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Institutional context, innovations, and energy transitions: Exploring solar photovoltaics with hydrogen storage at a secondary school in Norway

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Abstract

Public administrative action is crucial in facilitating sustainability transitions. Although organizational structures, cultures and established practices have been shown to lead to differing innovation results and technological diffusion at various levels of governance, little attention has been paid to the role of local government and administration in sustainable energy transitions. This study analyses renewable energy innovation at the local level of public administration in Norway. Drawing on the institutional and entrepreneurial literature, we examine the key formal decisions and organizational culture development that, combined with policy entrepreneurship, ultimately led to an unlikely and risky decision: to include a costly and unusual local energy system in the construction of a new secondary school. Tracing the administrative processes over 20 years, and drawing on document data supported by 14 interviews, we find that the strong and politically shielded administrative section, backed by a firm mandate and an established internal culture of innovation anchored in historic and local identity among the population and local industry, led to this decision. These factors were further facilitated by acts of policy entrepreneurship at crucial moments, shaping the underlying structures and institutional culture. The independence and strong direction of the administrative section can be emulated in other contexts in order to facilitate innovation. With suitable adaptations to other contexts, our findings may help to accelerate energy transitions through system innovations elsewhere.

Key Words: Energy transition; Public innovation; Local government; Institutional theory; institutional entrepreneurship

1. Introduction

Local governments have a key role to play in mitigating climate-gas emissions [1,2]. They are usually the main decision-makers in land-use and transport planning, and are central in facilitating local business developments. In Norway, municipalities *(kommuner)* own and run significant infrastructures and buildings, and often enjoy discretionary powers to plan and implement policies beyond mandatory tasks, including climate-mitigation engagement [3–5]. This opens opportunities for various climate-change measures, including energy savings and investments in renewable-energy technologies [6,7].

Public action has a crucial role to play in energy transitions [8,9], but how this is best facilitated and the roles of different levels of governance have been less in focus. We do know that public organizational structures, cultures and established practices lead to different results for innovation, renewable solutions, and technological diffusion at different levels of governance [10–12]. Another crucial factor is the presence of institutional entrepreneurs who can adapt to and/or challenge formal rules, offering new interpretations that facilitate new policies and decisions [7,13]. However, within energy transitions, research is sparse on the role of local government [7,14–17].

We need to know more of how this level of governance influences the ability to push change transitions, as generators of 'local practices' or as intermediaries [18–23]. A further research gap concerns how certain conditions, like organisational structure, shielding, or linkages to local and organisational culture, may enable technological and institutional entrepreneurship [24–26]. Facilitating such conditions can lead to innovative technical solutions that drive change. A stronger focus on the role of local municipalities can promote a better understanding of how this level of government can contribute to entrepreneurship, innovation, and boost transition.

Our study addresses this research gap by focusing on a Norwegian municipality and the decisionmaking process that led to innovative energy investments in a new secondary school, to see what motivates and hinders such investment processes. *How do decision-making processes in local government shape energy transition results?*

We examine the process that culminated in the municipal decision to construct a public building with pioneering energy solutions that included PV solutions and a novel hydrogen storage system. This was both costly and risky. Tracing the decisionmaking process, we investigate the main drivers and barriers involved, and how this can offer lessons for institutional and entrepreneurial processes that facilitate energy transition.

For maximal analytical leverage, we use a case of an apparently unlikely public energy system decision involving the 'interlinked mix of technologies, infrastructures, organizations, markets, regulations and user practices that together deliver societal functions' [27]. The Vestsiden Secondary School in Kongsberg municipality in South-Eastern Norway opened in August 2019. The project was highly innovative regarding the choice of materials, energy solutions and planning design, and more specifically involved several 'unnecessary', expensive design elements, including rooftop solar panels combined with grid connection, chemical batteries, water reservoir temperature storage, ground heating, and metal hydride hydrogen-based energy storage.[1] The hydrogen unit is to be used for storing energy between seasons, and is a highly unusual solution in buildings – and particularly public

[1] The system includes 300kWp of solar panels, 50 kWh chemical battery and 5600 kWh metal hydride hydrogen-based energy storage.

buildings. The construction itself is a 'plus-building' in solid wood that uses less energy than it produces.

The project is 'unlikely' as it involved unusual technical solutions, uncommon decisions, and called for significant capacity and knowledge in terms of financial and human resources. From an organizational perspective, it would have been logical to reduce risks by progressing iteratively over time, with several public buildings using proven solutions in the region, instead of embarking on a large, complex, high-risk project.

To study the decision process involved, we map initial conditions within Kongsberg municipality, using process-tracing to examine the decisions, actors, arenas considering how they play out over time, and processes that eventually led to finalization of the school and the energy solutions that were chosen. We take our point of departure in rational choice and sociological institutional theory, in combination with entrepreneurship perspectives. While seeking to contribute to the academic literature, we also aim to identify practical and policy relevant lessons for other municipalities and actors.

We develop and present the theory framework, before turning to methodology choices in Section 3. Section 4 maps the conditions for the municipal organization, process-tracing the development of decisions regarding the school. Section 5 explores the main explanations for the municipal decisions, and their implications for theory. We conclude by linking our findings to energy transitions and institutional theory.

2. Analytical framework

Analyses of behaviour in public administration often highlight general formal factors like resources, information access, and formal steering documents – or take a more cultural approach [28]. These two perspectives – rational-choice and sociological institutionalism – can help to shed light on how formal rules and informal practices in an organization interact, affecting who is heard and who is not, as well as how internal culture serves to undermine or strengthen the signals from formal rules. We combine this with perspectives from theories of entrepreneurship to explore how entrepreneurial action interacted with institutional factors in the process of planning and implementing this ambitious project. The linkages between structural forces and those originating in agentic processes for the shaping of regional development paths have been held to be fruitful for such analyses, as entrepreneurship can be seen as facilitated by institutionalism and place-based leadership [29]. In the context of local governments as drivers for societal transformation, the links between institutionalisation and entrepreneurship has been a focus in explaining success [30]. Hence, linking as we do perspectives from theories of entrepreneurship and theories of institutionalism are founded in both earlier theoretical and empirical work on change processes.

2.1. Rational-choice institutionalism

A key assumption in *rational-choice institutionalism* is that formal organizational structures influence actions. This makes such structures instruments for steering and directing behaviour that can be determined through design [31]. Action is driven by a logic of consequence, so altering formal structures influences behaviour. Boundedly rational organizational agents, who satisfy goals and yield limited information, will act on the basis of formal rules, creating incentives for desired behaviour, and sanctions against undesirable behaviour. Organizations will seek to maximize the interests related to their mandate. The formal rules can be changed according to the goals desired, modifying or channelling rationality limitations to satisfy different organizational goals [32,33].

There are many examples from the literature on how formal structures may influence municipalities in their work with climate and energy issues. Through her investigation of three Canadian municipalities, Burch [34] identified what she termed powerful levers for climate action at the local level. She underlined that climate action needed to move beyond being dependent on personalities (as engaged individuals) and political initiatives, and towards institutionalisation of the policy area in the form of for instance standard operating procedures, job descriptions and specific criteria for evaluating sustainability, all part of what can be characterized as rational- choice institutionalism.

By changing the rules or structures, the formal structure can over time affect and channel attitudes and actions as well as which parts of the organizations have influence and access to the process, in turn leading to different results. Such formal changes can potentially layer successively over time, to increase the room for manoeuvre and directionality of an organisation's decisional space. This can be anchored in key decisions or policies, and thus produce gradually stronger impact, or happen incrementally [35].

Viewed in this perspective, a broad mandate, secure financing, and ample room for manoeuvre for the key organisational units, though few formal restrictions on the ability to define own projects, would lead to more new buildings with greater room for innovative energy solutions. Given successive developments in this direction over time, one should expect this effect to increase in strength. Conversely, a formal distribution of responsibility that included a strictly limited mandate, along with uncertain financing and many checks on the organization, would entail less likelihood of developing new and innovative solutions.

2.2. Sociological institutionalism

By contrast, the *institutional-cultural perspective* views organizational actors as constrained by traditions, informal norms, values and routines. 'Institutionalization' is here understood as the process whereby organizations or organizational fields gradually become infused with values beyond the technical requirements of a given task [36]. Such values and norms provide stability but may lead to organizational inertia [37] – particularly if they conflict with formal structures. Behaviour is based on perceptions of 'appropriateness' as defined by shared tacit assumptions – norms, values, beliefs – that underlie administrative behaviour [38,39]. Individuals and organizations fulfil or enact identities by following those informal rules and procedures that they consider appropriate to the situation at hand, matching roles and situations through such informal 'rules'. Such rules tend to evolve over time and are not designed like formal decisions.

Rizzi et al [11] draw our attention to informal dimensions such as values, beliefs and cultural factors for understanding energy efficiency performance of municipalities. Their results demonstrate the importance of accounting for these informal factors in addition to the formal dimensions of an organization. Further, place-based leadership as a factor enabling entrepreneurship, [29], point towards how informal factors rooted in social relations and commitment to place may drive change. A clear example of the latter is the significance of linking local climate policies to local identity and place-based contexts for increasing the transformative potential of local climate policies [40].

According to this perspective, an internal logic that favours an identity of innovative technological solutions and building projects, anchored in a basically insulated working environment, would encourage independent thinking and room for new technological solutions [11]. Conversely, an institutional culture that favours other factors like budget maximising, traditional constructions and following established routines is less likely to create projects that include costly, untried technological solutions. As organisational culture typically *evolves* over time, key here is investigating such developments over sufficient timespan.

2.3. Policy entrepreneurship

Political and organizational entrepreneurs invest effort in identifying and advancing particular policy solutions [41]. In some sense they resemble the Schumpeterian entrepreneur in that they 'keep searching for new opportunities' [42], but are today seen to reach far beyond economic motivations and scope. They are '[p]ersistent and skilled actors who launch original ideas, create new alliances, work efficiently or otherwise seek to "punch above their weight"', aiming to achieve greater results than their position or material resources indicate [43]. This happens through the use of strategic and discursive skills, where cooperation is facilitated, institutional solutions are developed and institutions are maintained, and particularly by translating policy problem definitions and creatively matching them to solutions, creating new kinds of meaning in their institutional environment [25,44]. This includes matching creative use of frames or narratives to other actors' 'identity, belief, and interests, while […] using those same stories to frame action against various opponents' [44]. Aasen et al. [7] have shown the importance of this for municipality energy-use entrepreneurs, where involving individuals committed to promoting and implementing energy savings in municipal buildings can make a significant difference. They hold the technical and economic competence to evaluate the potential of various energy-saving measures, as well as the organizational competence to navigate and influence decision-making processes and channels.

Following Capano and Galanti, we are primarily interested in *acts of entrepreneurship*, not the characteristics of the individuals themselves [45]. Different entrepreneurial actions can be fulfilled by different actors during different phases [46]. Even though this does not remove the focus from individual *acts*, although several individuals may be involved in entrepreneurship, it emphasizes the interaction between formal steering structure, institutional culture, and likelihood of successful entrepreneurial actions. This includes what Chatman [47] and later Rizzi et al. [11] refer to as the 'fit' between the person (or acts) and the institutionalized organization as paramount for performance within organizations, including the willingness of employees to undertake extra-role behaviour.

While individuals will remain the entrepreneurial unit of interest, Hjern and Porter [48] and Kasa et al [4] show that how the implementation of policies can be facilitated by co-operation between several individuals, and that coalitions of committed individuals in municipal organizations influence the level of engagement by municipalities for climate mitigation initiatives. Collective interplay between several entrepreneurs may occur but is here regarded as ad-hoc and individual initiatives, and remains a distinct feature from the collective culture represented by the sociological institutionalism presented above. These entrepreneurs still shed light on links between "individuals and organizations, and institutions" [29].

Thus, we view acts of entrepreneurship as an important and sometimes necessary condition for inducing change, often as a trigger. Such acts may be undertaken by different individuals at different times in the policy process, and will be evident through skilful navigation of specific influences where policy-problem definitions are translated and matched to solutions in novel ways, relating to formal rules and organizational culture, and where the result is changed in ways not otherwise likely without these actions. These interlinkages and the analytical framework is illustrated in Figure 1.

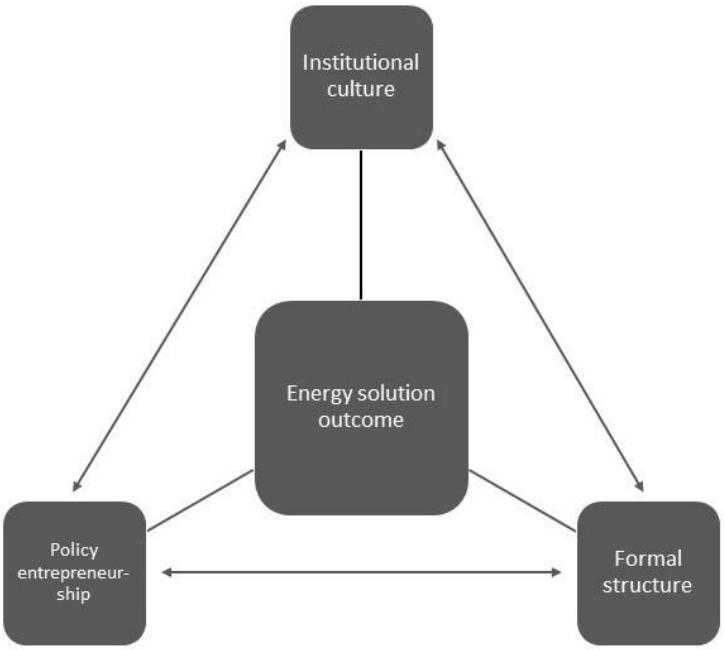

Figure 1: Illustration of analytical framework

3. Methodological approach

Our case-study concerns an innovative and unusual municipal decision to construct a school building intended to reduce emissions and energy use in the public building sector. We chose it primarily because of the high explanatory potential indicated by the technical innovativeness in the result, as well as its organizational setting with a shielded organizational unit that opens up possibilities for theory-building.

Process tracing is a powerful approach for tracing (and then understanding or explaining) a decision-process leading to a known result [49]. Here we apply it to explain the outcome and understand the barriers involved, and how these were overcome, considering how they play out over time. Process tracing can also be used to establish lessons generalizable to other, similar case categories [49,50]. We have process-traced the decisions backwards in time from the opening of the school in 2019, using empirical data sources from relevant regional and local public documents and interviews. Identification of these documents was done independently by the researchers, but also guided by interview information. Examples of relevant documents include Kongsberg municipal master plan, strategy documents, municipal budgets, local media sources and political party programmes.

Our 14 interviewees were an important source of information. They were recruited through two main strategies. First, we started with key individuals in and around the municipal property enterprise Kongsberg Municipal Property (KKE)[2], and used a snowball approach. Through information from the initial interviews onwards, we identified relevant individuals. In parallel and to compensate for potential information bias, we used common sense in combination with publicly available information for identification of relevant persons, beyond the KKE representatives. While there were few discrepancies between the individuals listed in the two approaches,[3] we felt that ensuring an

[2] Kongsberg Municipal Property (KKE) is a municipal enterprise established to maintain municipal buildings like schools, retirement homes and town halls. KKE is also responsible for new municipal building projects.
[3] We identified two individuals through the independent strategic approach compared to snowballing.

independent list was important. to minimize any selection bias. We interviewed representatives from KKE, Kongsberg municipality political representatives and officials, employees of relevance from different departments with potentially conflicting interests and perspectives, as well as sub-contractors and national public officials (e.g. the Norwegian Directorate for Civil Protection, instrumental in approving the hydrogen storage plans). See interview list in Appendix, Table 1.

All interviews were semi-structured, in order to enable our respondents to take the initiative to share information that they considered relevant. Because of the Covid-19 pandemic, we conducted all interviews through electronic meeting platforms, using the same interview guide. This guide included questions on the interviewee's background and role, as well as involvement with decisions of relevance (depending on that person's position), and on the major general and specific factors that enabled or hindered the school project. We also asked about internal organization in the municipality and KKE, including possible trade-offs and benefits. All interviewees were asked to identify the central points along a timeline, starting at a point of their discretion.

In all interviews, three researchers were present, each with specific roles: to lead the interview, take detailed notes, or fill in on topics not covered. This ensured that important details were not missed and that all topics of relevance were covered. All interviews were recorded. Interview data were structured according to the timeline for the decision-making and construction processes, and sorted according to categories of 'formal decisions', 'organizational culture', and 'acts of entrepreneurship'. All quotes were checked with informants to ensure accuracy.

4. Empirical mapping

4.1. Municipalities in Norway

Municipalities are the primary unit of local government and administration in Norway. Together with the counties *(fylker)* they constitute the two levels of sub-national government. As of 2020 there were 356 municipalities and 11 counties in Norway [51]. Municipalities are highly diverse, ranging in size from under 200 residents (Utsira on the West Coast) to nearly 700 000 (the capital Oslo). Municipalities, governed by councils elected every four years, provide major community welfare and educational services. They are responsible for technical infrastructure and for community developments through land-use planning, and also enjoy discretionary powers allowing them to plan and implement policies beyond their mandated tasks. Climate and energy policies are areas with such flexibility. Attention to climate mitigation is mandatory, but the municipalities themselves determine the level of engagement and the focus areas [3,5].

The municipality of Kongsberg has nearly 28 000 residents [52]. It is located in southeastern Norway, 80 km southwest of Oslo. Kongsberg is an old silver-mining town. Although this industry closed in the 1950s, the engineering legacy and town identity live on, with the town hosting Norway's major technology and defence contractor – Kongsberg Gruppen [53] – along with many other technology industries, including petroleum extraction subcontracting, aviation and automobile parts production, and shipment positioning systems. Kongsberg's business structure is reflected in the official vision as stated in the municipal master plan: *Technology town Kongsberg – growth through knowledge and culture* [54]. The municipality has incurred significant debt over time, and the establishment of KKE (below) was partly done to get this under control. The municipality was termed 'economically vulnerable' by the head of administration in 2019, referring to the debt of over €200 mill [55]. This is roughly on par with the national average for municipalities, as share of income [56].

4.2. Kongsberg municipality: climate and energy planning

Kongsberg's first climate and energy plan dates to 2008. It had a strong focus on stationary energy use through technological improvements, greater use of renewables, and energy savings in municipal buildings. The plan made it compulsory to investigate the opportunities for use of renewable energy in all new building projects [57].

Climate ambitions feature in the current municipal plan. The aim stated by the municipal council in 2018 was to reduce climate emissions in Kongsberg by 50% within 2019 as compared to 1990 [54]. In 2015 it was decided to incorporate climate accounts in the municipality's budgetary process, partly a result of the efforts of the Green Party.

Climate is one of four distinct focus areas in the municipal plan. The earlier focus on technology and measures to reduce stationary energy use from Kongsberg's first climate and energy plan is still apparent, as in the stated goal to 'increase the use of energy-efficient building technology, from climate-neutral energy sources, and the use of wood as building material'. Further, 'Kongsberg will use new technology from an early stage, […] to create new opportunities within services, town, and commercial development' [54].

The first climate accounts were prepared by the consultancy company Asplan Viak in 2018 [58] in close collaboration with KKE and Kongsberg municipality. These accounts focused on direct and indirect climate emissions from the municipality's own activities. Emissions peaked in 2016, and have been slightly reduced since. Further, total energy use in municipal operations has decreased by nearly 40% because of reduced use of electricity and oil for heating [58].

4.3. Developing KKE's organizational structure and opportunity space over time

Kongsberg Municipal Property (KKE) was established in 2001, in line with a public enterprise model for municipal property management. Core activities concerning building construction and management are generally outsourced to the public company, which performs its core activities at arm's length from political day-to-day influences. KKE is in effect a real-estate company with devolved competencies and distinct mandates, but is owned by Kongsberg municipality. KKE's main responsibilities are to maintain municipal properties, as well as constructing new buildings. KKE derives its mandate and tasks from the municipal council, but enjoys considerable autonomy in the day-to-day conduct of its operations and finances.

In 2007, two mechanisms were adopted which our interviewees described as central to the current functioning of KKE, particularly its relative autonomy and long-term operating perspective. The first is an internal building-rent scheme [59] , where the municipality pays annual rent to KKE for the use of their buildings, the cost of which incorporates loans taken up for the original construction of the building as well as total maintenance costs. The second mechanism is a capital fund [60], where profits from sales of municipal properties are accumulated in a fund administered by KKE for use in future building projects, rather than being channelled back into the overall municipal budget. Implementation of these decisions took time [61], but the mechanisms fundamentally enabled KKE to channel funds from property sales to their own fund. This point was mentioned by several interviewees, as previously there was always the risk that the funds from a sale would be channelled to completely different areas of the municipal budget – not least because the municipal council is an elected political body. Given the various considerations, constituencies and party programmes that could influence decisions, and local elections every four years, low economic predictability was seen as a problem that significantly hampered incentives for conducting otherwise feasible property sales.

An interviewee who had held a key role in KKE described how both mechanisms encountered initial resistance in the municipality, to which KKE responded with significant advocacy efforts. For the

municipality, the new internal building-rent system was particularly important, as it incorporated previously building-related 'invisible' costs into the budget of each building user, instead of including them in KKE's general budget. The combination of the rent scheme and the capital fund gave KKE significantly increased financial autonomy:

> If we were to go back to the main organization of the municipality and have new rounds of political discussions for every decision, then there is a risk that things would have stopped. The fact that we have a public enterprise model with established self-determination in its financial framework is of great importance. (Interview 4)

The predictability resulting from these mechanisms was described as having additional ripple effects. Two of these, particularly valued by the KKE service workers, was the adoption of uniforms and as well as longer-term contracts; 'the unions noted that staff felt professionalized. This again enabled KKE to increase the attractiveness of the organization as a workplace:

> It became a place with a reputation for competence and passion, a focus on long-term goals, professionalism and a place where each individual could contribute (Interview 7)

However, discussions relating to the enterprise model in this and other municipalities are still ongoing. Some interviewees noted the challenges in balancing KKE's autonomy with anchoring the decisions made with the municipality and political leadership. Our interviews revealed differing perceptions: whereas some held that communication between KKE and the municipality works rather well, others noted challenges that in cases led to delays in building processes, as arising issues might be flagged at a late stage. Also noted was the risk of KKE becoming a 'state within the state' and dominating municipal operations, if property management and building were to sap resources from other municipal responsibilities. KKE interviewees expressed concerns that high rental costs might result in political pressure to change the rental model again, which they felt would undermine KKE's functional integrity.

However, the majority of our interviewees said that they were satisfied with the organization of KKE, and that the benefits outweighed the downsides. This included interviewees who said they had originally been opposed to instituting the enterprise system for KKE.

KKE stepped up its focus on energy efficiency and incorporating climate issues into building projects when it created and filled the position of Energy Efficiency Consultant in 2009. In 2011, KKE entered into an Energy Performance Contract (EPC) for energy savings with an external energy service company (ESCO), which significantly increased KKE's budget for work on climate and energy savings. In 2012, when the municipality required KKE to deal with the maintenance backlog in its property portfolio, KKE linked this problem to the EPC contract – while also recognizing an opportunity to establish energy efficiency firmly in their mandate. KKE's proposed package solution was approved later that year, and included a decision that KKE's new buildings would all be built as 'passive constructions' in terms of energy use.

In 2015, KKE's first 'passive building', the administrative headquarters and multifunctional *Krona*, was completed. The same year, the Norwegian Green Party was voted into the municipal council as part of a coalition with Red, the Progress Party, the Christian Democratic Party, the Centre Party and the 'Kongsberg list'.[4] A KKE respondent noted that particularly the inclusion of the Green Party in the

[4] Kongsberglista is a local electoral list first represented in the municipal council election in 2015. It was established as a reaction against the city development around *Krona* – the central municipal building – in the center of Kongsberg.

municipal council facilitated opportunities for more ambitious climate policies in KKE and the municipality:

> They brought up issues which everyone agreed on, but which hadn't been brought up before. Like climate accounting and [building] certification (Interview 3)

In addition, the Centre Party, which became the leading party in the coalition and held the mayorship, also invested in Kongsberg's identity as a 'foresting town'[5]. As such, they supported the decision to construct all new KKE buildings in solid wood. In 2016, this culminated in a new strategy for constructing all new KKE buildings as *energy-plus certified constructions in solid wood*.

Our interviews gave the clear impression that by the time of Vestsiden's construction, KKE had become a focal point for climate work in the municipality. The person hired in 2009 as KKE's Energy Efficiency Consultant is central to most of the municipality's climate-related projects and processes, including climate budgeting, climate accounting, certification schemes and energy monitoring programmes. The municipality has little specialized expertise on climate measures outside of KKE, and climate work is incorporated as a sub-task in the responsibilities of other sections. There is an Environment Consultant, but this individual's expertise was described to us in interviews as focused primarily on local environmental issues like conservation, pollution of local water sources, and similar.

4.4. Deciding to construct Vestsiden High School

Around 2014 the question of what to do with the old building at Vestsiden High School came up on the formal agenda, although an interviewee with previous professional relations to the school noted that replacing that school building had been a topic of discussion in the municipality 'for at least 20 years' (Interview 8).

Whether to renovate or demolish it was debated, with some arguing that the historical legacy of the original school building from 1957 should be preserved. A central figure in KKE at the time explained how they applied the emerging issue of energy efficiency and climate to argue for a new building. The argument was linked to the growing attention to energy efficiency and the recently adopted policy on energy-plus buildings, both part of the municipality's adopted climate policy. On 7 September 2016, plans to construct a new school building at Vestsiden were adopted by the municipality, without specifying any energy solutions. In 2017, construction began.

The total budget for building the school was € 26.8 mill. Of this, €735,000 came as specific public support for the use of innovative energy solutions, and €496,000 from another public source for the use of solid wood in the construction. Thus, nearly all the innovative energy-relevant solutions that helped to make the new school an energy-plus-building were paid by external sources, leaving the municipality to pay for mainly the more 'ordinary' construction costs. The complexity of the project, however, was high.

4.5. Main decisions and the process of designing and constructing the school

Certain conditions were set at the outset: Vestsiden would be a certified energy-plus-building, constructed in solid wood. In addition, the school grounds would include limited public parking spaces, following the municipal policy of reducing private car traffic. The specific energy solutions, however, were determined later in the process.

[5] The Centre Party in general focuses largely on the interests of rural populations and primary sector workers.

The lay-out and design was decided through an architecture competition, where the school principal sat on the deciding panel. In accordance with KKE's general project manual, 'the leader of the organization, together with employee representatives' was part of the project group, according to interviewees from the KKE (interviews 1, 2, 4, 7). The school's further design was influenced by a participatory process including the school and its pupils. Interviewees who were involved described the process as positive and constructive.

The energy-plus requirement implied that the building would need to generate energy beyond grid-connected heating. The use of solar PV in combination with a solution for storing energy was decided early on, and according to a central individual in the design of the energy solutions, the PV system is limited and makes out around 2% of the total costs (Interview 3). The specific decision to use hydrogen storage came later in the process, after construction had started, and originated within the project group at KKE. A critical figure in establishing this solution was the organization's energy efficiency consultant. One of the key informants involved in the energy solutions design indicate that KKE had significant support from the local technology park, and that there was a fit between the hydrogen storage and some of the pilot projects that some of the companies were running (Interview 3). The local FMC branch was particularly supportive. While the concrete information about their projects is confidential, and the ultimate hydrogen storage partner was outside of Kongsberg, KKE and FMC did explore potential links to the Vestsiden project.

All interviewees confirm that the energy solutions as such were not subject to much political debate, and were generally endorsed across the municipal administration, political leadership, and KKE. However, other aspects of the school's design underwent contentious debate in the local media and among local political parties. Issues debated included the proposed demolition of two structures near the school, listed in the Register of Historical Buildings, to make space for the school and school grounds, as well as the lack of parking spaces for teachers. Thus, several informants described the planning and construction of Vestsiden as a highly contentious process.

The only energy-related challenge to the process followed from the decision to use hydrogen storage. In September 2019, the municipality contacted the Norwegian Directorate for Civil Protection (DSB) requesting a safety assessment of the plans for the hydrogen storage facility. Some of our interviewees indicated that this was a result of concerns following an explosion at a hydrogen storage facility in the nearby town of Sandvika in June 2019. KKE had previously been in contact with DSB to inquire whether permission was needed – which it was not, according to Norwegian law. However, the request from the municipality for a safety assessment triggered DSB to review KKE's own risk assessment of the facility performed by a third party – hence activating a need for approval of the hydrogen system. In November 2019, DSB informed the municipality that, based on this review, they had determined that consent from DSB would be needed prior to construction of the hydrogen storage, a process which entailed further documentation.

Moreover, KKE was planning to use an innovative technology for storing hydrogen in metal hydrides, which had not been used before in Norway – sited in a school yard. Although the company Lloyds had been used for scrutinising safety issues, and this was later double-checked by DNV GL, lack of familiarity with the technology was given as the reason for DSB requiring consent.

> This is a new kind of facility – neither DSB, the fire department, or the consultant who made the risk assessment have experience with this type of facility, because it's new in Norway. When you are evaluating a risk assessment you need to have a gut feeling about whether all factors have been included, and that's difficult when you don't have experience with the technology.(Interview 10)

in April 2020, KKE submitted its application, which was finally granted by DSB in February 2021. As a result of this extensive process, while the rest of the Vestsiden building has been completed and is operational, the hydrogen storage facility is currently under production abroad to be finalized in 2023.

4.6. Institutional and reputational legacy and learning

Controversies over issues such as the historical buildings and the parking facilities have influenced reception of the project, although (and according to our interviews) the energy solutions themselves have been hailed widely. The project has received several awards, and been covered in an hour-long programme on national TV as well as receiving other media attention for its use of innovative energy technologies. For instance, in 2019, the public insurance company KLP awarded a prize to Kongsberg for the Vestsiden energy solutions, also stating that introducing hydrogen as an energy carrier is of paramount importance for to reducing fossil-fuel dependences.

The work of KKE and Kongsberg municipality has also received considerable attention from other municipalities. In their 2017 Climate and Energy Plan, Karmøy municipality note Kongsberg and its energy performance contract as setting an example for their own work on reducing energy use. Several municipalities have sent delegations to visit the school.

Our interviewees noted how the school administration and the municipality have greatly enjoyed this positive attention:

> It's music to the municipality's ears, getting visits from environmental ministers and climate researchers. (Interview 1)

KKE itself highlighted in our interviews that the main lesson gained through this process is the importance of 'anchoring' projects with the municipal council and political leadership, early in the planning process. Several construction delays were due to political debates and concerns like the Register of Listed Buildings and the use of hydrogen storage. An interviewee from the municipal administration indicated that approval delays at various steps of the planning process triggered an internal evaluation of their planning systems.

Table 1: Milestone decision points for Vestsiden High School

Year	**Milestone**
2001	KKE established
2007	Rental system and capital fund formally adopted in the Municipal Council
2008	Kongsberg's first climate and energy plan
2009	Energy Efficiency Consultant hired in KKE
2010	Increased maintenance component in the KKE rental system
2011	KKE lands EPC contract with Enova
2012	Plan to combine EPC contract and maintenance backlog ratified by Municipal Council
2012	Decision to construct KKE buildings as passive buildings
2014	Discussions on renovating/replacing the Vestsiden school building begin
2015	Krona, the first KKE passive building, is completed
2015	The Green Party enters the Municipal Council; municipal govt. led by the Centre (former Agrarian) Party
2015	Decision to incorporate climate accounting as part of municipality budget process

2016	Municipal strategy adopted: all municipal buildings are to be energy-plus-constructions, certified, and in solid wood
2016	Plans to construct a new building at Vestsiden ratified by the municipality
2017	KKE wins external funding to implement innovative energy solutions at Vestsiden
2017	Decision to use hydrogen storage at Vestsiden
2017	Construction at Vestsiden begins
2017	The municipality receives Klimasats funding to construct the school in solid wood
2019	Construction at Vestsiden completed (without hydrogen storage facility)
2019	Municipality contacts DSB, voicing security concerns about the hydrogen storage facility
2020	KKE applies to DSB for consent for the hydrogen storage facility. License obtained in 2021
2022	Hydrogen unit under production

5. Explaining Vestsiden High School

Here we analyse formal structures, the organizational culture, and the role of entrepreneurship that led up to the decisions enabling Vestsiden High School, and how barriers encountered underway were dealt with. This we do separately for each perspective, before discussing the interactions involved and the theoretical implications, as well as policy lessons.

5.1. Rational choice institutionalism and formal structure explanations

The empirical data show how formal decisions and policies were instrumental in both enabling and driving Kongsberg municipality and its organizational elements towards new and innovative energy solutions in buildings. KKE was established as a public company owned and indirectly steered by the Municipal Council. This formal structure provided significant leeway for KKE to define its own agenda, within its mandate.

However, the initial decision to establish KKE had some significant formal limitations. Most important was KKE's lack of control over its own financial flows: this reduced its ability to pursue long-term strategies, as the risk of political considerations taking precedence over KKE's plans and interests made ambitious and innovative projects vulnerable.

This changed with the 2007 decision to create a more independent revenue stream for KKE. Apart from the expected effects of a more appropriate and realistic distribution of costs between organizational units within the municipality, noted by some of our interviewees, the main consequence of rational-actor institutionalism was a significant increase in the independence and agency of KKE. This, combined with KKE being allowed to protect their financing over time by creating a fund, was noted by many interviewees as a crucial decision towards increased discretion for KKE to further define its priorities – and ambitions to do so. This is an example of layering of decisions over time, where incremental decisions enabled a larger room for manoeuvre to follow up KKE's mandate more strongly.

The evolution of formal municipal strategies and planning documents further shaped the direction of KKE's focus. The first municipal climate and energy plan was adopted in 2008. Further momentum came with the recruitment and free mandate of a key individual with expertise in energy savings and technology. This mandate led to the next formal point in the process towards Vestsiden: KKE's proposal of an energy savings programme as part of the maintenance programme in 2010 (see Table 1). This was expanded with the decision to remove the maintenance backlog, enabled by the new financing

structure and formal signals from the municipal plans – thereby paving the way for increased professionalization and mainstreaming programmes, and greater ability, influence, and also ambitions within KKE.

In line with rational-choice institutionalism, these formal decisions points and expansion in KKE mandate that in sum and layering over time gave KKE to greater ability to produce innovative systems. This led to a focus on energy solutions, and in effect *required* KKE to find solutions to constructing a building that would generate energy – in line with plus-building requirements. Some of these decisions were strengthened when the Green Party entered the Municipal Council, enabling higher ambitions in this area, but coincided with the focus other political parties on wood as construction material. The decisions from the new Council provided firm signals to KKE that formally legitimized and strengthened ambitious cuts in energy consumption from buildings, encouraged by the use of innovative energy technology. Over time, and partly enabled with external funding, this formal structure enabled and motivated the innovative energy solutions package that included solar PV and hydrogen storage.

However, the rational choice and focus on formal structure cannot fully explain motivations that over and beyond the formal mandates and steering, for understanding the particular ambitions with Vestsiden High School. Here, cultural factors and entrepreneurship in the organization proved important.

5.2. Sociological institutionalism and informal (cultural) explanations

Sociological institutionalism's focus on culturally established perceptions of appropriate organizational behaviour contributes to explaining the energy solutions at Vestsiden. Kongsberg's identity as an industry and technology town, for example, is evident in much of the empirical data – ranging from interviewee reports to central municipal documents beyond formal decisions. The vision 'Kongsberg – the technology town' in Kongsberg's first climate and energy plan expresses a perceived shared focus and facilitates relevant activities. However, this took more the shape of general links to perceived municipality culture, with some interaction with the local industry regarding the concrete energy solutions of Vestsiden.

Traces of how the local context influences choices in climate strategy are also apparent in the links between Kongsberg's additional identity as a forestry town and the requirement to use solid wood in new municipal buildings. This was echoed in the interviews, where we noted the clear connection between Kongsberg's identity as a technology town and how work with climate and energy policies was operationalized as deeply linked to the local industrial context.

The strong focus on technology development in the local community in general and in municipal planning in particular has served as an external legitimization of KKE's ambitious and innovative strategies for energy use in municipal buildings. This is in line with earlier findings which hold that a key success factor of local climate policy is how municipalities anchor these in local identity, qualities and resources [62–64]. Tørnblad et al. [63], show how local context – local historic decisions in particular – can influence the legitimacy of climate policies. This applies well to the case of Vestsiden, where the development of climate and energy strategies linked to the town's historical identity helped to reduce possible culturally based organizational barriers. A key effect of this was the focus of involved decision-makers, where this technology focus aligned and legitimized such solutions, and particularly the 'higher tech' ones, like the hydrogen storage system.

KKE's internal culture further helps to explain the focus on energy use and energy technologies. Several informants noted KKE's internal organizational culture as a success factor for its innovative energy

strategies. Over its 20-year existence, KKE has developed into an attractive competence hub with forward-directed practices – where a focus on buildings and energy solutions gives informal organizational credit. This has empowered KKE's work in the field of energy area, as further indicated by the municipality shifting tasks to KKE and the secondment of KKE staff to work with climate strategies and climate budgeting in the broader municipal organization.

Our data indicate an informal culture of 'thinking outside the box', encouraging employees to contribute with innovative solutions. This internal culture has further helped to legitimize KKE's ambitious strategies, and contribute to facilitate entrepreneurial acts as discussed in the next section. These findings are in line with what we would expect to find from a sociological-institutional perspective [36], where the values, norms and beliefs established within an organization empower (or restrict) action [38]. Thus, company culture has represented an organizational logic with a focus on energy use, innovation and creativity, in turn laying the foundations for KKE's push in this area, and concrete energy solutions for Vestsiden.

While the rational-choice perspective can identify concrete decision-points that contributes to the development of the mandate over time (Table 1), the sociological institutionalism does not enable the identification of such concrete points along a time-dimension. However, the company culture has clearly evolved in tandem with these developments, and the interviews have confirmed that the KKE has grown to become perceived as a more distinct unit within the municipal structure, and confident to push its energy technology solutions over time.

Our results also indicate some cultural differences between Kongsberg Municipality and KKE. Only to a limited extent has the municipality addressed climate policy beyond what was allocated to KKE or was conducted in collaboration with KKE. Establishing an organization like KKE with such implementation capacity relative to other parts of the municipality, combined with a culture favourable to 'seeing things through', leads to money and tasks 'flow[ing] in their direction' (Interview 5). This may, at times, come at the expense of attention to other municipal tasks, like climate issues outside energy use in buildings, and water/sewage treatment. Several interviewees also indicated that more bureaucratic and slower decisionmaking processes have characterized other parts of the municipal organization.

In sum, we find that both the local community identity of Kongsberg, and the KKE organizational culture established a setting for technical solutions to innovative transition-relevant energy solutions, laying the foundations for KKE as a frontrunner in innovative energy solutions in buildings. This in turn led to a culture within which the energy solutions at Vestsiden High School were organizationally highly appropriate. The close fit with the historical identity of Kongsberg as a technology town facilitated endorsement in the wider local community, thus facilitating political approval of the final package – in particular when KKE could secure additional funding for these solutions. However, to explain more than the general feasibility of these decisions and a favourable environment for such, we need to focus also on individual agency and the role of entrepreneurship.

5.3. The role of entrepreneurship

Entrepreneurship should be viewed, not as an inherent characteristic of specific individuals, but rather as a pattern of entrepreneurial actions undertaken with the aim of promoting innovation [45]. Here, entrepreneurship can be viewed as a pattern of action with different individuals taking entrepreneurial actions toward a common goal.

We have identified three instances of key entrepreneurial action that led up to Vestsiden's energy solutions. The first instance of entrepreneurship is the advocacy work carried out by KKE's leadership between 2005 and 2007 to gain approval from the municipality's administrative and political leadership for establishing the rental system and capital fund. The formal changes did not come about by themselves, and there was also resistance in the municipal administration. A central KKE figure noted that, since Kongsberg's municipal leadership did not support the idea initially, considerable 'pedagogical work' with key decision-makers was required (Interview 7). This interviewee was instrumental in spreading a narrative that framed KKE's then-institutional mechanisms, with its lack of autonomy and long-term perspective, as a problem. KKE positioned the rental system and capital fund as solutions to this problem, while insisting that this would make the costs visible, without increasing them. This kind of innovation promotion through problem framing, also by leadership actors, has been described as a core characteristic of entrepreneurial action [45].

The second point is the work by the Energy Efficiency Consultant in securing an energy savings contract with an energy service company (ESCO), along with KKE's proposal to the Municipal Council to combine this contract with the task of addressing the municipal properties' maintenance backlog. This creative linking significantly increased the budget for work on climate and energy efficiency in KKE, while effectively cementing energy efficiency as an important part of KKE's mandate. This is also an example of creative linkage of problems and solutions, a typical component of policy entrepreneurship [25,44].

A third instance of entrepreneurship is the work by the Energy Efficiency Consultant on selecting and designing the energy solutions used at Vestsiden. From *all* our interviews, it was clear that the work done by the Energy Efficiency Consultant was widely deemed essential to the solutions used at Vestsiden, as well as to the overall climate and energy work in KKE and in Kongsberg municipality as a whole. Using the more-focussed energy efficiency mandate as a stepping-stone, this person skilfully worked with a coalition of committed individuals to propose and increase acceptance for a novel energy solution at Vestsiden, with hydrogen storage in particular, which was an untried measure entailing high risk. Our interviews showed that this person and role, together with others in KKE, strategically used Kongsberg's formal policies and structures, as well as the municipality's identity as a 'technology town', to argue for increasingly ambitious energy strategies. This use of narratives about municipal identity aligns with one of the abilities highlighted by Fligstein and McAdam [44] as characteristic of entrepreneurs. The Energy Efficiency Consultant navigated external networks and expertise, identifying ways around possible risks, as well as securing funding from external sources: all of these necessary conditions for realizing Vestsiden's energy solutions.

The instances of entrepreneurship discussed above show that three kinds of entrepreneurial activity were particularly important to KKE's strategies for promoting innovation: problem framing, coalition building, and creative matching of solutions to problems [44,45]. The involvement of these entrepreneurial acts was facilitated by the formal structures of KKE, its established internal organizational culture, and an external environment favouring innovative energy solutions and forward-looking strategies regarding energy use. Without these formal structures and the external and internal culture, these individuals might have had less success in promoting their proposed innovations. At the same time, the entrepreneurial acts combined to develop a formal structure that enabled the KKE to perform its mandate and innovative structure, while also contribute to developing the internal culture. Also here is an evident time-dimension, where more general developments were facilitated by entrepreneurial acts in the earlier phases of KKE. Once this was established, the acts performed were more targeted to facilitate and create acceptance for increasingly new technical solutions – first the EPCs, then particularly the solar system and the hydrogen storage as a highly bold

(and risky) solution. This was further enabled by seeking external funding to shield the municipality from too high a risk.

Each instance of entrepreneurship iteratively enabled the subsequent ones. The autonomy and long-term perspective afforded by the rental system and capital fund was essential to KKE's ability to develop independently its ambitions for energy efficiency, and recruit individuals who could take entrepreneurial action. Combining the EPC contract with the municipal properties' maintenance backlog cemented energy efficiency as core to KKE's mandate and opened a space for future ambitious innovations, such as the technologies used at Vestsiden.

5.4. Causal interplay and theoretical insights

5.4.1 Enabling factors and the theoretical implications

Our analysis indicates that an important part of the explanation for the innovative energy solutions, and particularly installing solar with hydrogen storage, at Vestsiden was the continual mutual interaction between factors under all three dimensions. The rational-choice and sociological institutionalism perspectives were not in conflict here. Rather, these factors should be seen as mutually reinforcing, leading to the resulting solutions, through an interaction that can be summed up as a process of mutual interactions among the three perspectives, starting with the establishment of KKE in 2001, then gradually becoming less tied to the municipal structure and political considerations. This occurred in parallel with a cultural development *within* KKE, which increasingly focused on innovative solutions, room for creative thinking, and encouragement for individual agency through skilful engagement with municipal plans, politicians and officials, as well as the Kongsberg cultural identity. All this unfolded within an external context that favoured innovative technological energy solutions, through key developments over time.

It can be difficult to determine all the details of how formal, cultural factors and entrepreneurship influenced each other. Parts of the formal structure served as a first mover, with the establishment of the KKE and the emerging focus on energy efficiency. This resembles Tolbert and Zucker's [65] argument that institutionalization should be viewed as a process where formal and cultural factors interact. However, we see the ongoing interactions among the various factors as key to the outcome of the decision process studied here. Rational choice institutionalism and sociological institutionalism do not necessarily represent 'two ends of a continuum of decision-making processes and behaviors' [65]: they may interact throughout an institutionalization process, together with entrepreneurial actions. This has taken time to unfold, through iterative formal decisions and gradual cultural developments, again triggered by key entrepreneurial acts.

In the case studied here, it appears that the institutionalization of a strong identity favouring energy rose from the external environment within the local community and its businesses and the competency and success of KKE, creating positive feedback [66]. This further enabled entrepreneurial activity expanding and focussing the mandate to enable energy transition activities by pushing novel solutions.

Our observations concerning the interactions between dynamics from all three perspectives have implications for the entrepreneurship and institutional literatures. Entrepreneurship scholars have increasingly employed institutional theory as a background for their research, although still with a narrow scope [67,68]. Tolbert et al. [69] argue that rational-choice institutionalism, with its focus on formal structures as key for influencing actions, has paved the way for the interaction between institutional theory and entrepreneurship research. Both Tolbert et al. [69] and Su et al. [67] argue that

a lack of focus on sociological institutionalism limits possibilities for exploiting insights arising from cross-fertilization between these different theory traditions. In traditional rational-institutional approaches, formal structures set the boundaries for what entrepreneurship can achieve [70], unless it contributes to changing the structure itself. However, such change would often be determined by interest structures and be more strongly influenced by more powerful actors. Traditional sociological institutionalism expects institutionalized culture to set the boundaries for appropriate actions, including the direction of entrepreneurship acts [39], with any room for influence from individuals significantly limited if not in accordance with the culture. In the case of Vestsiden, each entrepreneurial act was made possible by linking to aspects within formal mandates or decisions, as well as institutionalized culture [71], or what has been termed 'place-based leadership' in combination with different types of entrepreneurial activities [29]. This shows the importance of integrating perspective from different traditions within institutional theories as well as entrepreneurship perspectives for understanding energy transitions, and the links to geographically embedded actors and contexts.

We have described a case of close and mutual reinforcement and alignment between formal factors – often from rational-actor institutionalism – and the more cultural factors of sociological institutionalism [72]. We show how these factors layer and develops over time, to produce the final solution of solar and hydrogen storage, as part of a larger energy solution package. In cases of mismatch, cultural aspects will sometimes win out over formal factors, but not always [28,71]. The entrepreneurial acts in our study range from 'senior leaders expanding organizational mandates and independence, to senior advisers using political decisions and ambiguities in the formalized relationship between the principal to expand specific innovations, often 'packaged' together with other solutions. However, these actions have not occurred in isolation: we see examples of entrepreneurship changing formal structures (organizational mandate and independence), and formal structures creating and cementing frames for cultural development (enabled by the presence of a still-young organization), leading to energy-transition initiatives. The focus on entrepreneurship as acts rather than specific 'entrepreneurial' individuals can help to explain our findings: there are instances of individual 'serial entrepreneurs', but we also find individuals enacting various types of entrepreneurship [45] – so designing formal mandates and facilitating organizational cultures for energy-innovation activities in the local public sector can contribute to boosting the pace of energy transition.

Further, the matching of formal and cultural factors in a municipality-owned organization has analogies to the concept of 'energy cultures' [73] as shaping individual energy behaviour as well as national behaviour [74]. KKE exists within 'hard structures' that resemble an agent-principal-relationship with the municipality, together with a situation where the municipality (with its arms-length subsidiary KKE) exists in a multi-level governance structure between the state, the county council, and accountability to the citizenry. This is regulated through numerous formal requirements and incentive structures which in combination strongly influence municipal actions. Organizing key public activities into separate focused entities is nothing new. But our example of the municipal–KKE-relationship holds key lessons, as it has become rather 'clean' model, reducing the number of considerations and tasks and enabling a key focus on energy innovation. Further cases like Vestsiden are more likely to take place in such a situation than in more traditionally organized municipalities and cultures.

There are also other ways of organizing such generic functions. A carbon copy of the Kongsberg model, but in a different context, with a different legitimacy and institutionalized culture in the organizational environment, intra- and internal-organizationally, may yield different results. Possible scalability to other locations requires assessment of the local context, taking into account mandates, organizational room for manoeuvre, sufficient resources and the matching to local institutional culture [62,75].

5.4.2 Policy-relevant challenges

The successful dynamics involving formal structures, external and internal culture and entrepreneurial actions to foster energy-transition solutions, however, runs the risk of limiting attention to and restricting engagement in other important areas of municipal responsibility – as it is both culturally and formally 'defined out' [36,76]. Kongsberg's institutionalized culture and formally mandated structure clearly has led to an impressive impetus for innovation in the building sector, but this also has important drawbacks.

First, there is a risk of policy and measures being biased towards technological solutions, while other approaches – like mainstreaming the energy transition, transportation measures, behavioural change, information, or attitude campaigns – are likely to remain outside the municipal tool-box. Second, the success of KKE as a semi-independent part of the municipality may draw resources and inhibit the institutionalization of climate policies in the wider municipality organization, as KKE is a dominant entity in its area. Some of our results indicate this, as it has proven difficult to institutionalize wider climate considerations in the municipality.

Third, adapting climate policy to the local context and a climate-related identity for a municipality may help to build successful local policies in this area [63,64]. However, this may also limit municipal engagement if it is overly focused on certain aspects of these policies – as seen in the case of Kongsberg. The climate-related identity of successful municipalities is often holistic, not based on a narrow sectoral approach [40]. While this is not necessarily a downside of supporting energy transition through local government innovation behaviour, it runs the risk of constraining broader approaches to climate measures.

6. Conclusions

In 2019, the new Vestsiden High School in Kongsberg municipality was officially opened. As part of a larger energy solution package, it featured radical new – and costly – technologies that included solar PV production, a local smart-grid optimization system intended to utilize several storage facilities based on chemical batteries, temperature storage, and, most novel and radical, a hydrogen storage facility for seasonal storage. In this study we have asked: *why and how did the municipality decide to develop this project? what have been the main drivers and barriers?* and *how can a better understanding of institutional and entrepreneurial processes facilitate energy transitions?*

Through public documents and interviews we traced the process leading up to the opening of new Vestsiden High School, dating back to when Kongsberg municipality established a semi-independent public property company (KKE) in 2001. Applying institutional and entrepreneurship theory, we find that formal factors together with an increasingly institutionalized cultural identity worked together to create considerable room for individual agency within the organization, serving working as enabling factors for solutions. Formal factors – like mandates, official decisions and steering documents – layered over time, to provide increasingly and significant independence from the everyday politics of the municipality, offering financial openings and room for innovative decisions.

This enabled and facilitated experimentation and innovation work within the local sector – factors that are perhaps less in focus in energy transition studies. We have shown how these formal factors were strengthened and further amplified by Kongsberg's historical identity as a technology town, and an organizational culture of novel technical solutions. Key is that these factors developed and layered over time, to lead to the outcome of solar and seasonal hydrogen storage. Combined, these provided room and encouragement for individual initiatives and leveraging of projects and radical technical

solutions. Such individual entrepreneurship, together with formal and cultural factors, made possible the room for experimentation and the manifestation of innovative solutions, in the case of Vestsiden High School.

However, the success of the project analysed here could have had affected other areas of municipal organization. These may include a narrow and possibly over-technological focus on climate measures, difficulties in mainstreaming climate policy across and beyond the municipal structure, a dominant organizational unit at the expense of other parts of the administration, and a set of activities more shielded from daily democratic scrutiny than elsewhere within the municipal administration.

A caveat is in order here: our claim about formal room is derived by *de facto* functions arising from the municipal organizational structures (e.g. autonomy, long-term perspective, professionalism, room for innovation, etc.), not necessarily by any specific organizational model. There are probably numerous possibilities here, and before applying the findings from this case to other municipalities and organizational settings, one should take due consideration of the local context.

Our findings have several significant theoretical implications beyond the case at hand. KKE's success in encouraging and implementing innovative energy solutions was made possible by the fit not only between formal and informal organizational structures, but also between informal structures and entrepreneurial actions. Chatman [47] has underlined the importance of taking an interactional view of an organization – positive interaction and fit between the organization itself and the individual is advantageous for the organization and the individuals concerned. Similarly, we emphasize the importance of an interactional view of the organization with a fit between not only the organization and its individuals, but the organization itself with its formal and informal structures, entrepreneurial actions and the organization's external environment. Perspectives from rational-choice institutionalism, institutional cultural perspectives and entrepreneurship are not stand-alone factors for explaining organizational processes: they are interwoven in complex relationships.

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Appendix

Table 1: Interview list

No.	Date	Role	Organization
1	23 March 2020	Manager	KKE
2	24 March 2020	School leader	Vestsiden High School
3	24 March 2020	Manager, planning and development	KKE
4	25 March 2020	Former director	KKE
5	26 March 2020	Manager	Kongsberg Municipality
6	26 March 2020	Party politician	Kongsberg Municipality
7	27 March 2020	Former director	KKE
8	15 April 2020	Mayor	Kongsberg Municipality
9	28 May 2020	Former spatial planner	Kongsberg Municipality
10	02 June 2020	Engineer	DSB
11	08 June 2020	Project manager	Rambøll
12	10 June 2020	Project member; City Council Member	Rambøll/MDG
13	20 August 2020	Project manager	Skorve
14	20 August 2020	Consultant	Kongsberg Municipality