Journal of Sustainability Perspectives 4 (2), 2024, 129-147

Journal of Sustainability Perspectives

journal homepage: https://ejournal2.undip.ac.id/index.php/jsp/

The Way Forward in the Energy Transition; Good Practices and Challenges at Wageningen University & Research

Erna Maters[*1], Django Milner Vaas[1], Joke Luttik[1], Wouter van Leeuwen[1]*

[1]*Wageningen University & Research, The Netherlands*
[*]corresponding author: erna.maters@wur.nl

Article Info

Received:
04 June 2024
Accepted:
11 October 2024
Published:
25 October 2024

DOI:
10.14710/jsp.2024.24798

Presented in the 10th International Workshop on UI GreenMetric World University Rankings (IWGM 2024)

Abstract. Reducing greenhouse gas (GHG) emissions due to changes in energy used in buildings is the most successful part of Wageningen University & Research's (WUR) climate policy. In this article the authors evaluate sustainable energy measures and identify key success factors, based on internal documents, discussions with stakeholders, and relevant literature. The role of government and stakeholders has been important, as were the technical possibilities to take a major step with constructing the heat and cold storage on campus. Geopolitical factors also played a role, in particular the war in Ukraine, which increased energy prices, acutely reinforcing the need for energy savings. In addition to saving energy, WUR aims to contribute to the energy transition by generating green electricity with wind turbines and solar panels. Furthermore, electricity used from the grid is offset with wind energy through Dutch guarantees of origin (GVOs), allowing us to offset GHG emissions for electricity at zero. Yet, there are other reasons to save as much as possible on electricity use. In addition to environmental considerations, congestion of the electricity grid plays a role, which is largely associated with the energy transition. Looking ahead, we describe further potential energy reduction opportunities and related challenges. As described in the Rough Outline of WUR Energy Transition 2050 [1], WUR provides clear targets and possible sets of measures to achieve these targets. Challenges include the uncertainty surrounding technological solutions and the availability of funding. We recently expanded our carbon footprint to include Scope 3 emissions of purchased goods and services. An additional challenge is the reduction of implicit energy use through the purchasing chain.

Keywords:
Climate change, Energy crisis, Energy transition, Energy reduction, Key success factors, Stakeholders.

1. Introduction

WUR is working towards a sustainable future on all aspects - education, research, value creation and business operations. 'Science for Impact' is the explicit starting point for research and education [2], aiming to contribute to the major social challenges in the areas of food, health, liveable cities and sustainable land use, and thus to the UN Sustainable Development Goals (SDGs). In addition, WUR contributes to the SDGs by making its business operations more sustainable. Every year, we participate in sustainability benchmarks to monitor progress and learn from the results, which helps us improve. Recognition for sustainability efforts was reflected in high scores in sustainability rankings in recent years. Internationally, WUR topped the UI GreenMetric Rankings for the seventh time in a row in 2023, as the most sustainable university in the world [3].

Sustainable energy is one of the major themes in making WUR's business operations more sustainable and climate proof. It can also be considered as the most successful part of WUR's sustainability policy, as measured by a large reduction in greenhouse gas (GHG) emissions due to changes in energy use in buildings [4, 5]. Other aspects that are linked to the use of fossil fuel resources are transportation (e.g., staff commute, student travel and international travel) and indirect emissions in the supply chain. In this paper we focus on sustainable energy measures targeting energy reduction and realising an energy transition.

The energy transition, defined as the change from the use of fossil fuels to more sustainable and renewable energy sources, is one of the major challenges in global sustainable development. The global energy transition means a thorough renovation of the European energy system. This became extra clear due to the war in Ukraine. The war, the subsequent energy crisis and the tightened Dutch energy policy had serious consequences for universities in the Netherlands, WUR included, as the rates for the supply of electricity and gas rose sharply [6]. On top of that, the Netherlands is facing the phenomenon of electricity grid congestion [1].

In its sustainability reporting [4, 5] WUR links sustainable energy to the Sustainable Development Goals (SDGs) 7 and 13. SDG7 calls for "affordable, reliable, sustainable and modern energy for all" by 2030 [7]. For SDG 13 the UN is urging the world to take action to combat climate change and its impact [8]. When considering the societal role of universities, SDG 4 is also highly relevant, as emphasised by Leal Filho et al.: "…the importance of preparing students to consider sustainable development impacts in their actions as citizens and professionals." Energy efficiency initiatives in universities contribute to encourage habits and attitudes to support sustainable development [9].

Climate change presents an enormous challenge, requiring a significant effort from governments, citizens, companies and other organisations. A sizable part of the effort involves making the energy use in buildings more sustainable, by making buildings natural gas-free, use sustainable energy systems, and taking measures to save energy.

2. Sustainable energy strategy at WUR; policies and results

Energy savings and generating sustainable energy are the two cornerstones of the sustainable energy policy of WUR. Careful monitoring of installations and placing freezers together in a conditioned hall are examples of energy-saving measures. By using heat and cold storage, the amount of gas used for heating buildings has been reduced considerably.

In response to the energy crisis, additional energy-saving measures were introduced in 2022, such as lowering the temperature in buildings and closing buildings for holidays. Students and employees are sacrificing a bit of comfort in exchange for substantial energy savings [10].

To generate sustainable energy, WUR operates wind turbine parks and is installing solar panels on all suitable roofs. On its site in Lelystad, WUR manages three wind parks with 26 wind turbines in total. The parks deliver, depending on the wind, between 65 and 70 GWh per annum. In 2023, 66 GWh was produced, which is more than WUR's total electricity demand [4, 5].

On Wageningen Campus buildings are heated and cooled with Aquifer Thermal Energy Storage (ATES). Heat and cold are stored via heat exchangers in a water-bearing sand pack at a depth of 90 meters in the ground. The heated water from the cold wells is stored in the heat wells and the cooled water from the heat wells in the cold wells. In summer buildings are cooled with groundwater from the cold wells and in winter buildings are heated with groundwater from the heat well. To make more efficient use of the ATES system on campus distribution loops were constructed in 2021. For heating and cooling all buildings on campus will be connected to these loops. With the heat and cold storage and the loops, WUR aims to save more than 1.3 million cubic meters of natural gas annually. This will lead to a reduction of approximately 2,400 tonnes of CO_2-e per year [11].

Policy is to install solar panels on all suitable roofs. In recent years we managed to fill roofs and grounds with over 17,000 solar panels. Solar panels currently generate around 4.5 GWh per year (as opposed to 1.3 GWh in 2019) [4, 5].

The WUR energy vision, adopted in 2014, set the guidelines for energy policy, with goals and targets up to 2030 [12]. More recently, in 2021, the Rough Outline of WUR Energy Transition 2050 [1] was adopted to be well prepared to deal with the latest developments, such as the Paris Climate Agreement, the European ‘Fit for 55’ climate policy and national (Dutch) laws and regulations concerning carbon emissions and the use of natural gas and electricity. Moreover, it has become increasingly urgent to take action to combat climate change. The Rough Outline presents a vision that WUR considers feasible and acceptable for its entire real estate portfolio. Figure 1 shows the targeted carbon emission reduction. Given the uncertainties concerning the future energy landscape, this rough outline remains a work in progress. The further we look to the future, the greater the technical, financial and policy-related uncertainties. However, the Rough Outline allows us to draw an initial picture of our ambitions. Climate neutrality in 2050 is the ultimate goal [1].

The rapid development in energy policy and technology provides opportunities, but also uncertainties. To respond to this, a portfolio roadmap has been drawn up based on the framework of the Rough Outline and prevailing legislation and regulations, containing a sustainability plan for all WUR buildings for 2023-2026 [13].

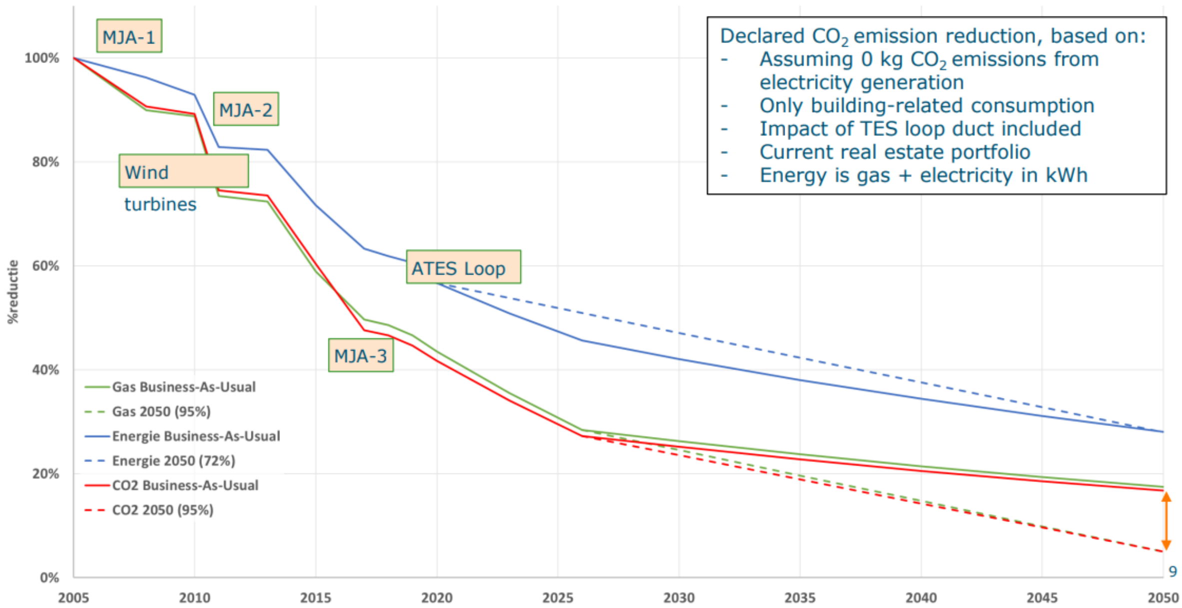

Figure 1. Targeted carbon emission reduction in 2050 [1]

Given the energy crisis, it was decided in 2022 to accelerate the connection of the buildings on campus to the Aquifer Thermal Energy Storage (ATES) distribution loops for heat and cold storage. The work is expected to be completed in 2025, making the targeted 90% gas reduction a reality. Additional measures to save energy introduced at the end of 2022, such as lowering the temperature in buildings and closing buildings for holidays, remained in force in 2023. The results show that gas use fell by 20% in 2023 compared to 2022, while electricity use fell by 1.4% [5].

WUR also made great strides in generating sustainable energy. In 2023, 84% of WUR's total energy use was generated sustainably. In fact, 35% more renewable electricity was generated than consumed. The wind turbines in Lelystad generated more than 66 GWh of energy in 2023. In 2023, WUR generated 8.3 GWh with heat and cold storage and 4.5 GWh of solar energy. Table 1 shows sustainable energy generated per renewable energy source in 2019-2023 [4, 5]. All in all, WUR is on track to achieve the 2050 targets for the sustainable energy theme: energy use in 2050 back to 25% of that in 2005; with zero carbon emissions, as is shown in figure 2.

Table 1. Generated Energy (MWh) per Renewable Energy Source in 2019-2023

Renewable source in MWh	**2019**	**2020**	**2021**	**2022**	**2023**
Wind energy	66,338	71,176	54,228	58,472	66,297
Heat and cold energy storage (ATES)	6,157	5,581	5,992	7,212	8,302
Solar energy	1,373	1,954	3,341	4,563	4,516
Total renewable energy	**73,868**	**78,954**	**63,562**	**70,248**	**79,116**
Total electricity consumption	55,487	52,072	56,124	53,293	52,563
Total energy consumption	108,047	103,283	110,104	105,387	94,472
% of total energy consumption	**68%**	**76%**	**58%**	**67%**	**84%**

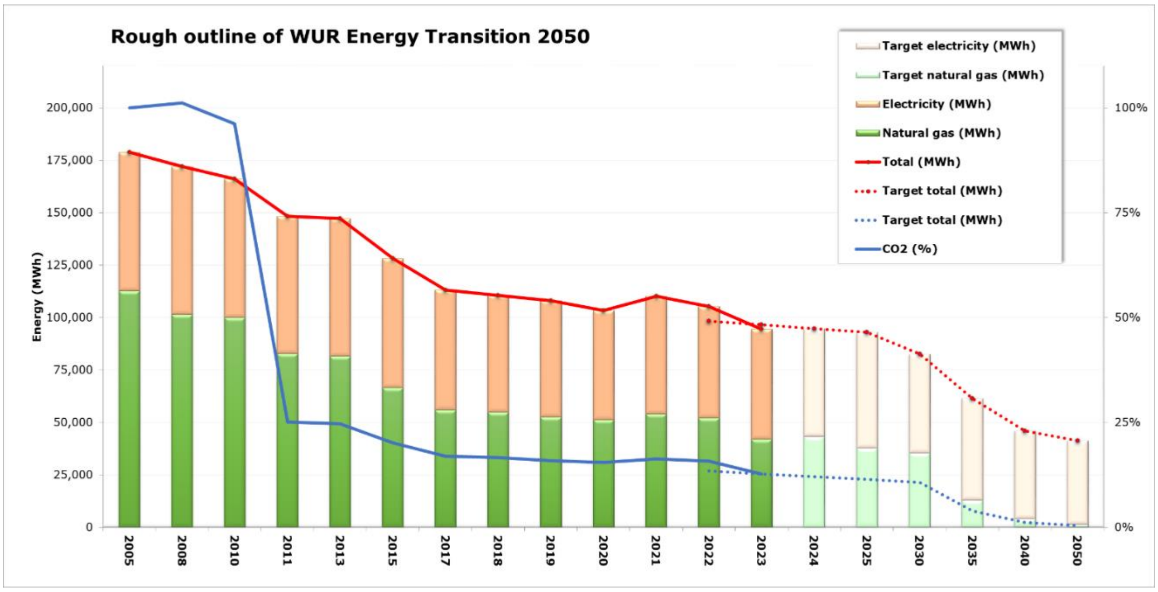

Figure 2. Development of Rough Outline for the Energy Transition 2050 in 2005-2050 [5]

3. Key success factors

Table 2. Identified key success factors

Element	Key success factor	Description
Strategy & policy	Clear goals and targets	The Energy vision and the Rough Outline for the Energy Transition 2050 provide clear goals and targets, reinforced by agreements, laws and regulations, such as the Multi-Year Agreement (MYA, in Dutch: MJA) and the European Energy Directive (EED).
	Integrated approach	An integrated approach combines policy and measures on building-related, process-related and user-related energy consumption. An integrated perspective on energy includes facets like infrastructure, energy generation and storage, collective facilities, electric transport, and behavioural change.
	Integration into institutional planning	One of the guiding principles is to integrate sustainability issues in all decision making. The guideline is to always choose the most sustainable option if something needs to be replaced - not the most economically advantageous option.
Engagement	Commitment from leadership	Sustainability as a core value for the entire WUR and the notion that it is important to ‘practise what you preach’ are clearly communicated by the Executive Board, for example in the Strategic Plan.
	Involvement of staff and students	In regular news updates staff and students are informed on the progress made. Sustainability projects or actions of staff and students, individual or via bottom-up initiatives such as Green Office Wageningen, LEAF, Green Impact, and Scientists4Future.
	Stakeholder pressure	More and more staff and students are looking critically at our energy and climate policies and practices. The awareness that action is required is widespread.

Element	Key success factor	Description
	Partnerships and collaboration	Collaboration with scientists (internal and external), partner organisations, companies and suppliers.
Energy management	Energy Management System	WUR has implemented an energy management system, in accordance with the guidelines published by Netherlands Enterprise Agency and the Plan-Do-Check-Act philosophy. The energy management organisation is based on a specification of roles (duties, responsibilities and powers).
	E-teams	Every organisational division of WUR has an E-team (Energy team), supported by a central E-team. Members of the decentral teams are building location managers, technical building managers, and safety and environment advisers. Teams work together on joint themes and share knowledge and experience.
	Data Monitoring and Evaluation	The energy consumption is measured and recorded for all WUR buildings and installations in the energy monitoring system Erbis. Energy data are used in the calculation of the carbon footprint.
Advancements in technology	Thermal heat and cold storage	Several buildings on Wageningen Campus are connected to the Aquifer Thermal Energy Storage (ATES) system. In 2021 ATES heat and cold distribution loops were added to the system for an efficient exchange of energy between buildings. Ultimately all buildings on Wageningen Campus will be connected to the ATES loop in 2025.
	New buildings	New construction projects and renovation projects offer ideal opportunities to make energy supplies sustainable and future-resilient, e.g., by investing in new technologies as heat and cold storage, heat pumps, and LED lighting.
Investments and funding	Energy incentive	From 2011 till 2022 organisational divisions of WUR were made responsible for their own energy budgets, in order to give insight into their energy consumption and further stimulate energy saving by taking measures. Revenues from these measures were credited to the relevant divisions.
	Own wind turbines	WUR invested in the construction of three wind parks with in total 26 wind turbines at its location in Lelystad.
	Purchasing Green electricity	As from 2011, all electricity procured by WUR is wind energy, with a Guarantee of Origin seal of approval.

WUR did book results in reducing energy and the switch to more sustainable energy sources. To identify key success factors energy measures were evaluated, based on internal documents, discussions with stakeholders, and relevant literature. Identified key success factors are listed in Table 2 and are described in this chapter.

3.1 Energy strategy and policies

The Energy vision [12] and the Rough Outline of WUR Energy Transition 2050 [1] provide clear goals and targets, which are reinforced by agreements such as the Paris Climate Agreement, the European Energy Directive (EED) and local laws and regulations. Examples of local regulations for energy are among others the multi-year energy agreements, sectoral road maps, and the Label A requirement for office buildings.

One of the WUR guiding principles is to integrate sustainability issues in all decision making. The guideline is to choose the most sustainable option if something needs to be procured or replaced and not the most economically advantageous option. Making sustainability an integrated part of the broader policy and strategy will give every employee and student extra support and stimulates their involvement at all levels of the organisation.

For thirty years, energy agreements (covenants) formed part of Dutch energy policy. A covenant is an agreement between the government and one or more parties aimed at achieving certain (policy) objectives. WUR participated, along with other universities, in the Energy Multi-Year Agreement (MYA) for Dutch universities. The MYA-3 imposed an obligation to implement an energy management system and to draw up an Energy Efficiency Plan (EEP) once every four years. For MYA-3 the target percentage of 2% energy savings per year was translated into 30% during 2005-2020, to be achieved through process efficiency, chain efficiency and sustainable energy. After 2020 WUR has to follow the legislation from the European Energy Directive (EED) and its transposition into Dutch law. The EED includes an obligation to report energy measures to realise energy savings and generate sustainable energy. Sectoral roadmaps were created for goals after 2030 with an increasing focus on chain efficiency and cross-sector collaboration [1, 13].

3.2 Engagement

Commitment from leadership is crucial for a successful energy strategy. Sustainability is a core value for the entire WUR and the notion that it is important to ‘practise what you preach’ is clearly communicated by the Executive Board, not only in the Strategic Plan or in annual reports but also in internal and external communication. In regular news updates staff and students are informed on the progress we make. Additionally, more dedicated, specific information is offered through various communication channels, e.g., concerning the importance and impact of shutting fume hoods in laboratories. Long term, substantial investments are needed in order to switch to sustainable energy systems. These types of major investments require broad support throughout the organisation.

More and more staff and students are involved in our policy actions for energy savings. The awareness that action is required is widespread. One of the success factors is the involvement of the entire organisation. Every organisational division within WUR has an Energy team, E-team in short (see table 2). Members of these teams are staff members who are actively involved in energy management, e.g., technical building managers, facility managers and safety and environment advisers. Energy consumption is monitored by the teams, and possible energy-saving measures are discussed and proposed. Supported by the central E-team, led by WUR’s energy coordinator, the E-teams work together on joint themes and share knowledge and experience.

Green Office Wageningen (GOW) is the student led initiative that supports sustainability at WUR by offering a network to sustainability-minded students and staff. As part of the operations portfolio, GOW organises activities that contribute to sustainable energy use. Activities in the past to save energy were organising warm sweater days and Shut the Hood campaigns (targeted at closing windows of fume hoods in laboratories). In 2024 Green Office co-organised the Honours Energy Challenge, a two day think tank where students tackle an energy related issue at Wageningen University, and the Student Energy Saving Challenge to save energy in student houses [14].

To create a more sustainable working environment at WUR, several employees are involved in sustainability teams or groups. Between 2018 and 2023 teams were engaged in the Green Impact programme. Supported by an online toolkit, student assistants and workshops, Green Impact participants worked together on concrete sustainable actions. Linked to Green Impact, LEAF, a sustainability programme for laboratories, was introduced at WUR in 2022. The LEAF network is explained in paragraph 5.1. In both the Green Impact and LEAF programmes Green Office Wageningen is involved [4, 5].

Examples of collaboration from a scientific perspective are the Wageningen Energy Alliance and ACRRES. The Wageningen Energy Alliance is a network community of WUR affiliated scientists, researchers and other employees within WUR with an interest in energy. The ambition is to have an impact on the transition towards sustainable energy systems from a WUR perspective. The alliance aims to increase visibility of energy research within WUR, but also to the outside world, by putting knowledge into practice and facilitating collaboration between WUR research groups and WUR's Facilities and Services department [15]. Recently the Wageningen Energy Alliance became a full member of the Netherlands Energy Research Alliance (NERA), which brings together energy research from several Dutch universities, as well as research institutes [16]. ACRRES, the Application Centre for Renewable Resources, is a partnership between two WUR research institutes in Lelystad (Applied Plant Research and Animal Sciences Group). ACRRES carries out research projects in the field of renewable energy, based on solar, wind and biomass, including potential applications of renewable resources and for recycling [17].

The pressure of stakeholders is increasing, as more and more staff and students are critically looking at our climate policies and practices. An example is a dialogue series held in 2023, concerning responsible partnerships surrounding collaboration with the fossil fuel industry, which, according to some employees and students, is no longer justified. The WUR Executive Board decided to work towards additional rules for collaboration, and formed an advisory group to draft an assessment framework on collaborations with the fossil fuel industry for research projects. This framework was adopted by the Executive Board in 2024. The final conclusion was that collaboration with the fossil sector is still possible, but under revised conditions [18, 19].

3.3 Energy management

The integration of energy management in the organisation was not only a requirement under the MYA-3 but is also a logical step in achieving sustainability. The energy management organisation is based on a specification of roles (duties, responsibilities and powers), with a division between corporate – assigned to WUR Facility Services – and decentral (organisational divisions). Facility Services is entrusted with a large proportion of the work, whereas an Energy Main Process Model makes a further division between the departments and Facility Services. The energy management system is based on several important pillars:

- Energy Efficiency Plan (EEP), specifying the measures that need to be implemented in a period of four years to achieve the savings target. The most important categories of measures are technical projects, good housekeeping, projects in the chain and the generation and procurement of sustainable energy. The parties involved must jointly provide for the implementation of the planned or alternative measures. Following the current European Energy Directive, the EEP is replaced by sector roadmaps (as explained in paragraph 3.1).
- Monitoring Control of the organisation's energy consumption is feasible solely when accurate and reliable information is available and when the necessary control mechanisms are in place. The indoor climate of the buildings is adjusted via building management systems. Monitoring the installations provides the information required to adjust the settings to optimum levels as based on the balance between energy efficiency and comfort.
- The energy management system (EMS) records all energy and water flows and then converts data into usable information at a range of levels (per meter, building, organisational division and total). The EMS also encompasses relevant financial data, comprised of the procurement costs – and invoice control – and assigning the costs to internal and external end users [4, 5].

3.4 Advancements in technology

All buildings on Campus will ultimately be connected to the heat and cold loops of the ATES. With the distribution loops, connected buildings can exchange energy and residual heat and cold can be stored in the ground. The ATES distribution loop itself was completed at the beginning of 2021 and many buildings have already been connected to it.

WUR used to be located in many separate, relatively old buildings in different locations in the town of Wageningen. With the gradual move to the campus, and predominantly new buildings, a first major step forward in energy reduction was made. New construction and renovation projects offer ideal opportunities to make energy supplies sustainable and future-resilient.

3.5 Investments and funding

WUR introduced an energy incentive in 2011 [12]. The mechanism behind the 'energy incentive' measure was that WUR divisions which managed to reduce energy costs by saving energy would see direct financial benefits. This worked particularly well for the Plant Sciences Group, that managed to reduce energy use by 30% in the eight-year period after the measure was introduced. The measure was recently suspended; the construction of the heat and cold storage distribution loop on Wageningen Campus complicated the distribution of savings over the various organisational departments. Once all buildings on campus are connected to the ATES heat and cold loops the incentive might be adopted again [4].

In the Netherlands, the Province of Flevoland is a relatively suitable location for wind energy generation. Since one of WUR's main sites is situated in Flevoland, WUR was provided with the opportunity to be involved in the development of wind parks and invested in the construction of 26 wind turbines on its grounds at Lelystad (see also chapter 2). At the major campus location in Wageningen, realising wind turbines is not an option.

The wind energy generated in Lelystad is not directly used, but delivered to the national electricity grid. To ensure that electricity used in all WUR locations is from renewable sources, all electricity procured by the organisation is green electricity (wind or solar), with a Guarantee of Origin seal of approval. This seal of approval guarantees the provision of incentives for the development of new sustainable production plants and allows us to assign zero carbon emissions to all purchased electricity [1].

4. Stakeholder feedback on key success factors

A survey was performed to gain insights regarding the influence of key success factors implemented at WUR. The gained perspective was from key WUR stakeholders who had direct involvement with the success factors and key energy management topics.

4.1. Survey design

The target audience of the survey was stakeholders who had direct involvement with one or more energy practices or management topics. Their perspective is most useful since they have most knowledge on the factors. A semi quantitative approach (5-point Likert scale) was utilized as it is less time consuming to answer, and allows for determining averages from all respondents. The respondents were also given the opportunity to provide a more detailed response or to elaborate in the open answer fields. Knowing their involvement with certain success factors was crucial for interpreting the responses, which were then also categorized per type of involvement (respondents from the energy alliance versus non energy alliance). Including a question related to missed opportunities allowed for identifying what else could potentially be done from the perspective of people who are actively involved in the related area. A predetermined list of success factors was provided in the form, however there was also an opportunity for respondents to mention or elaborate on any other key success factors not in the predetermined list. Doing so ensured that the list of key success was as complete as possible.

4.2. Data collection

A survey including the key success factors outlined in chapter 3 was constructed. Respondents were asked to rate how much influence the factor had using a 5-point Likert scale. The survey was shared online to specific groups of employees involved in energy management, as they were the groups which had the most accurate insights and relevant knowledge. The target population of circa 100 people consisted of members of the Energy teams (see paragraph 3.2); staff of the Facility Services department (location managers, technical building managers, and electrotechnicians); staff of Quality, Environment, Safety and Health (QESH) units; and members of the Wageningen Energy Alliance (see for description paragraph 3.2). The survey was sent out on 21st May 2024 and was open for two weeks. The survey gained 17 responses in total.

4.3. Data analysis

Responses were processed in 3 groups to facilitate comparison. Firstly, all responses (n=17) were taken into account. Secondly, only the responses from respondents in the energy alliance (n=7) were taken into account. Thirdly, all responses excluding those from the energy alliance (n=10) were taken into account. Visualizing the data in this way was beneficial to see differences between the two groups of respondents.

4.4. All responses

Figure 3 below shows each factor's average response on a 5-point Likert scale, from all respondents (n=17). The three factors scoring highest in terms of influence were the energy incentive, advancements in technology, and the integrated approach, respectively. The energy incentive allowed departments which employed energy-saving measures to see direct financial benefits (see table 2 and paragraph 3.5). The lowest scoring in terms of influence was 'Bottom-up initiatives'. This could be because many initiatives are helpful in terms of spreading awareness and creating impact on a small(er) scale, however translating and transferring those incentives is usually met with various barriers.

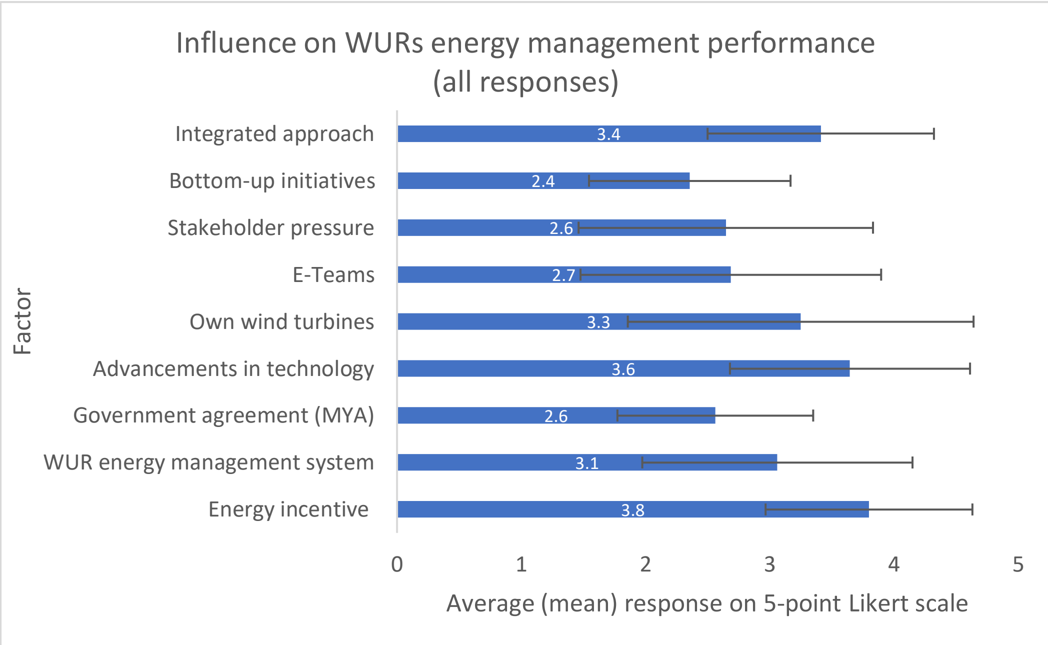

Figure 3. Influence on WURs energy management performance (all responses)

The key success factor 'own wind turbines' had the largest discrepancy in responses (e.g., the largest standard deviation), suggesting that the respondents had conflicting opinions on the factor, possibly stemming from the fact that respondents were divided in two major groups (energy alliance and non-energy alliance). 'Government agreement (MYA3)' had a low average response on the 5-point Likert scale, and the lowest standard deviation, indicating a perceived low influence and a low discrepancy among respondents.

4.5. Responses from the energy alliance

Figure 4 shows each factor's average response on a 5-point Likert scale, only from respondents in the energy alliance (n=7). The two (tied) most influential factors, according to the energy alliance respondents, were 'own wind turbines' and 'advancements in technology', with 'energy incentive', in third place. The main difference when compared to all respondents (see figure 3), is that the factor 'Own wind turbines' scores much higher, albeit with a very high discrepancy (standard deviation). This again suggests that the perceived influence the wind turbines have largely depends on who was asked and most likely their involvement with the success factor. The energy alliance members generally have an overview of the larger picture, including how much energy and impact the wind turbines generate.

Advancements in technology has enabled WUR to implement an on-site ATES system, which many local buildings are connected to. According to the responses from the energy alliance seen in figure 4, it has the (tied) highest influence on the WURs energy management performance. Unlike 'own wind turbines', which has the same response on the 5-point Likert scale, 'Advancements in technology' has a relatively low standard deviation, indicating a lower discrepancy in the results. Similarly to the results from all respondents (figure 3), 'Advancements in technology' has one of the highest ratings.

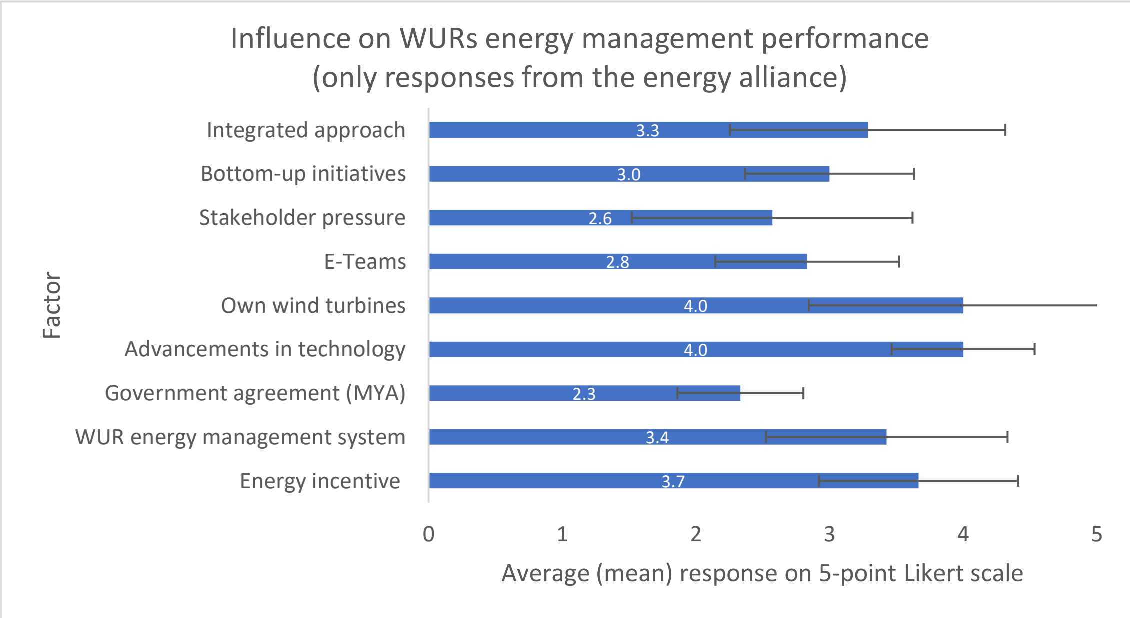

Figure 4. Influence on WURs energy management performance (only responses from the energy alliance)

4.6. Responses excluding those from the energy alliance

Figure 5 below shows each factor's average response on a 5-point Likert scale, excluding responses from the energy alliance respondents (n=10). 'Energy incentive', 'integrated approach', and 'advancements in technology' have the three highest influences according to these respondents. There is a major difference between the respondents from the energy alliance (figure 4) and respondents not from the energy alliance (figure 5). The perceived influence that the factor 'own wind turbines' has is much lower when the responses from the energy alliance are excluded.

This result makes sense considering the previously mentioned perspective that the energy alliance has. 'Bottom-up initiatives' has the lowest influence when determined by this group. This result is in line with the responses from the energy alliance and suggests that there is a low discrepancy between groups regarding this key success factor.

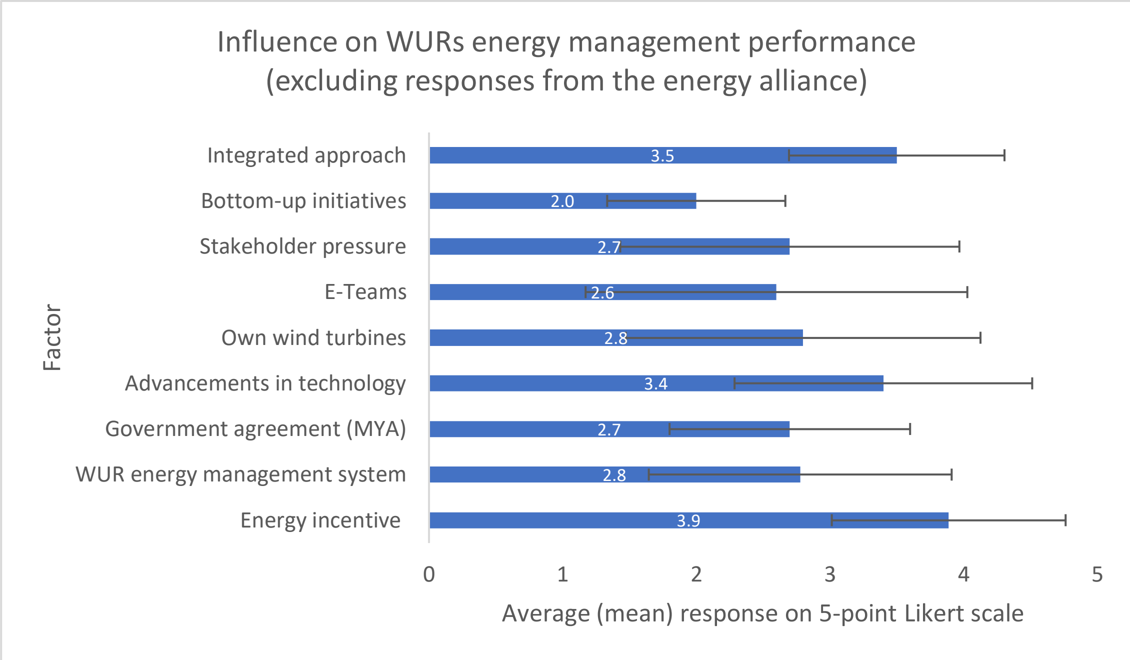

Figure 5. Influence on WURs energy management performance (excluding responses from the energy alliance)

4.7. Responses to open questions: success and failure factors

Two open questions were part of the survey. Respondents were asked if they could think of any other success factor explaining the good results of WUR's energy policy. From the 17 respondents 10 added an other success factor. Four persons mention the dedication and personal involvement of staff working on energy management. Two respondents linked success to costs: insight in the direct cost-benefits of energy-saving measures and the rising energy costs. Two replies referred specifically to the ATES system and the fact that the main WUR location is suitable for use of heat and cold storage. Other comments were that only mandatory factors bring success and the pressure of international rankings.

The second open question was: “Do you think there are missed opportunities or failure factors that should be mentioned?” Four respondents mentioned the lack of capacity and knowledge for the complicated energy issues at hand. This demands a lot from the staff working on energy management. Other comments varied from the speed of the implementation of measures to communication challenges. It is difficult to reach employees, especially when it comes to behavioural change.

One respondent mentioned the need to evaluate energy-saving measures during the winter period. Because offices were heated a few degrees less in winter, more employees worked at home. This could lead to a net environmental loss caused by the energy use from less sustainable sources at home. A similar observation was made about a negative effect of working during hot summers, as not all buildings have optimal climatic conditions. Problems with replacing equipment were also mentioned due to the complicated financial structure and that some E-teams did not function as well. Missed opportunities mentioned were the lack of collaboration with students and employees (3x) and exploiting the financial benefits of producing (surplus) renewable energy for profit.

4.8 Outcomes of the survey

In conclusion, the overall influence that key success factors have depends on the respondent and their involvement with the factor. The results from the survey show that when all responses are considered, the factors with the highest perceived influence were 'advancements in technology' and 'energy incentive'. Key success factors with the lowest perceived influence were 'bottom-up initiatives' and 'Government agreement'. 'Own wind turbines' had a high variation in influence and standard deviation.

5. Looking ahead: possibilities and challenges

5.1. Energy consumption in laboratories

Laboratories are high energy consumers, typically consuming 10 times more than an office of the same floorspace [20]. Although undoubtably crucial for research, advancing society, and education, some energy-saving measures can be safely implemented. It is, therefore, important to identify measures which allow laboratories to function well, while simultaneously efficiently reducing their energy use. The Laboratory Efficiency Assessment Framework (LEAF) [21], developed at University College London (UCL), facilitates (among other things), the assessment and calculation of a laboratory's energy use and helps identify areas where energy consumption can be reduced.

Fume hoods are one of the largest energy consumers in laboratory buildings, with each fume hood consuming roughly as much energy as 2-3 houses annually [20]. Behavioural changes, assisted by visual aids on the fume hoods, can help reduce their energy consumption. Harvard university's shut the sash programme managed to reduce laboratory energy consumption up to 70%, equalling circa 300-350 tonnes CO_2-e per annum [22]. Energy consumption can be further reduced by turning off fume hoods (while complying with safety rules and not interfering with experiments) overnight and during weekends and holidays. Devices such as sensors and alarms can be built into the fume hoods to further assist in keeping them closed where possible. For example, the university of Twente incorporated alarms into the fume hoods, and saw a 70% reduction in the time fume hoods were open [23].

Aided by the LEAF framework, laboratories have been able to reduce the energy consumption of ultra-low temperature (ULT) storage 30-35%, by changing the ULT freezer temperature from -80^{o}C to -70^{o}C. Reports show that -70^{o}C is a safe storage temperature for various samples [24, 25]. Establishing and following a maintenance procedure (i.e., cleanup, cleaning filters, defrosting every 6 months, etc.) of freezers can also reduce energy consumption [20].

Additional savings can be achieved through turning off equipment (e.g., ovens, centrifuges, etc.) in the laboratories when not in use. Visual aids such as informative stickers, power strips with on/off switches, and plugs with timers can help facilitate reductions in energy consumption. A future goal is to facilitate the expansion of the aforementioned incentives to all WUR laboratories. However, that is not without its challenges.

Experience has shown that laboratory users are not always open to behavioural changes, even if they can potentially reduce energy consumption or be less impactful on the environment in other ways. This can be due to several things, including conflicting opinions between lab users, and differences in previous training. Lab users are commonly under other pressures such as performing experiments and conducting research, financial constraints, and lack of collaboration or communication between other key stakeholders. Identifying and tackling these influences would help gain a deeper understanding regarding critical barriers laboratory users experience when trying to implement more sustainable practices, including those which contribute to reduced energy consumption.

5.2. Energy transition challenges

The Rough Outline of WUR Energy Transition 2050 carries the word 'rough' in its title for a reason. As indicated in the policy document: "The further we look into the future, the greater the technical, financial and policy-related uncertainties." [1]. For this reason, measures of the Rough Outline are divided in certain, probable and uncertain measures. Identified uncertainties are:

- Geopolitical factors, in particular the war in Ukraine, which increased energy prices, acutely reinforcing the need for energy savings.
- Congestion of the electricity grid in the Netherlands.
- Changes in government policies, such as changes in legislation (global, European, local) or the change of government (after elections).
- Support for energy-saving measures and the willingness to change behaviour to influence process and user related energy consumption.

Wind energy generation is for WUR crucial for reaching the energy transition ambitions, but is considered as an uncertain measure in the Rough Outline. The wind turbines owned by WUR were constructed in 2004, but will have to be replaced by new, modern wind turbines in future. The latter is a long-term and complex process, which is difficult for WUR to influence. It is up to various (national and local) governments to make decisions on where to allow wind turbines. Furthermore, there are many stakeholders involved. Large wind turbine projects are receiving increasing criticism and resistance [1].

Congestion of the electricity grid is another problem in the energy landscape of the Netherlands. Grid congestion occurs when the total supply of electricity from renewable and traditional sources exceeds the grid's capacity. As a result, facilities that generate renewable energy (solar and wind) cannot (always) deliver to the grid. This will complicate energy transition ambitions [1].

Influencing user related energy use is challenging, as behavioural change is involved. In order to realise energy savings, users of facilities have to actively contribute and might also experience some discomfort. Support for energy-saving measures is very important. In 2022, WUR started the campaign 'Turn it down a notch' [6] to respond to the rising energy prices due to the war in Ukraine. Measures ranged from lowering temperatures, turning off lights and unnecessary equipment, and closing buildings at the end of the year. To canvass opinions of employees on the campaign a survey was conducted early 2023. The survey was completed by 849 employees. Results showed that 36% of employees supported all measures, but that 64% of respondents had one or more objections. The biggest dissatisfaction was expressed about lowering the temperature in buildings. Employees reported working at home more often because offices were too cold. Measures were therefore adjusted, by slightly turning up the heating in buildings and improving communication about the measures [26].

The uncertainties are challenging. But challenges usually also create possibilities, for example:

- Looking for possibilities to address process- and user-related energy consumption, by promoting energy efficiency in laboratories (as described in paragraph 5.1) and exploring opportunities to influence IT energy use (think of data storage and the impact of Artificial Intelligence).
- Putting more emphasis on the indirect energy use of purchased goods and services.
- Finding new ways to involve our stakeholders - students, staff, researchers, teachers, partners, suppliers and others - even more.

6. Summary and conclusions

The energy transition, defined as the transition from the use of fossil fuels to sustainable and renewable energy sources, is a major challenge in global sustainable development. Universities have a societal role: they can actively contribute to the energy transition by conducting research on sustainable energy and climate impact. Universities also prepare students to act responsibly and consider the impact of their actions as citizens and professionals on sustainable development. At the same time, universities should lead by example as sustainable and energy-efficient organisations.

Sustainable energy is one of the central themes in making WUR’s business operations more sustainable and climate-proof. WUR contributes to the energy transition by generating green electricity with wind turbines and solar panels, and took a major step with constructing and improving heat and cold storage on campus. Measured by the reduction in greenhouse gas (GHG) emissions related to WUR’s energy consumption between 2005 and 2023, this can be considered as a very successful part of WUR's sustainability policy.

WUR achieved the targeted 30% energy savings between 2005 and 2020. Measures necessary because of recent geopolitical developments and rising energy costs resulted in even more energy savings during the past three years. Overall, WUR is on track to meet the 2050 targets as formulated in the Rough Outline of WUR Energy Transition 2050 [1]: bringing down energy consumption to 25% of that of 2005, with zero carbon emissions in 2050. However, uncertainties about the implementation of technological solutions, funding availability, and the influence on user-related energy consumption will make it challenging.

Key factors for success are clear goals and objectives in energy transition policy. Elements consist of an integrated approach (addressing building-, process- and user-related energy consumption), and institutional (energy) planning. WUR’s past investments include wind farms, solar panels on roofs and grounds, heat and cold storage on Wageningen Campus, and sustainable, energy-efficient buildings. Progress is monitored and evaluated, supported by reliable energy data. The introduction of an energy incentive encouraged WUR organisational units to save energy. The financial benefits of the energy savings could be used to invest in new energy-saving measures.

To investigate the influence of key success factors on the results of energy policy and practices, a survey among staff involved in energy management was performed. Their opinions on success factors identified in chapter 3 were collected. The outcomes (see chapter 4) show that the factors with the highest perceived influence were Advancements in Technology, and the Energy Incentive. The influence of Bottom-up Initiatives was perceived as lowest. Additionally, Government Agreements, Stakeholder Involvement, and Energy Teams received lower scores. It is likely that this is related to the degree of influence of the respondents on these factors. Staff involved in energy management have more insight into the technical and financial factors. Furthermore, it is difficult to measure the effect of energy-saving initiatives of stakeholders on energy consumption.

Nevertheless, stakeholder engagement is considered an important key success factor. As highlighted by Luttik et al.: “Everyone in the entire organization plays a role in sustainability progress.” Staff and students are looking critically at WUR’s sustainability strategy and ambitions. That being said, WUR also benefits from the feedback received. Critical feedback often leads to projects and initiatives in which students and staff are involved [27]. Great initiatives to improve energy efficiency within the organisation originally came from students and staff, through for example the Green Office Wageningen, and programmes such as LEAF and Green Impact. Research and education staff are joining forces in the Wageningen Energy Alliance, to contribute to the energy transition from a WUR perspective. Ultimately, commitment from leadership is crucial for a successful energy strategy. Sustainability as a core value must be supported by senior management and promoted on all levels.

References

1. WUR. Rough outline of WUR Energy Transition 2050. 2021. Available from: https://www.wur.nl/en/show/rough-outline-energy-transition.htm.
2. WUR. Strategic Plan Wageningen University & Research 2019-2022 [Internet]. 2018. Available from: https://www.wur.nl/en/about-wur/strategy.htm.
3. UI GreenMetric. 2023 UI GreenMetric World University Rankings. 2023. Available from: https://greenmetric.ui.ac.id/rankings/overall-rankings-2023.
4. Wageningen University & Research. WUR Sustainability Report 2022. 2023. Available from: https://www.wur.nl/en/show/wur-sustainability-report-2022.htm.
5. WUR. Duurzaamheidsverslag 2023 (concept). 2024; not published, English version will be available from: https://www.wur.nl/en/about-wur/our-values/sustainable-business-operations.htm.
6. WUR. Energy transition and lowering temperature of buildings at WUR [Internet]. 2022. Available from: https://www.wur.nl/en/newsarticle/energy-transition-and-lowering-temperature-of-buildings-at-wur.htm.
7. UN. SDG 7 Affordable and Clean Energy [Internet]. 2017. Available from: https://sdgs.un.org/goals/goal7.
8. UN. SDG 13 Climate Action [Internet]. Available from: https://www.globalgoals.org/goals/13-climate-action/.
9. Leal Filho W, Salvia AL, Paço A do, Anholon R, Gonçalves Quelhas OL, Rampasso IS, et al. A comparative study of approaches towards energy efficiency and renewable energy use at higher education institutions. Journal of Cleaner Production. 2019 Nov 10;237.

10. WUR. Energy-saving measures and end-of-year building closure implemented again [Internet]. 2024. Available from: https://www.wur.nl/en/article/turn-it-down-a-notch.htm.
11. WUR. Aquifer Thermal Energy Storage [Internet]. Available from: https://www.wur.nl/en/show/aquifer-thermal-energy-storage.htm.
12. WUR. Energy Vision for 2030. 2014. Available from: https://www.wur.nl/en/show/energy-vision-2030.htm.
13. WUR. The roadmap for energy savings within WUR [Internet]. 2024. Available from: https://subsites.wur.nl/en/article/the-roadmap-for-energy-savings-within-wur.htm.
14. WUR. Green Office Wageningen [Internet]. Available from: https://www.wur.nl/en/about-wur/sustainability/green-office-wageningen.htm.
15. WUR. Wageningen Energy Alliance [Internet]. 2018. Available from: https://www.wur.nl/en/research-results/chair-groups/environmental-sciences/landscape-architecture-and-spatial-planning-1/collaboration/wageningen-energy-alliance.htm.
16. WUR. Joint Energy Research: WUR Member of the Netherlands Energy Research Alliance [Internet]. 2024. Available from: https://www.wur.nl/en/newsarticle/joint-energy-research-wur-member-of-the-netherlands-energy-research-alliance.htm.
17. ACRRES. Application Centre for Renewable Resources (ACRRES) [Internet]. Available from: https://www.acrres.nl/en/what-we-do/.
18. WUR. Working with the fossil fuel industry [Internet]. 2023. Available from: https://www.wur.nl/en/about-wur/our-values/finding-answers-together/working-with-the-fossil-fuel-industry.htm
19. WUR. Executive Board adopts advice on fossil collaboration [Internet]. 2024. Available from: https://www.wur.nl/en/newsarticle/executive-board-adopts-advice-on-fossil-collaboration.htm.
20. Freese T, Kat R, Lanooij SD, Böllersen TC, De Roo CM, Elzinga N, et al. A guidebook for sustainability in laboratories. ChemRxiv. 2024; doi:10.26434/chemrxiv-2023-g3lmq-v4. This content is a preprint and has not been peer-reviewed.
21. University College London (UCL). LEAF - Laboratory Efficiency Assessment Framework [Internet]. Available from: https://www.ucl.ac.uk/sustainable/take-action/staff-action/leaf-laboratory-efficiency-assessment-framework.
22. Gilly Q. Validating cost and energy savings from Harvard's shut the shash program. Tackling energy use in labs [Internet]. 2023. Available from: https://sustainable.harvard.edu/wp-content/uploads/2023/09/FumeHoodWhitePaper-1.pdf
23. Slaats RH. Sustainable labs. Update from the University Twente [presentation]. 2023.
24. Radboud university medical center. -70 is the new - 80. The temperature setting of freezers. [Internet]. 2020. Available from:

https://www.freezerchallenge.org/uploads/2/1/9/4/21945752/minus_70_is_the_new_minus_80_updated_may_2022_v2.pdf

25. Espinel-Ingroff A, Montero D, Martin-Mazuelos E. Long-Term Preservation of Fungal Isolates in Commercially Prepared Cryogenic Microbank Vials. Journal of Clinical Microbiology. 2004 Mar;42(3):1257–9.
26. WUR. Survey on energy saving at WUR has led to some modifications [Internet]. 2023. Available from: https://www.wur.nl/en/article/survey-on-energy-saving-at-wur-has-led-to-some-modifications.htm.
27. Luttik J, Maters E, Milner Vaas D. On the journey toward a zero-carbon, nature-positive campus in Wageningen (submitted). 2024.