lower their indoor temperature for similar, but more distinctive comfort reasons. However, several households reported that they simply attempted to 'live with' the new temperature without making adjustments to their lifestyle.

- *Interviewee: "We simply just did it. It was as simple as that."*
- *Interviewer: Did the heating challenge present problems for you?*
- *Interviewee: "No, not really."*
  (NL199)

This response is typical for many participants in our ELLs. While not all of them reached 18 degrees, they mostly lived comfortably at a lower temperature without much change to their daily life.

- *Interviewee: "I used to drink one cup of tea in the evening, after dinner. I now notice that I sometimes I drink multiple cups, because it is nice and warm."*
  (NL199)

- *Interviewee: "Perhaps I used a blanket on the couch in the evenings, but we already did this before the challenge as well."*
  (NL204)

Participants did employ new skills as indicated in the leaflets included in the challenge kits. Many attempted to air out their rooms in order to heat them more efficiently, while others attempted to turn down the heating earlier in the evening, before going to bed. Participants who were resistant to the

use of blankets or other methods of personal heating were less able to reduce their indoor temperature. Many participants reported that the challenge persuaded them to respond to feeling cold indoors by putting on extra items of clothing or wearing warm socks or slippers – rather than turning up the thermostat.

Overall participants in our ELLs did not change the way in which they used space in their home for the purpose of thermal comfort. There were, however, some who reported an increase in the use of wood-burning fireplaces, in order to compensate for the lower setting on the thermostat. Compensatory behavior like this was seen in both ELLs, but in only a few households.

Participants reported that since engaging in the heating challenge, their perception of adequate indoor temperature has changed. Several participants stated that they have experienced feeling too warm when visiting friends or family, or that visitors to their home during the challenge perceived it as rather cold.

- *Interviewee: "I noticed that when I go to work, I am dressed too warmly for the office environment, whereas at home I am perfectly comfortable."*
  (NL205)

Most of our ELL participants stated that they intend to continue with their new heating behavior beyond the ENERGISE project. Many stated that 18 degrees was perhaps a bit low for their desired level of comfort, but nearly all participants found that a reduction could be made without much cost to their indoor thermal comfort. Those who accepted the common challenge were generally more willing to continue with a reduction in indoor temperature than those who accepted personalized challenges.

3.2 CHANGES IN LAUNDRY PRACTICES

Most participants in the ELLs did not manage to reduce their number of laundry cycles by half (nor had all agreed to this commitment, due to various personal circumstances, such as a new baby or the need to have clean clothes at work). However, participants did reduce their number of laundry cycles by 29% during the challenge period (Figure 2).

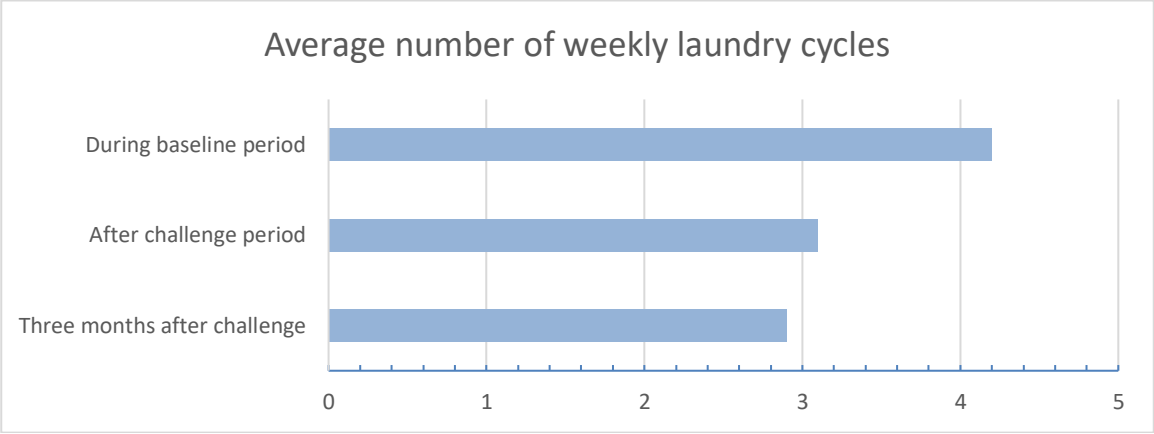


Figure 2: Number of laundry cycles washed during baseline and challenge periods, as well as three months after the end of the challenge.

When confronted with the laundry challenge during the deliberation interviews and focus group meetings, many participants were apprehensive and skeptical of the goal of the common challenge; reducing the weekly number of laundry cycles by 50%. Participants who accepted the common challenge stated that they welcomed the challenge but were unsure that they would be able to manage the full 50% reduction.

In order to achieve the challenge many participants reported saving up clothing items until the washing machine could be fully loaded before running a cycle. Other households employed different strategies such as increased use of the 'airing out method', and combining previously separated laundry loads.

Table 11: Weekly electricity consumption (cumulative) for laundry appliances during baseline and challenge periods. Source: laundry diaries.

Cumulative power consumption for laundry appliances, kWh	Mean	Lowest	Highest
Baseline	13,1042	4,441	24,311
Challenge	23,57781	7,81	51,27
After challenge (and during heating challenge)	28,77981	8,98	54,49

Nearly all participants reported that they experimented with different temperature settings and programs on their washing machines. This included increased use of 'cold' and 30*C temperature settings, as well as the short-cycle and eco-setting. There was a diverse response to these experiments from the pool of Dutch ELL participants. Some reported that they were not satisfied with the cleanliness of their clothing after washing on a lower temperature setting, while others noted that the eco-setting often takes a much longer time than other programs, and that the short-cycle did not save much electricity as observed from the energy meters. Still others, however, reported that while they had previously not used the eco-setting or lower temperature settings, they were satisfied with the results they could achieve and wished to continue to use these settings more frequently.

3.3. POTENTIAL RUPTURES AND SUFFICIENCY POTENTIAL

During the ELL process, participants gave evidence of ruptures in their behavior – a disruption or change to their habits. Many participants reported that the installation of thermometers, as well as energy meters made them immediately more conscious of their behavior. One participant noted that the act of recording each cycle of laundry made her more aware of her laundry behavior. Several participants resisted the potential rupture before the challenge and noted that they actively attempted to retain old routines for the purpose of recording an accurate baseline measurement of their behavior. The ELL process featured challenge kits that were meant to facilitate behavior adaptation to new routines, and their contribution to potential ruptures, as well as the impact of the ELL2 'community', can also be found in the participants' responses. Below are some excerpts from exit interviews and focus group meetings that reveal the potential rupture (or purposeful continuation) of habitual behavior.

- Baseline behavior:
- *Interviewee: "Yes I especially started thinking about the heating already during the baseline, but I refused to turn it down even though one may be inclined to do so already." (NL204)*

- *Interviewee: "No, I intentionally did not change my behavior because then I would mess up your measurements – your baseline. I was extra aware of this because I also have a research background so, otherwise I may have changed my behavior."*

- *Interviewee: "I believe that perhaps with the laundry I did already make a change. [pause] Although, I attempted to continue doing laundry as I had been doing." (NL201)*

- Focus group impact:
- *Focus group attendee: "The fact that we committed to these challenges as a group motivated me to really engage with the challenge." [other attendees nod]*

- Impact of challenge (kits):
- *Interviewee: "We had completely forgotten about the challenge box and placed it in the basement. Then, when we received the email telling us to open the box and start the challenge that was a nice little surprise, and an impulse to start changing things." (NL278)*

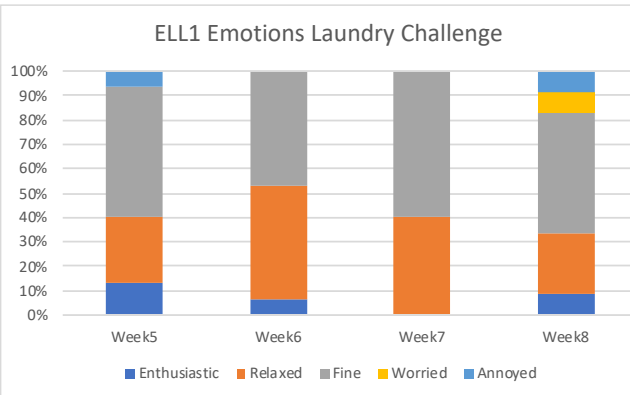
- *Focus group attendee: "We found that the 'control light' that is on the power strip uses around 20 Watts per day, so now we turn off the power strip when the washing machine is not in use. That is 7,5 kW per year, from just one little lamp. So that is an area where we managed to make a difference."*

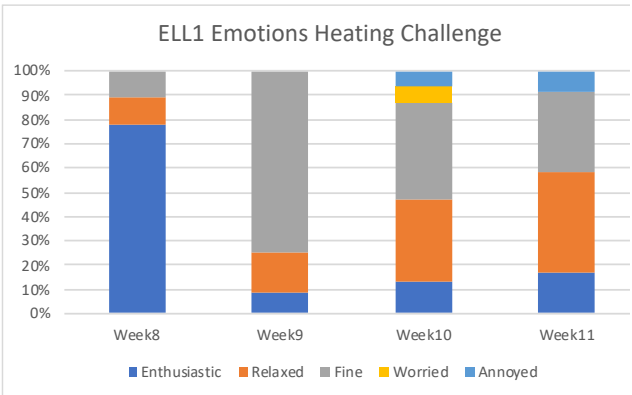
- *Focus group attendee: "We became more conscious of airing out clothing after, for example, going to a restaurant or a café, so that the clothes do not have to be washed, but rather can air out and be worn again."*

- *Focus group attendee: "I have been experimenting with wearing socks two days in a row, if I have not walked much – I do not have very sweaty feet – then I can wear them twice and put them in the laundry after."*

- *Interviewee: "The [ENERGISE] project did stimulate me to look more critically at whether items of clothing needed to be washed. I used to wash a lot of items on 60*, and now I often use 40*" (NL201)*

There were differences in how seriously participants took the challenges, and how significant the resulting changes were. We monitored how participants felt during the challenge on a weekly basis, and the results of these questionnaires show that for the most part, participants in both ELL 1 and ELL2 reported feeling relaxed or "more or less fine" (Figure 3). Somewhat more participants in ELL2 appear to have felt excited, whereas somewhat more participants in ELL1 appear to have felt annoyed.





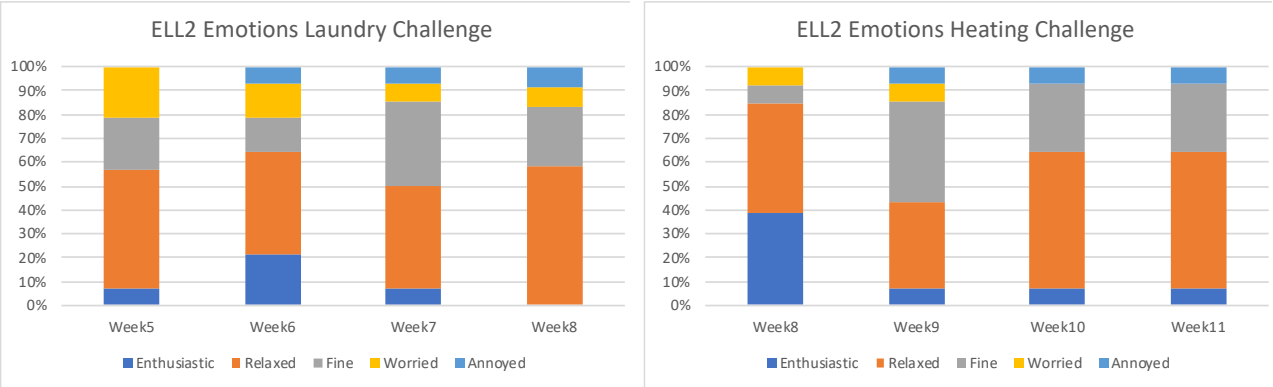


Figure 3. How participants felt during the laundry and heating challenge, % of participants with different feelings during weeks 1-4 of the challenge. Source: weekly surveys.

There were large differences between the experiences of different participants. Our data suggests that the participants in the community living lab had a more relaxed attitude towards the challenges, and that they were more consistent in their attitudes as the challenges progressed. ELL1 participants were generally more anxious, annoyed, and less enthusiastic about the challenges. More than one of the participants in ELL1 were slightly annoyed with the weekly surveys and did not feel that they added important information to the project. The overlap between questions in the diaries and weekly surveys were the main reason for irritation.

> *Interviewee: "What I did not enjoy so much was that in the evening, I would often be relaxing on the couch and suddenly realize "oh right, the thermometers." Then, although you just got comfortable on the couch, you have to go upstairs and write down the temperatures in each room. Yes, that was the only thing that I found annoying, was reading the thermometers." – (NL206)*

> *Interviewee: "I did not think the weekly surveys added much value to this project. I thought it would have been more interesting to include other factors outside of laundry and heating, so I stopped responding to the weekly surveys." (NL209)*

> *Focus group attendee: "It was nice to be able to take on these challenges as a group. It felt good to make changes together. It made it easier."*

One indication of sufficiency measures and a potential rupture caused by the ELLs would be if alternative, more adaptive practices of thermal comfort and keeping clean have increased. Figure 4 shows changes in the number of adaptive practices of thermal comfort used by participants before and after the heating challenge. The vertical axis shows the number of adaptive practices, and the horizontal axis shows the number of participants using these practices. The most common adaptive practices before the challenge were to use warm socks or slippers and to use warm clothing. After the challenge, the use of warm clothing and blankets increased, as well as the use of draught excluders, whereas the use of hot showers decreased.

Interestingly, while several participants stated in interviews and focus groups that they had increased the use of adaptive practices, this is not reflected in the data collected from the closing and follow-up surveys.

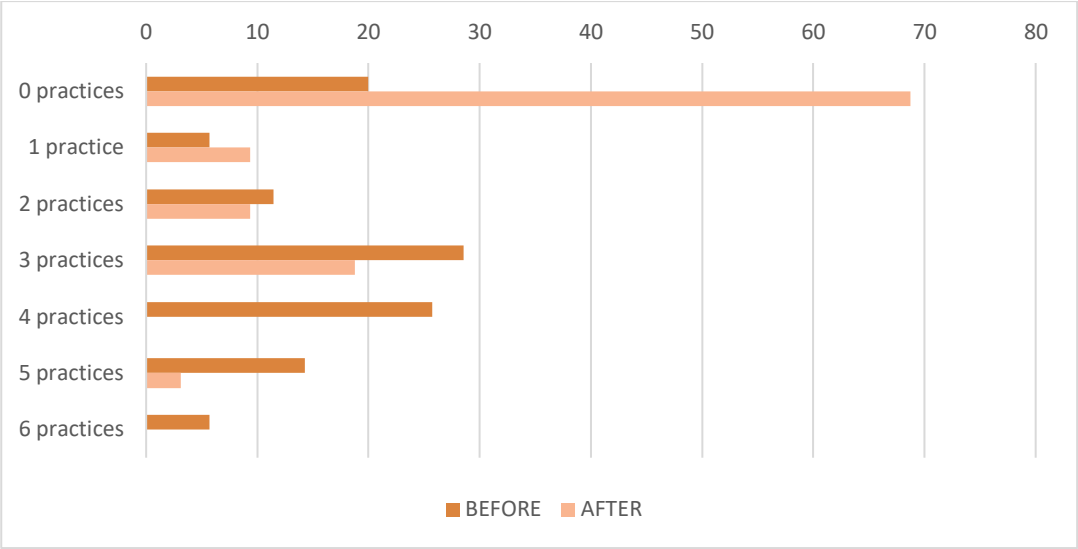


Figure4. Changes in the number of adaptive practices of thermal comfort Source: baseline and closing surveys, in percentage.

Participants report using less alternative practices to adapt to reduced indoor temperature or frequency of laundry, see Figure 5.

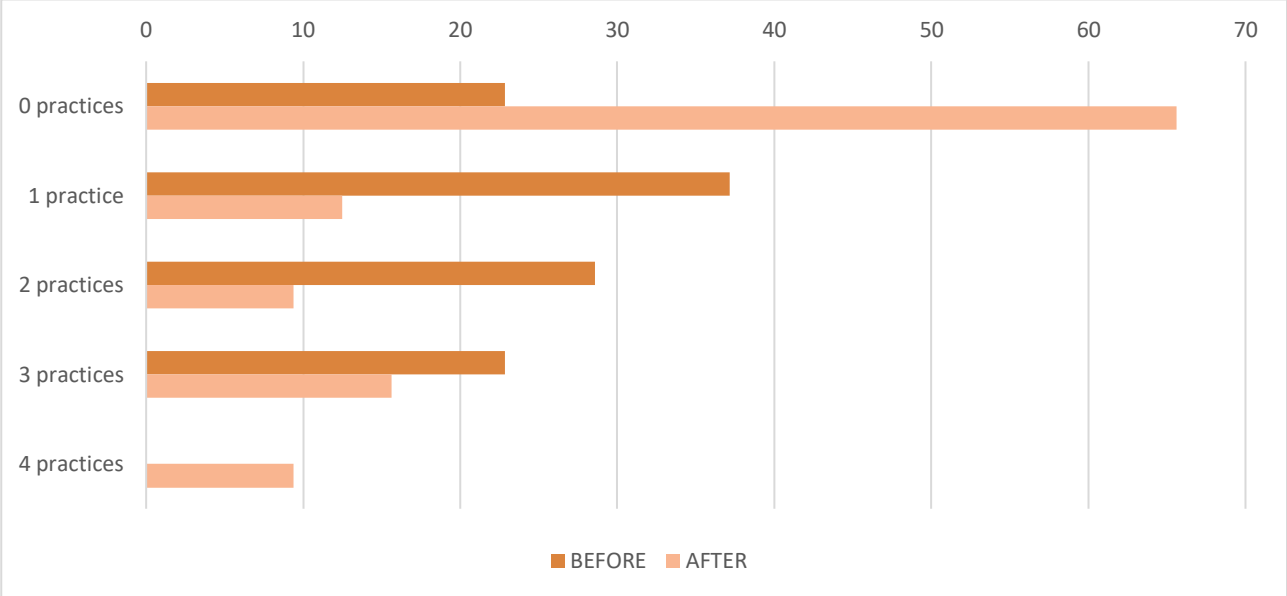


Figure 5. Adaptive laundry practices. Source: baseline and closing surveys.

4. PRACTICES A FEW MONTHS AFTER THE CHALLENGE

This section explores the extent to which changes in practices arising as a result of the laundry and heating challenges persisted in the participating households after the end of the challenge periods. These observations are based on a comparison between the baseline and closing surveys as well as a follow-up survey that was administered approximately three months after the end of the challenges. In the follow-up survey, we also asked households which practices they felt they had retained and explored potential rebound effects.

4.1 PERSISTENCE OF CHANGES IN HEATING PRACTICES

Table 12 explores the persistence of indoor temperatures, by showcasing the change in actual, measured temperatures T1 is based on the average of the measured temperatures reported on in week 7 (just before the heating challenge started) and T2 is based on the average of the measured temperatures reported on in week 11 (the final week of the challenge). T3 is based on the average of the measured temperatures reported on by participants, in the follow up survey.

Table 12. Indoor temperatures before and after the challenge. Source: baseline, closing and follow-up surveys.

	Mean temperatures before and after the challenge, in °C			
	T1: Before	T2: Directly after	T3: Three months after	Difference T3-T1
Living area, °C	20.1	19.4	19.3	-0.8
Bedroom 1, °C	20.2	15.8	15.5	-4.7
Bedroom 2, °C	21.0	17.3	16.5	-4.5

Notably, a reduction of 0.7 can be detected between week 7 and week 11. But it is also worthwhile noticing that T3 is lower than T2 in most cases, which indicates that some of the changes that came around during the challenges, have persisted, and continued.
It is also important to note that the autumn in the Netherlands was unusually warm, and therefore an average based on more entries would not necessarily be representative either.

Table 13 explores the persistence of alternative ways of keeping warm. From the tables it can be seen that it seems as if participants from both ELL1 and ELL2 have continued to use extra clothing and blankets and maybe even increased the use of these things. It is however difficult to derive from the tables, as some of the data may be misleading, given potential misunderstandings of questions raised in the surveys. Please see specific comments for the tables in the footnotes.

Table 13. Persistence of alternative practices of keeping warm. Source: Baseline, closing and follow-up surveys.

Ways of keeping warm	**Alternative practices, %**		
	BEFORE	**AFTER**	**3 MONTHS**
I do nothing additional	9%	22%	30%
I use warm socks/slippers	69%	63%	56%
I use an extra blanket	66%	59%	33%
I use extra clothing (sweater, cardigan, etc.)	80%	66%	56%
I use blinds/curtains on windows	60%	19%	4%
I use draught excluders	37%	13%	7%
I take a hot bath or shower	11%	0%	0%
Other	0%	0%	0%

Table 14 examines the persistence of potential changes in expectations toward indoor comfort. It is interesting to see that participants' desired living room temperatures before the challenge, is slightly higher than the temperature that was measured for week 7. The desired temperature for the bedroom was on the other hand lower than the measured temperature. After the challenges the measure temperatures on the living rooms (week 11) were the same or slightly higher than the desired temperatures, according to the exit survey.

There is not a one-to-one relationship between supposed desired temperatures and actual, measured temperatures, and according to table 14, it seems that some participants may think that they have lowered their temperatures slightly more than they actually have.

Table 14 examines the persistence of potential changes in expectations toward indoor comfort.

Table 14. ELL participants' perceptions of desirable temperatures in the winter during daytime before and after the challenge. Source: baseline, closing and follow-up surveys.

	Mean before	Mean directly after	Mean 3 months after
Living area, °C	20.2	19.1	19.2
Bedroom, °C	15.4	16.0	15.9
Child's bedroom, °C	16.7	16.1	

4.2 PERSISTANCE OF CHANGES IN PRACTICES OF CLEANLINESS

As concerns laundry, table 15 examines the persistence of reduced laundering cycles. Interestingly, a continued reduction in weekly laundry cycles seem to have happened in ELL1, where it gone slightly in ELL2, however still maintaining a reduction compared to before the challenge.

Table 15. Average number of laundry cycles before and after the challenge. Source: baseline, closing and follow-up surveys.

	Mean before	Mean directly after	Mean 3 months after[2]
Number of laundry cycles	4.2	3.1	2.9

Table 16 demonstrates the persistence of alternative ways of keeping clothes clean. Interestingly, it seems like 'no-water' approaches such as airing clothes have been increasingly used after the challenges.

Table 16. Persistence of alternative practices of keeping clean. Source: baseline, closing and follow-up surveys.

	BEFORE	AFTER	3 MONTHS AFTER

[2] This is also less reliable at T3 than when based on laundry diaries.

No other ways.	20%	22%	22%
Wash out stains by hand.	31%	41%	41%
Brush out stains.	9%	28%	22%
Air out clothes.	71%	63%	67%
Prevent stains (e.g. by wearing an apron).	51%	47%	37%
Other	0%	0%	0%

Table 17 examines potential changes in norms related to laundering by exploring changes in how households decide when an item requires washing. Interestingly, criterion for determining whether clothes needs washing seems to be increasingly based on smell (and to some extent stains) and decreasingly about 'length of wear'.

Table 17. Persistence of changes in criteria for deciding when items require washing

	Share of households using this criterion, %		
	Before	**Directly after**	**3 months after**
Stains	20	44	33
Smell	26	28	37
Length of wear	49	25	22
Don't know or other	0	0	0

4.3 POTENTIAL EFFECTS: CALCULATED CO2 SAVINGS, SPILLOVER EFFECTS, REBOUND EFFECTS AND POTENTIAL FOR SCALING UP

This section explores the potential effects of the ELL challenges, based on data collected in the follow-up survey sent out three months after the end of the challenge. We consider the achievable CO_2 savings from the ELL challenges, as well as potential spillover effects, which can magnify the effectiveness of the ELLs. We also explore potential monetary and time savings, as well as potential rebound effects that might undermine energy savings achieved, if the case is that money or time is consequently spent for more energy-intensive activities. We also explore the potential for scaling up on the basis of how participating households have communicated and are willing to communicate on the ELLs.

On the basis of the observed changes in laundry and heating practices, measured through monitoring of laundry cycles, power consumption and indoor temperatures, it can be estimated that the participating households reduced their CO_2 emissions.

In addition to savings achieved in laundry and heating, it was expected that experimentation with new practices in the ELLs might also encourage households to experiment with new energy saving practices in other areas. Table 18 explores spillover effects from the ELLs into broader engagement with energy, as well as the persistence of these changes three months after the end of the challenge.

Table 18. Spillover effects from the ELLs: changes in general engagement with energy and climate issues. Source: baseline, closing and follow-up surveys.

	Before	Directly After	3 months after
Not specifically.	14%	22%	7%
Raise energy and climate issues at home or with friends.	71%	38%	81%
Raise energy and climate issues at work.	34%	34%	44%
Raise energy and climate issues in NGOs or other groups of which I am a member.	17%	13%	26%
Actively search for news or information on energy and climate issues.	40%	25%	48%
Consider energy and climate issues when voting.	57%	13%	70%
Consider energy efficiency when buying electrical appliances/devices.	77%	31%	93%
Other	0%	0%	0%

Some participants reported that they were influenced to reconsider their environmental impact in other parts of their daily life.

- Interviewee: *"I did go to the supermarket and purchased those re-usable bags that you can use instead of the plastic bags for fruits and vegetables and breads etc. [as a result of the ENERGISE project]"*

The potential socioeconomic impacts of the ELLs were evaluated on the basis of money and time saved. Most commonly, participants estimated having saved money in the range 20-50€ but reported no time saved. This also serves as a basis for further considering the extent to which there are rebound effects based on money saved in one household domain being used in another, as well as time-use rebounds based on time saved in one household domain, e.g. laundry, being used for another, potentially more energy intensive activity (see Heiskanen et al. 2018, D3.5). Table 19 explores households' most common expectations concerning activities for which they would use any money saved. In terms of time saved, participants reported using time for reading, social activities and spending time with their family. From the responses to this question we cannot determine whether the alternative uses of time and money are more energy intensive than the amount of energy saved through the challenges.

Table 19 What would savings be used for: most common responses (n=22). Source: follow-up survey.

Not applicable, no money saved	27%
Everyday running costs	18%
Savings	23%
Entertainment	0%
Travel	0%
Don't know	59%
Other	0%

On the basis of these observations, there does not appear to be any indication of rebound effects.

The broader impacts of the ELLs on everyday practices depend on the participants sharing their new routines and norms beyond the participating households. Table 20 presents the extent to which

participants have shared or would consider sharing their experiences from the challenge in their daily life, outside of the ELL context.

Table 20. Share of households having shared or willing to share experiences (n= 27). Source: follow-up survey.

Not particularly	22%
Other members of my household	26%
Relatives	4%
Friends	70%
Neighbours	19%
Co-workers	41%
Groups/associations	22%
Children's school or e.g. sports club	0%
Others	4%
Facebook, Twitter or Instagram	93%
Blog post	4%
Newspaper article	0%
Other	0%

- *Interviewee: "I would recommend anyone to do such a challenge. The concept of a challenge really makes you reconsider your routine and could be used to change other things in your life too." (NL204)*

5. FEEDBACK FROM PARTICIPANTS AND IMPLEMENTATION TEAM ON ELL IMPLEMENTATION

Overall participants had a positive response to the ENERGISE project and its laundry and heating challenges. Several participants reported that they enjoyed the challenges, and that participating in the ELL was easy and comfortable. Many stated that reading the thermometers every week was their least favorite part about the project, but that the diaries and questionnaires were easy to complete, and that the communication and set up of the challenges was clear throughout.

- Interviewee: *"What I did not enjoy so much was that in the evening, I would often be relaxing on the couch and suddenly realize "oh right, the thermometers." Then, although you just got comfortable on the couch, you have to go upstairs and write down the temperatures in each room. Yes, that was the only thing that I found annoying, was reading the thermometers." (NL206)*
- Interviewee: *"I feel fine, every week I received an email {with the questionnaire}, sometimes the time varied a little bit, but it went well. It was all communicated very well; there is nothing else I can really say about it. I had fun participating – and [husband] has nice slippers now!" (NL201)*
- Focus group attendee: *"The fact that we committed as a group stimulated me to live more sustainably and consciously."*

Participants shared their experience in the ELLs with friends, family and colleagues. This way one household's participation in the challenges may have influenced others outside of the ELL context. Other participants, however, were apprehensive to engage in conversations about laundry with those outside of the ELLs.

- Interviewee: *"It did come up at work – I promoted it a little bit. We did talk about it and colleagues were interested and asked "Well, but isn't that too cold?" And "How do you do it?" So it did come up in that sense, yes." – "I mentioned it one day, and a few days later my boss brought it up to me again and said: "You said you were participating in something, and what is that exactly …" and then we talked about it for a little while, he was interested." (NL201)*

- Interviewee: *"I did not ask people about their laundry or heating behavior as a result of the challenge." (NL204)*

- Interviewee: *"I did discuss it, because I brought the coffee mug to work, and – let me think – I think I talked to two people about it; about heating people instead of spaces etc. And the laundry, well I am not sure, but I think I talked to my in-laws about this. My sister-in-law is someone who does a lot of laundry, so we compared how much laundry we both did, but our behavior was so far apart that we did not understand one another at all. I did about three per week and she did about 13 or something." (NL206)*

As interviewers and focus group facilitators, the local implementation team experienced first-hand the participants' response to the ENERGISE project. The interview sessions, as well as the focus groups gave the members of our team additional insights into the experience of participating households. Moreover, the interview/focus group format allowed the team to continuously engage participants and thereby, perhaps, influence the success of the challenges. Several participants reported that the recurring interview and focus group sessions were helpful to stay mindful and involved throughout the project's duration. The personal familiarity that was established with participants, in particular during the interview rounds, appeared to make participants feel more comfortable to challenge their norms and their routines. It is also possible that the personal interaction with a member of the research team increased participants' motivation to seriously engage with the challenges. The weekly surveys gave us another window to look inside the challenge sites, and intermittently reflect on their progress and potential disrupting events that occurred within the households.

6. CONCLUSIONS/REFLECTION

During the ENERGISE project's challenge periods, households were able to reduce their number of laundry cycles by approximately 30%, and reduce their indoor temperature by 0,9 degrees Celcius, on average. Participants made use of alternative methods to keep clothing clean or to reduce the need for indoor heating. Many simply wore clothing for a longer period of time between laundry cycles, while others removed stains by hand or aired out clothes that were not visibly dirty. With regard to heating, several participants reported that they made use of blankets and slippers to stay warm even before the challenge period. However, there was an increase in the use of alternative practices, and participants stated that they made use of warm beverages as well as sweaters to feel more comfortable at a lower indoor temperature. Some participants reported that the temperature of 18 degrees Celsius as set by the challenge was too low for their comfort, while others stated that they hardly noted the difference, and that adapting to the new temperature was effortless.

The implementation team did also encounter difficulties during the challenges. The participants in ELL2, living in apartment buildings, were not able to reduce their indoor temperatures much because of the heat leakage from adjoining apartments. Many older participants stated their health as a reason for accepting a personalized heating challenge with a temperature target above 18 degrees Celcius. With regard to laundry several participants noted that they were already at their limit before the reduction. Households with small children in particular had difficulties making a significant reduction in their number of laundry cycles, due to the regular need for washing reusable diapers or washcloths, for example. Several participants also stated that they feel uncomfortable washing their clothes at lower temperatures or using shorter cycles. Moreover, a number of participants reported allergies that require washing specific items at higher temperature settings and therefore were unable to save more energy.

Many participants reported that they had discussed the ENERGISE project with their friends and colleagues at work, and some had also posted about the project on social media. However, on the basis of the interviews, it was sometimes easier to discuss about heating than about laundry, which was considered by some to be private and somewhat embarrassing. This norm especially translated to the reluctance for participants to engage in meaningful discussions with friends or colleagues about their specific laundry behavior and potential changes.

Acknowledgments:

Annexes:

- Annex 1. Changes in indoor and outdoor temperatures before and after the heating challenge. This data is based on temperature loggers inside the living rooms of participating households.

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Annex 1. Changes in indoor and outdoor temperatures before and after the heating challenge

Figures 1 provides details on indoor temperatures in ELL1 at 8 am and 3 pm each day. Figures 2 provides details on indoor temperatures in ELL2 at the same times, based on data from temperature loggers placed in the participants' living rooms. Among ELL1 participants there was an outlier on November 3, when for a few hours the temperature registered on a particular logger reached 31,4 degrees, as is clearly visible in the second part of Figure 1 on November 3 2018.

Figure A1. Indoor temperatures in ELL1 households at 8 am and 3 pm each day.

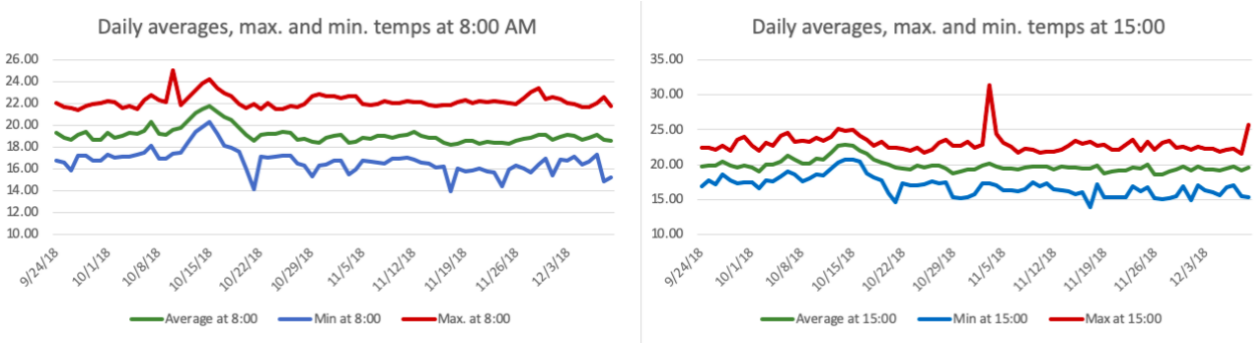
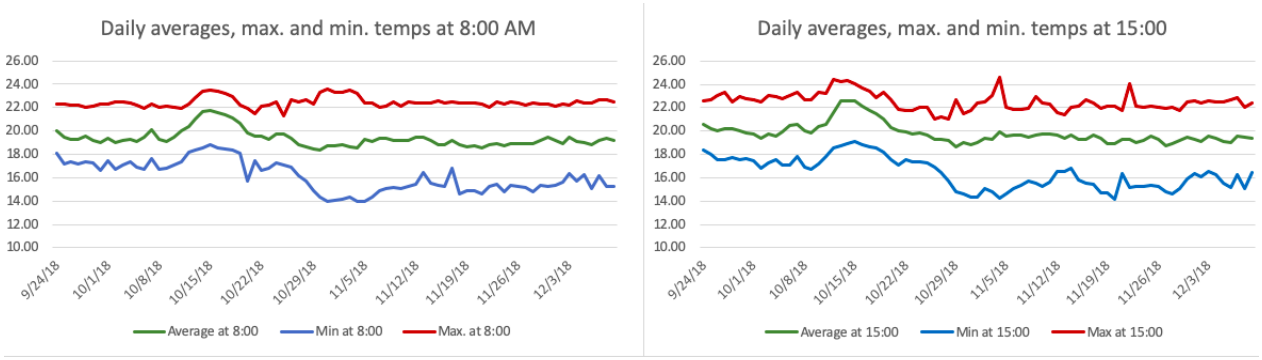


Figure A2. Indoor temperatures in ELL2 households at 8 am and 3 pm each day.



Annex 2. Changes in outdoor temperatures before and after the heating challenge

Data on outdoor temperatures at the two ELL locations, Maastricht and Roermond, are provided in Figure 3. Comparing figures 1 and 2 with figure 3 shows there is perhaps some relationship between indoor and outdoor temperatures in ELL1, but very little if at all in ELL2, since indoor temperatures are controlled by thermostats.

Figure 3. Outdoor temperatures at the ELL sites