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REPUBLISHED ARTICLE

A sustainable campus for an uncertain future. Two cases of infrastructural transformation at Norway's largest university

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ABSTRACT

Purpose – This study aims to convey lessons learned from two sustainability initiatives at Norway's largest university. This contributes to knowledge-based discussions of how future, sustainable higher education institutions (HEIs) infrastructures should be envisioned and planned if the fundamental uncertainty of the future development of learning, researching and teaching is acknowledged.

Design/methodology/approach – This study was submitted on 24 January 2023 and revised on 14 September 2023. HEIs, particularly when they are engaged in research activities, have a considerable environmental footprint. At the same time, HEIs are the main producers and disseminators of knowledge about environmental challenges and their employees have a high awareness of the urgent need to mitigate climate change and biodiversity loss. In this study, the gap between knowledge and environmental performance is addressed as a question of infrastructural change, which is explored in two case studies.

Findings – The first case study presents limitations of ambitious, top-down sustainability planning for HEI infrastructures: support from employees and political support are central for this strategy to succeed, but both could not be secured in the case presented leading to an abandonment of all sustainability ambitions. The second case study exposes important limitations of a circular approach: regulatory and legal barriers were found against a rapid and radical circular transformation, but also more fundamental factors such as the rationality of an institutional response to uncertainty by rapid cycles of discarding the old and investing in new equipment and facilities.

Research limitations/implications – Being based on qualitative methods, the case studies do not claim representativity for HEIs worldwide or even in Norway. Many of the factors described are contingent on their specific context. The goal, instead, is to contribute to learning by presenting an in-depth and context-sensitive report on obstacles encountered in two major sustainability initiatives.

Originality/value – Research reporting on sustainability initiatives too often focuses descriptively on the plans or reports the successes while downplaying problems and failures. This study deviates from this widespread practice by analysing reasons for failure informed by a theoretical frame (infrastructural change). Moreover, the juxtaposition of two cases within the same context shows the strengths and weaknesses of different approaches to infrastructural change particularly clearly.

Keywords Circular economy · Infrastructure · Planning · Construction · Uncertainty

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Introduction

Science and education promise to contribute with solutions to pressing environmental problems¹. However, to do their work, scientists, educators and students depend on the same infrastructures that are complicit in climate change and decreased biodiversity in contemporary societies. In this article, closing the gap between the size of these environmental impacts and increasing environmental awareness among researchers and teachers (Blanchard *et al.*, 2022) is addressed as a question of infrastructural change. While individual researchers and teachers may or may not intend to change their practices in reaction to their environmental concerns, e.g. by flying less (Katz-Rosene and Pasek, 2023), their participation in common infrastructures provided by higher education institutions (HEIs) leaves little room for individual mitigation of environmental impacts. This is particularly true if infrastructures are approached as inextricably intertwined with daily practices, which emphasises the prohibitive cost of establishing routines not supported by or even against existing infrastructures. Such an approach, which is widely used in information systems research (see Lee and Schmidt, 2018 for a critical overview of the evolution of this term in relation to networked computer systems), media studies (Hesmondhalgh, 2021) and science and technology studies (Star and Ruhleder, 1996), implies that infrastructural change and individual behaviour change must be discussed together. In this sense, reducing HEIs’ environmental footprint is both a question of infrastructural planning and of what shape teaching and research should take in a more sustainable future.

Taking the environmental footprint of HEIs and the observation that campus planning is dealing with high levels of uncertainty as starting point, in this article, we explore two diametrically opposed options to increase the sustainability of campus infrastructures:

1. top-down planning involving large investments into sustainable buildings; and
2. circular use of existing facilities.

We found that if the goal is rapid reduction of HEI’s environmental footprints, both options have their respective advantages and problems. We present and analyse two cases that represent these two options:

1. the ambitious plans to merge existing campuses at Norway’s largest university, the Norwegian University of Science and Technology (NTNU), into a zero-emission campus; and
2. a qualitative inquiry into circular strategies on one of the campuses.

The goal of the article is twofold. First, by exploring and experimenting with reuse and recycling at a large campus we aim at analysing opportunities and challenges attempting to meet a reduction of the environmental impact of higher education through re-use of existing facilities. Second, by connecting experiments with circular transformation with the larger context of campus development in Trondheim, we contribute to the

discussion of the role of ambitious sustainability initiatives considering the uncertainties of campus planning today. From these goals, we derive two research questions:

RQ1. *What are the conditions for, what are advantages and disadvantages of a top-down approach to sustainable campus planning?*

RQ2. *Can strategies inspired by circular-economic approaches, more specifically extended use, re-use and recycling, be alternatives to top-down approaches to sustainable transformation at campuses?*

These questions will be answered based on case studies, which implies an exploratory approach. Our empirical investigation and its presentation focuses on producing in-depth and context-aware knowledge about the cases, which enables learning (Flyvbjerg, 2006) from the processes that have unfolded between October 2021 and June 2022.

Before describing the context and the specifics of the two cases, we present the case for a focus on sustainable HEI infrastructures and why uncertainty is a central determinant of HEI infrastructure planning. Then we introduce and define differences between the top-down, middle-out (Parag and Janda, 2014) and bottom-up approaches to sustainable infrastructural change. The article ends with a discussion of findings and a presentation of lessons learned about the acceleration of sustainability improvements on HEI campuses and their impact on the future of HEIs in general.

From the sustainability of scientists to the sustainability of their infrastructures

That science can provide solutions to the various ecological crises the world is facing is well understood by governments and HEIs that increasingly include goals related to sustainability in their missions. However, this search for solutions also causes harm to the environment, despite researchers' awareness of these effects (Blanchard *et al.*, 2022). Particularly flying causes concern among researchers and teachers, as is reflected in a slowly growing refusal to return to pre-pandemic levels of academic flying (Katz-Rosene and Pasek, 2023). Flying is indeed by far the most conspicuous polluting practice found at HEIs. However, it represents only about one third of the environmental impacts (Ciers *et al.*, 2018). Achten *et al.* (2013) calculate that another 26% of a PhD's overall emissions were connected to the use of infrastructures, i.e. office, IT, food and printing. Considerable differences between disciplines notwithstanding, common to all academic research and teaching is the use of campus facilities: offices, auditoria, meeting rooms and recreational facilities.

The overall contribution of HEIs to the GHG emissions of the global built environment is undoubtedly only a small fraction. However, campuses, which are the dominant form of how HEI facilities are planned and built, provide a potential for learning about how to reduce emissions in similar, much more common and therefore impactful constellations, such as urban neighbourhoods and business districts (Finlay and Massey, 2012; Berker and Woods, 2020). In this sense, in line with their core-mission, which is education and learning, HEIs' contributions to meet the ambitious targets laid out in the Paris Agreement and the Agenda 2030 is supposed to be an example for others to follow while actively disseminating what was learned in the process.

Uncertainty in sustainable campus planning

No matter which shape campuses take – distributed, centralised or mixed – these combinations of buildings of varied sizes and uses, connections (e.g. streets or computer networks) and equipment share with other infrastructures that they are in the background, enabling their users to achieve their goals, usually in an invisible way – except when they break down (Star and Ruhleder, 1996).

The post-war building boom in higher education in the USA and Europe was driven by increasing student enrolment (Muthesius, 2000). Later, the motivations for investing in new campus facilities have become more composite and complex (Lidsky, 2002), including changing disciplines and the need for interdisciplinary col-

laboration (Sá 2008) and sustainability. Fernandez and Powers (2021, p. 25), find that, in addition to a continued place-based role of campus investments:

“[. . .] a new and more globalized outset provokes growth and change in the physicality of the modern neoliberal university, where the campus responds to an increasingly larger market of potential users and investors”.

Such a “larger market” contributes to the uncertainty in campus planning, as the “customers” of academic production are less easily defined than, for example, in a university which serves a specific local demand.

These complexities are further confounded by the dynamic and ongoing changes in how research and teaching is conducted. Academic research and learning styles change, and campus facilities must keep up with the transformation of media landscapes into which new generations are born (Acker and Miller, 2005). For example, Berker (2011) describes a newly built campus building that was planned to accommodate for increased digitalisation by expanding the space for computer workstations. However, shortly after commissioning, it became clear that this space was not used by students that preferred to use their own laptop computers, which had in the meanwhile become affordable and which enabled them to work wherever they liked.

With changing research, teaching and learning styles, a dynamic landscape of disciplines, new opportunities to move teaching and office work online and an increasingly global outlook, in which HEIs compete for the “brightest minds” and altogether new user groups and investors, the planning of new campus facilities today is dealing with mounting uncertainties. This is the context which meets the task to reduce environmental impacts of the infrastructures needed to conduct science and teaching.

Sustainable change of infrastructures

Owing to their fundamental and large-scale character, infrastructures tend to be planned and implemented by centrally located actors that can mobilise considerable resources. However, this top-down version of how infrastructures come into being and change is only part of the history of infrastructures. As the growing literature on “infrastructuring” (Pipek and Wulf, 2009; Karasti and Blomberg, 2018) – the planning, implementation, maintenance and use of infrastructures – has demonstrated, the understanding of how infrastructures are implemented, stabilised and changed is incomplete without an awareness of the contributions of two additional groups of actors. First, end-users influence the performance of infrastructures through their uses, and they engage in activities that counteract or accelerate infrastructural change. A third group with even more power to affect infrastructural change is actors tasked with maintenance and repair. Facilities management, which includes operational, tactical and strategic roles, while often being involved in the planning of new infrastructures only in later stages, are instrumental in the implementation, development and for the performance of infrastructures over their considerable lifetimes.

Applied to sustainable change of HEI infrastructures, the three actor groups introduced here – centrally located managers and planners, end-users and facilities management – correspond to three different approaches to dealing with sustainable change. In a top-down approach, ambitious goals are formulated and then realised by the top management of an organisation. A bottom-up approach seeks to motivate end-users, i.e. students, teachers, researchers and administrative staff, to engage in sustainable practices. And finally, a “middle out” approach (Parag and Janda, 2014) enables facility managers to initiate and implement sustainable change.

Method

The three approaches to infrastructure change introduced in the previous section present different campus development options. In line with an approach which considers infrastructural change as potentially affected by end-users, an empirical exploration of these options must cast a wide net of exploratory inquiry to capture both intended and unintended consequences of infrastructural transformations that seek to improve sustainability – wherever they may occur. Given the research questions of this article, a research design which pre-

supposes behavioural control, or *a priori* knowledge of the central variables was not applicable. Moreover, the studied phenomena developed contemporary to the research. Based on these conditions, following Yin's (2018, p. 33) advice, a case study approach was chosen.

Case studies based on qualitative methods allow “a detailed examination of a single example of a class of phenomena (Abercrombie, Hill and Turner 1984, p. 34, quoted in Flyvbjerg, 2011, p. 301). The ‘single example’ here is the contemporary efforts to transform the main campus of Norway’s largest university, NTNU, into a more sustainable direction.

The advantage of case studies is their ability to produce exploratory (e.g. theory generating) and descriptive research. These strengths are balanced by case studies’ inability to discover causal relations and to generate representative findings (e.g. Gerring, 2004, p. 346). Flyvbjerg (2006) argues that case studies and their explorations and descriptions are uniquely positioned to contribute to learning, because they produce “the type of context-dependent knowledge which research on learning shows to be necessary to allow people to develop from rule-based beginners to virtuoso experts” (Flyvbjerg, 2006, p. 4). This insistence on the context-dependence of human knowledge also informs the way results are presented below, where we convey findings together with a rich description of the cases and their context.

In line with the general literature on case studies, Flyvbjerg (2011, p. 301) reminds us that the decision to conduct a case study is “not so much making a methodological choice as a choice of what is to be studied”. The methods used in both cases differed slightly according to their internal characteristics. The first case, the ambitious plans to gather all campuses close to the city centre in a zero-emission campus, posed little difficulties in terms of access to material. Owing to the size and far-reaching consequences of the project rich material on discussions and plans was publicly available, above all on the university’s website², in Trondheim’s regional newspaper *Adresseavisen* and in the university’s own online newspaper *Universitetsavisa*. In addition, two of the co-authors of this article (redacted for peer review) were members of two committees that were established to ensure employee representation in the project. All authors were familiar with the technological aspects of the construction project through their involvement in the Research Centre on Zero Emission Neighbourhoods (FME ZEN, see fmezen.no), which had the project as one of its pilot projects.

The second case study which focused on the re-use of campus furniture and equipment, in terms of methodology consisted of qualitative expert interviews with NTNU employees involved in procurement, maintenance and disposal (N ¼ 8), a short survey distributed among employees and students (N ¼ 100) and an experimental intervention which was co-designed with the university’s facilities management team. The expert interviews were recorded, transcribed and the information gathered was used to map ongoing local sustainability practices that belong to the group of “middle-out” initiatives. The survey was conducted with the help of students that had undergone a half-day training session. These students randomly selected employees and students passing through the main axis of the Gløshaugen campus and asked them questions: about what the respondents knew about NTNU’s sustainability activities; about circular economy in general; and in relation to NTNU’s campus. The students worked in pairs one asking questions and one taking notes, which were then analysed by the research team. As the goal only was to get a rough overview of employees’ and students’ knowledge and general sentiments, a more in-depth analysis of the material was not necessary.

For both cases, material was collected during the period between October 2021 and March 2022.

Presentation of the cases

Case 1: top-down sustainable change in the campus project

The “campus project,” a big investment in campus infrastructure at Norway’s largest university, and its appurtenant rhetoric (Lloyd, 2021) demonstrate the advantages and disadvantages of a top-down approach to dealing with complexity and uncertainty in the sustainable change of campus infrastructures.

The primary motivation for this planned €1.18bn investment corresponded to what Hajrasouliha (2017) has categorised as turning a “deficient” campus into a “complete” campus. The rhetoric of deficiency and incompleteness focused on the university being spread around the city, instead of being co-located. Today, in the main campus close to the city centre, ca. 28,000 students and employees from the natural sciences are housed, while another campus is located close to the city’s boundaries with ca. 11,000 students and employees from the social sciences and humanities.

Solutions to this “deficiency”, which is manifested in the distances between the campus locations (see Figure 1), were discussed for a long time before planning started in 2015 and construction was planned to be completed in 2028. The aim is that the university’s activity should in the future be concentrated in and around one central main campus, which was planned to be achieved by building new and the deep rehabilitation of existing buildings comprising altogether 137,000 m².



Figure 1. Map of the “deficient” campus. Source: Gohari et al. (2019: 10; Creative Commons BY)

The goals and motivations of the project were described in 2016 in a quality program produced under the direction of the dean of the university’s architectural faculty (NTNU, 2016a), in which “bringing together” not only city and university but also students and researchers across disciplines featured prominently. Thus, the “incompleteness” of the campus was on the rhetorical level defined as being in a state of division, and spatial closeness in “a network of hubs” (NTNU, 2016a), which are connected in walkable distance, was proposed as state of completeness.

The quality program for the new campus (NTNU, 2016a) also gave high priority to sustainability, which was defined by reduced energy use and CO₂ emissions and green transport. The campus was included as a pilot area in a large-scale FME ZEN, which has as its goal to “create solutions for the zero emission buildings and neighbourhoods of the future³.” If this would succeed, the total climate emissions connected to the infrastructures of science and teaching would have been reduced to zero at the end of the campus’ estimated life-

time. This would include the operation of the facilities, and by a surplus of renewable energy production it would even balance out the emissions caused by the construction of the campus and production of building materials. In theory, this option would be robust to the uncertainties and complexities of campus planning because no matter what kind of research and teaching would happen on campus, it could rely on the infrastructures achieving zero emission in the end.

In line with the Scandinavian tradition of workplace democracy, university employees were extensively consulted during the development of the campus project, also involving two of the authors of this article, both through established channels of employee representation and in specifically created fora (NTNU, 2016b). However, these fora, working groups and workshops had a backdrop of most employees rejecting the premise that existing campuses in Trondheim had a need to be “completed.” Employees working at the campus which were to be moved, had experienced that the expected campus project meant that important investments in the extension and maintenance of buildings they currently were using were postponed for many years. They feared losing their individual offices and being relocated to a more open, activity-based work environment (Pennanen, 2004), which were proposed in line with the goal of “bringing together” and achieving area efficiency. Indeed, illustrations of the new buildings featured prominently what Austin and Sharr

1. have called “work-study lounges for the non-stop society”, i.e. spaces that do not resemble a traditional campus with offices and auditoria.

But the project did not only encounter bottom-up resistance. In 2022, the then-new Norwegian minister for research and higher education, Ola Borten Moe, instigated that using taxpayers’ money for university research and higher education had become economically unsustainable. He announced dramatic cuts in the funding of Norway’s National Research Council, fired its board and proposed the dramatic downscaling of the NTNU’s campus project. Norway is comfortably shielded against economic crises through its export of oil and natural gas, whose profits regularly increase in times of global turmoil. These profits add to continually growing funding to the Norwegian Government’s annual budget directly through public ownership and indirectly through tax income and licences. Thus, Borten Moe’s announcement was received as a shift in political priorities rather than as a reaction to economic difficulties.

Owing to the funding being cut from €1.18bn to €630m, a renewed discussion of the whole project flared up. Employee representatives distributed a Web-based questionnaire among unionised employees in which 59% (N = 1,583) described themselves as agreeing with the statement that the campus project should not proceed, whereas only 10% described the plans as good enough. The planners at the university, however, argued that reduced funding would be better than no funding and claimed that the move from one campus to the other would still be feasible. Grudgingly, they admitted that to reach this goal, the environmental “zero-emission” ambition would have to be abandoned completely.

Summarising the process so far, top-down planning has indeed managed to create a strong and unified vision for a sustainable campus, but it has not managed to convince employees, nor has it mobilised the funding necessary to realise the original vision. In the context of this article, and for the case presented here, top-down planning for increased sustainability is disqualified completely. It demonstrates the uncertainties of campus planning particularly clearly, which makes long-term, strategic top-down planning difficult.

Case 2: a bottom-up and middle-out alternative through circular strategies

As concerns for the immediate work situation dominated employees’ resistance against the campus project, it is not surprising that their option to “build no net additional square feet” did not focus on the question of the environmental sustainability of the continued use of old buildings that have outdated technical solutions.

To reduce existing buildings’ environmental footprint, there are three non-exclusive approaches. The first is retrofitting. The deeper a retrofit is performed the more it can improve energy performance; however, the more it also resembles the construction of a new building in terms of new CO₂ emissions. Moreover, it poses

at least two fundamental challenges: First, HEI buildings are often historical in which case they enforce trade-offs between heritage conservation and deep energy retrofits (Ide *et al.*, 2022). Additionally, retrofits interrupt daily operation, which presents a second trade-off between the depth of interruptions and how long the retrofit is spread over time. HEIs, through which generations of learners are constantly flowing, cannot afford to close for a period. Still, simultaneously, a constant series of more minor interruptions over time amounts to a reduction in HEI performance.

The second approach is improvement through minor but continuous adjustments, both in terms of organisation and behaviour and the building, that over time can amount to a more radical change in sustainability performance, as demonstrated in the case of residential buildings by Fawcett (2014). The main drawback of this approach, which avoids the trade-offs of deep energy retrofits, is time: even if incremental change over time may amount to considerable changes, the question arises whether this option is an adequate response to the urgency of environmental challenges.

A radical change towards circularity presents a third approach, which promises to lead to radical changes quickly while still being in line with the employees' preference for "not building additional net square feet". After an explosion of the use of the term circularity in policy and research which has occurred in the early 2000s, what exactly circularity entails is unclear and also contested. Kirchherr *et al.* (2017) identified more than 100 definitions (adding their own in the process) and claims of considerable sustainability potentials do not always stand up to closer scrutiny (Corvellec *et al.*, 2021). Despite this, circular-economic strategies have been widely adopted by the European Union, national and regional governments. According to its proponents, resource loops should be narrowed, closed and slowed (Bocken *et al.*, 2015), which, if combined, would deliver massive environmental benefits.

Campus operation includes many resource streams, such as equipment, furniture or food, which can be subjected to a circular reorganisation and reconfiguration. Narrowing these flows would amount to increasing resource efficiency, for example by producing furniture using less energy and materials. The closing of resource loops adds to this recycling, which reduces resource use in the production further. Slowing, finally, points to strategies which seek to eliminate the need for new things altogether by focusing on extending existing life times through robust designs and repair.

Existing studies of circular campus operation have stressed the barriers which are related to complexity both internally and related to the integration of campuses in larger infrastructures and the organisational issues at stake and the lack of clear and unified requirements (Hopff *et al.*, 2019). According to Mendoza *et al.* (2019), implementation of circular-economic strategies in the HEI sector is still in its infancy despite a well-established general understanding of the in relation to campus waste management. Moreover, campuses are slow to adapt newer developments in circular thinking, such as the shift in attention away from waste management and value chains and the incorporation of regenerative goals (Bucci Ancapi *et al.*, 2022).

Exploring alternatives on campus

Tracing existing sustainability initiatives on campus – which belongs into the category of middle-out or bottom-up transformation – in autumn 2021, the authors encountered a small group within the Property Division, the university's facilities management team, which had for years strategically worked towards reducing waste. Particularly, one long-term employee detailed to us the logistical pains she went through to reduce the replacement rate for furniture. This happened directly making sure that furniture would be moved along with the people when one of the frequent relocations of departments happened. But it also involved systemic changes that would make this task easier, such as standardising furniture sizes, reducing the use of tailor-made furniture and extending the lifetime of furniture by preferring robust materials and colours. This happened in collaboration with colleagues tasked with transport on campus and a colleague who established a Web-based second-hand market on the university's intranet where furniture was offered for free. Another initiative that we learned about was the procurement of a large composting facility, which enabled Campus Ser-

vice to recycle food waste from the university's cafeterias and produced compost used at the campus' parks and green areas. Despite these initiatives, we were told that not all employees in the Property Division share the same enthusiasm for re-use and recycling. When tasked with removing an outdated piece of equipment, janitors out in the field often choose the easier option: throw it away instead of finding out if there might be another use for it. Another practical barrier mentioned was the cost of storage facilities. NTNU uses a model for all its units in which the use of area relates to cost for the unit, which is supposed to make area use more efficient. As storing equipment while searching for new uses can take up much space, this can become costly over time. The number of storage facilities on the university campus is limited.

The facilities managers told us their efforts were only as effective as the procurement of furniture allowed them to be. If new furniture is procured at the same rate, reuse is restricted. This led us to the university's procurement officers, who explained in detail the barriers against reuse of equipment that are embedded in regulations, contracts, the procurement regime and the employees' demands. For example, it was impossible for the university to sell their used furniture because as a publicly funded entity this is in principle banned by law. Moreover, procurement happens through large-scale contracts that bind the university to one supplier who is chosen by cost-competitiveness as a major factor. Furthermore, the market does not offer service agreements for furniture, which would for example include repair, which are common for other goods. And finally, while the individuals working at the procurement office supported reuse and recycling, they had to procure what was ordered by their users, i.e. departments and faculties, and they had no way of interfering with these orders, no matter how wasteful they might appear.

Despite anecdotal evidence for staunch support of reuse and recycling in conversations with colleagues, the procurement officers' statements pointed towards the end-users' collusion in the wasteful treatment of equipment. To shed light on this, a short, exploratory survey was conducted on campus which resulted in responses of a total of 84 students and 16 employees ($n = 100$), who were asked for attitudes towards and knowledge about reuse and recycling on campus. The questions sought to elicit reflections, knowledge and attitudes about reuse and recycling on campus. What became clear on one side was that there was overwhelming support and desire for more reuse of furniture and electronic equipment. On the other, there were concerns about the lack of communication about the university's reuse practices and that not taking steps towards an increase of these would, over time, damage the university's reputation and fail to reach the Sustainable Development Goals. Among the scientific personnel, there were utterances that there is a lot of research on sustainability, but that this knowledge is not sufficiently embodied in sustainable practices on the campuses. One student even proposed dire consequences ("Armageddon") would result if the university did not change its practices.

In sum, we found a considerable interest in reuse and recycling among employees, students, facilities managers and procurement officers. However, the professionals struggled with a lack of support and structural barriers, and end-users lacked knowledge about how to show their support in practical ways.

Based on these findings, we developed the first ideas for an experimental intervention together with the local facilities management team with the goal of increasing knowledge among the end-users and to increase support for more reuse and recycling on campus. These ideas were discussed and developed further in a workshop with representatives from the campus project, the facilities management, students and interested individuals.

A circular campus intervention

The resulting re-use intervention was conducted in March 2022 over three days, when the authors, supported by the university's facilities management team, opened stands of approximately 30 m² in central spaces in two buildings on the university's main campus. Furniture, electronics and other equipment were given away to students and employees. The stands were decorated with posters containing information about reuse and recycling at the university. In exchange for the object, a short questionnaire about the intended use of the object was collected, and our "customers" were involved in conversations.

As expected, based on the findings from the exploratory survey, the response was overwhelmingly positive. Over the three days, 179 items found new owners. While some people scouted for specific objects, others saw it as a treasure hunt, motivated by the possibility of finding something useful or a pre-established interest in certain kinds of objects. Regardless of the motivation for visiting the reuse stations, common feedback to the initiative was that the reuse zones were important and appreciated. The insight from the interviews were confirmed when both students and employees pointed to the significance of NTNU being a trailblazer for practices of reuse. Several shared stories about how they had witnessed perfectly usable furniture being thrown away and considered the practice damaging to NTNU's reputation.

Although people were happy about getting things for free, more importantly, they were grateful for the opportunity to contribute to a more sustainable campus. It was obvious that collecting an item made people feel good. Reuse was not just about filling a need for specific items but also an act of care, for both things and the environment. Thus, the reuse zones represented a tangible and accessible measure for increasing sustainability, challenging assumptions about new being an improvement.

While giving things away might seem easy and effortless, the organisation and implementation of the reuse stations demonstrated how reuse demands both labour and logistical planning.

Discussion

In this article, we have presented the tragic fate of a top-down approach at increasing HEI infrastructure sustainability dramatically and rapidly. Its lessons are first and foremost valid for the case of Norway, an affluent, Nordic country. A *direct* comparison with other campus projects in different national or regional settings is impossible because of the massive complexity of such a process, which involves not only national policies and regulatory frameworks and a large number of institutions, such as the HEI itself and its different organisational units, but also municipal planning authorities and private companies. Despite this complexity, on a higher level of abstraction, lessons can be derived, which should be relevant for a broad variety of settings.

In relation to *RQ1*, which was about conditions for, and advantages and disadvantages of top-down approaches, the central lesson which can be derived from this case is that even carefully planned and well-established efforts of ambitious top-down transformation are vulnerable to politics. The campus project might have survived employee resistance by seeking compromises in relation to office size and by pointing to the advantages among which the zero-emission ambition would have been a relevant argument. The large-scale, long-term investment, however, which is necessary to realise such a project, turned out to be its weakest point. While the dramatic reduction in funding came as a surprise, the dependence on national, political priorities is a well-known factor in campus planning as the literature on the history and the uncertainties of campus planning reviewed above (Lidsky, 2002; Sá, 2008; Fernandez and Powers, 2021) has shown. The original level of ambition – both in terms of sustainability and in size and quality of the planned facilities – was unique to Norway, which enjoys comfortable budgetary conditions owing to public ownership of oil and natural gas resources. Despite – or rather because of – this uniqueness, the case demonstrates particularly clearly the specific vulnerability of approaches to top-down sustainability transformation. The campus project survived by eliminating the zero-emission goal, which delegates future sustainability improvements to incremental changes of existing buildings.

The mapping and exploration of middle-out and bottom-up alternatives to top-down sustainable transformation on campus led us to circular initiatives led by the facilities management team. We found that their approach has indeed engendered a high degree of positive response among all students and employees. Particularly powerful was the support for reuse: That perfectly useable furniture was being declared waste was evoked by many participants in our activities and described as a “scandal.” However, as we have seen, the path from a desire to avoid waste to the implementation of wide-spread reuse and recycling on campus meets regulatory and economic barriers: Norwegian laws pertaining to publicly funded entities restrict what these entities can do, and most importantly they prevent the university from participating in a wider market for equip-

ment that is not used any longer. As these rules are unlikely to change any time soon, this means that reuse and recycling must be restricted to the university, its units, employees and students. Other rules and regulations that prevent reuse and recycling, however, can be changed by the university. For instance, a stronger push towards long lifetimes, which in medium and long term reduce procurement budgets, should be possible. As we have learned, the market for furniture has only recently started to offer service-agreements, yet, if a large customer like the university demands it, it is possible that such agreements will appear for example as part product-service systems (Öhgren *et al.*, 2019). Moreover, the use of space for the storing of used furniture, which acts as a buffer before reuse, would have to be exempted from the university's system in which internal units pay rent for the space they use. This would turn the system into a tool for increasing campus sustainability. The establishment of temporary storage zones could be made easier and cost-free.

Storing equipment until it has found new uses would presuppose tight coordination and an efficient system of campus wide coordination to avoid it growing beyond reasonable limits. This includes transport availability and motivation among facility managers across the university campuses. These organisational barriers described by the facilities managers can be addressed by establishing systems that support the allocation of used equipment to users that need it. In our case, parts of such a system were already in place (i.e. Web-based second-hand store), designed, implemented and operated by particularly engaged individuals. However, their reach was limited. They were a small team of six motivated individuals. Additional resources in the form of more workforce for facilities management to extend these systems and to operate them would address this challenge. The procurement officers that were part of the exploration of top-down and middle-out initiatives presented above pointed towards the end-users as drivers of demand for rapid replacement of existing equipment and furniture. This observation of unabated hunger for new things is in seeming contradiction to the overwhelming support for re-use which was encountered throughout the study and the broad support for sustainability among HEI employees documented elsewhere (e.g. Blanchard *et al.*, 2022). We can only speculate about reasons for this gap. One candidate for an explanation could be that there is still a common equation of “new” with “better”, which informs decisions made when departments and faculties procure equipment for their employees and students. While this may have a practical aspect in the case of computer equipment with its inbuilt obsolescence, furniture and other infrastructures still seem to be evaluated according to the symbolic value of newness as part of a larger narrative of progress.

Summing up in relation to the second research question which was about the feasibility, advantages and disadvantages of circular approaches to sustainable transformation, we see strong, widespread support but also many structural barriers related to laws, regulations, organisation. While some of these could be overcome by organisational change, others are outside the HEI's reach and arguably also rooted in more fundamental ideas of progress.

Comparing both cases (see Table 1), considering the discussion of uncertainty in sustainable campus planning, it should first be stated that both approaches are not mutually exclusive. In principle, reuse and recycling are possible, no matter whether they are implemented in a zero-emission campus which is planned and implemented in a top-down manner or not. Quite the opposite, as we have seen, the result of the campus project was that future improvements will be incremental and be conducted through middle-out and bottom-up approaches.

Table 1. Comparison of the two approaches to sustainable campus planning

Approach to sustainable campus planning	Conditions	Advantages	Disadvantages
Top-down approach (zero emission campus)	Depends on strong national political support	Able to formulate unified, consistent, and ambitious goals for sustainable change	Vulnerable to uncertainties of campus planning
Middle-out and bottom-up approach (slowing, closing and narrowing resource loops)	Depends on strong support from employees, students and facilities management teams	Does only require modest additional investments Is flexible regarding the implementation of the individual measures	Meets legal and regulatory barriers Depends on the motivation and active engagement of individuals

Source: Authors' own creation

Conclusion

In the discussion, a detailed overview of the barriers is given, which must be overcome to accelerate incremental changes and presented proposals of how to do so. These changes do not depend on large-scale investments, and – according to the case studies – they can rely on widespread positive attitudes towards reuse and recycling. They are, however, not sufficient on their own. For example, computer equipment as a driver of environmental harm in university work would need different approaches, as would other aspects of research and teaching infrastructures that present strong reasons for discarding “outdated” equipment and replacing it with new.

In addition to these accounts of limitations and practical recommendations for how to implement an ambitious circular organisational changes, the discussion of findings considering the uncertainties of campus planning also allows to ask more fundamental questions about the future of infrastructure planning for HEIs. The case of the campus project shows that the uncertainty of the future of higher education indeed exposes large and comprehensive investments to vulnerabilities related to shifting political support. But preservation of the status-quo or slow, incremental change is obviously not preparing HEIs for an ever-expanding portfolio of expectations and clients, which we found in the literature on the uncertainties riddling campus development (Lidsky, 2002; Sá 2008; Fernandez and Powers, 2021). Constant and rapid renewal of HEI equipment and facilities in reaction to ever-shifting demands and opportunities, in this sense, can be seen as rational strategy to deal with uncertainty, while profoundly counteracting a transformation towards more circular resource use. Considering this unintended consequence of flexible adaptation, much more research on and experimentation with options for sustainable transformations of campus infrastructures that account for uncertainty is needed. The option to “build no net additional square feet” (Haggans, 2016) is not automatically increasing sustainability, neither does it solve the various challenges facing HEIs in the present and future. What is needed instead is knowledge-based, responsible stewardship of existing facilities.

A campus is a microcosm, which provides a testing and learning arena for larger, urban transformations (Finlay and Massey, 2012). In this sense, the observations presented here have relevance beyond the case of HEI infrastructures. Cities worldwide invest in large-scale efforts to establish zero emission neighbourhoods and positive energy districts (Brozovsky *et al.*, 2021). The focus on infrastructure development chosen in this article enables an application of findings beyond the case of HEI campuses, which should be pursued in further research.

Notes

1. <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator> ↵
2. <https://www.ntnu.edu/campusdevelopment/about-campus-development> ↵
3. <https://fmezen.no/about-us> ↵

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Further reading

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