


## Article

# Getting Municipal Energy Management Systems ISO 50001 Certified: A Study with 28 European Municipalities

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**Abstract:** Managing energy use by municipalities should be an important part of local energy and climate policy. The ISO 50001 standard constitutes an internationally recognized catalogue of requirements for systematic energy management. Currently, this standard is mostly implemented by companies. Our study presents an approach where consultants supported 28 European municipalities in establishing energy management systems. A majority (71%) of these municipalities had achieved ISO 50001 certification by the end of our study. We also conducted two surveys to learn more about motivations and challenges when it comes to establishing municipal energy management systems. We found that organizational challenges and resource constraints were the most important topics in this regard. Based on the experiences in our study we present lessons learned regarding supporting municipalities in establishing energy management systems.

**Keywords:** local climate and energy policy; energy management; ISO 50001; motivations; challenges



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## 1. Introduction

Municipalities are widely seen as important actors when it comes to mitigating climate change. Consequently, a large number of municipalities have committed to ambitious energy and climate policy goals. Many municipalities do so by joining transnational initiatives for climate action such as the Covenant of Mayors (CoM). By joining the CoM, municipalities not only commit to mitigation targets, but also develop Sustainable Energy and Climate Action Plans (SECAP). An important mode of governance in these plans is what Palermo et al. [1] named “municipal self-governing.” By analyzing the baseline inventories submitted by new signatories of the CoM, Bertoldi et al. [2] found that activities under direct municipal influence are responsible for, on average, 5% of a city’s emissions. This includes the emissions caused by municipal buildings, public lighting, the municipal fleet, public transportation, as well as waste and waste water management. An important measure to deal with these emissions is to introduce or improve energy management [1]. With an energy management system (EnMS) an organization can establish energy targets and processes to achieve those targets. An important standard in this regard is ISO50001:2018, which gives guidance on the elements of an energy management system [3]. The ISO 50001 standard defines a good practice standard for energy management, and models of energy management going beyond its requirements have also been discussed in the literature [4]. Energy management systems adhering to the ISO50001:2018 standard can be certified by external organizations. To date, EnMS based on this standard have mostly

been implemented by companies. The number of municipalities in the European Union holding an ISO 50001 certificate is very low [5]. Based on data from the ISO survey 2019, there were 18,227 valid ISO 50001 certificates at the end of 2019 [6], of which only 34 were from the public administration sector.

Scientific literature on energy management systems based on the ISO 50001 standard is scarce. Most papers on ISO 50001 EnMS deal with energy management systems in companies, for which even a standardized protocol for energy assessment has been developed [7]. Regarding energy management in industrial companies, several assessment models have been proposed and put to test [8]. In general, high hopes have been placed on the possible impacts of successful energy management. Against the backdrop of the European Union's 2030 climate and energy policy framework [9], ISO 50001 EnMS can contribute to attaining the EU-wide energy efficiency targets. McKane et al. [10] estimated annual primary energy savings of 16 Exajoule (EJ) and a reduction in greenhouse gas (GHG) emissions of 1 gigaton in the year 2030 assuming that 50% of global industrial and service sector energy consumption is managed according to ISO 50001 by then. In their scenario, cumulative energy cost savings amount to nearly USD 700 billion (2016 net present value). This shows that energy management in itself can contribute considerably to energy savings and mitigation. Although the ISO 50001 standard is mainly focused on energy use and energy consumption, the standard allows us to consider the consumption of renewable energy generated within the scope and boundaries of EnMS as a separate objective [3]. Thus, a widespread use of ISO 50001 could also contribute to the EU-wide use of renewable energy and sustainable energy development [11,12], which is important in light of the EU's energy and climate policy framework [9]. António da Silva Gonçalves and Mil-Homens dos Santos discussed possible changes to the ISO 50001:2011 standard that could help to increase the standard's impacts related to sustainable development [13]. The high salience of climate change and strong efforts to mitigate emissions have been found to be an important factor in ISO 50001 EnMS adoption [14].

As a main objective of the study was to collect data on the importance of certain challenges in establishing EnMS and motivations to do so, earlier results in this regard are especially pertinent to the study. Rampasso et al. [15] reviewed scientific literature on challenges in implementing an ISO 50001 EnMS and only found 17 articles dealing with this topic. The challenges they found most often were lacking resources (financial, technical, or personnel), data problems (e.g., problems with determining the energy baseline), human resource deficiencies, and lack of leadership support. Wulandari et al. [16] discussed motivations for establishing an ISO 50001 energy management system, difficulties, and benefits based on a survey of 57 Spanish companies. They identified increasing energy efficiency, raising employee awareness for energy-use behavior, and the leadership's initiative as the most important motivations for introducing an ISO 50001 EnMS. To their respondents, data collection and management as well as limited financial resources were the hardest difficulties [16]. Marimon and Casadesús [17] further analyzed the same dataset with respect to the companies' motivations for establishing an energy management system, the difficulties encountered during the process, and the benefits of the energy management system. Using exploratory factor analysis, they identified social requirements, ecology drivers, and competitive advantage as latent variables. Among the variables measured for social requirements were incentives from the government, ecology drivers such as the mitigation of GHG emissions, and also energy efficiency and energy costs, whereas competitive advantage was measured by items such as image improvement and requirements of clients [17]. Ecology drivers were found to have the highest importance, followed by competitive advantage and social requirements. Regarding difficulties in establishing the energy management system, Marimon and Casadesús [17] distinguished operational difficulties (e.g., data collection issues, inadequate economic resources) and organizational difficulty (e.g., weak leadership commitment and benefit uncertainty) and found operational difficulties to be a little more important (though still low). To the respondents in their sample, ecological benefits (e.g., energy savings and better environmental performance)

were more important than production benefits (e.g., productivity and process optimization). Karcher and Jochem [18] analyzed the results of a survey among 121 companies from Germany that had established a certified ISO 50001 energy management system. A large majority (84%) of these companies were from the manufacturing sector. In their sample, the reduction of energy costs was the main motivation for establishing an energy management system. Making use of subsidies, employee acceptance, and image advantages were additional motivators. Regarding the process of establishing and getting the energy management system certified, Karcher and Jochem [18] found that for more than half of the responding companies, involving external consultants was important. Fiedler and Mircea [19] also emphasized that consultant support is helpful in establishing an energy management system and pointed out that suitable software is very useful for collecting and monitoring energy data. De Sousa Jabbour et al. [20] highlighted that ISO 50001 energy management systems can also contribute to better considering sustainability in procurement decisions. Most of the scientific literature on ISO 50001 energy management systems covers results from companies. The use of energy management systems by public administrations in general and municipalities in particular is an under-researched area. Dzene et al. [21] pointed out that energy management systems based on the ISO 50001 standard can lead to real energy savings by municipalities. Therefore, an energy management system can contribute to attaining municipal energy and climate goals and fulfilling the aims stipulated in SECAPs. Establishing an energy management system can both form ground for appointing an energy manager with responsibility for the energy consumption under direct control of the municipality and streamline the collection and analysis of energy consumption data. In their case studies this was something Dzene et al. [21] found to not have been optimal before the energy management system's establishment. Based on a case study for Latvia, Beihmanis and Rosa [22] gave guidelines for implementing energy management systems and stressed that having an energy team of municipal employees tasked with establishing the energy management system and equipped with the necessary resources has high priority. Kamenders et al. [23] noted that having no energy manager, small financial resources, and missing or incomplete data are major challenges to overcome on the way to a functioning EnMS. They also emphasized that assistance by consultants experienced with energy management systems can be of critical importance. Jekabsone et al. [5] reviewed the case study of the Latvian city of Daugavpils, where the authors supported the municipality in implementing an energy management system. The implemented energy management system was certified according to ISO 50001 in 2016. More than 100 public buildings, public street lighting, and the public transportation system are within the boundaries of the EnMS. In the case study by Jekabsone et al. [5], the EnMS helped identify public buildings with high specific and absolute energy consumption and prioritize energy efficiency measures, including renovation. In 2019, the heat consumption of public buildings was 12% lower and electricity consumption 8% lower than in 2016.

The results presented in this paper were generated within the project Compete4SECAP that was funded by the European Union within the Horizon 2020 framework. The municipalities participating in our study were from seven European countries: Croatia, Cyprus, France, Hungary, Italy, Latvia, and Spain. The first main objective of this study was to test whether a substantial number of municipalities could establish an energy management system fit to be certified according to the ISO50001:2018 standard with the help of external assistance. A second question in this regard was whether an EnMS constitutes a systematic approach that facilitates energy savings. The paper aims to contribute to the state of research by exemplifying the process of introducing energy management systems for municipalities. It also presents results on the share of municipalities that obtained ISO 50001 certification within the study period and data on energy savings that were possible even at an early stage of improvements of energy management. Four case studies serve to describe the examples of the EnMS that were established and impacts achieved by the end of the study period in greater detail.

The third main objective of the study was to collect data on motivations for establishing energy management systems, challenges encountered during the process, and energy management's potential benefits in the case of municipalities. As EnMS have mainly been established in private companies and not municipalities, data on motivations, challenges, and benefits exist for private companies but are novel for municipalities.

The structure of the paper is as follows: The Methods section details the external support the municipalities received in establishing the energy management system. Two surveys, which were conducted in 2020, are described in the Methods section as well. The result section gives data on the number of municipal energy management systems in place at the end of the project, their boundaries and scope, and, where available, changes in energy consumption observed in 2019. The Results section also reports the results of the two surveys. The paper closes with conclusions from our research and discusses lessons learned.

## 2. Materials and Methods

Developing an EnMS for a local authority is a one-time process, however, operation and improvement of it is continuous. The initial process is time consuming and in most of the cases municipalities need to have external assistance to establish an EnMS. The relevance of external assistance has already been identified in the case of companies [18,24]. As Figure 1 shows, the main activities within our study can be divided into pre-certification activities, post-certification activities, and evaluation. At the beginning of our study, we invited municipalities to join. Municipalities had to appoint energy managers and teams responsible for establishing the energy management system. In this work they were supported by consultants. The pre-certification phase ends with the certification audit. After the certification the EnMS is operated continuously and improved iteratively. A surveillance audit facilitates improving the EnMS. A consultant keeps supporting the municipalities during this phase when needed. The importance of continuous improvement of energy management practices was stipulated in the ISO 50001 standard [3], but was also widely discussed in earlier scientific studies on energy management [4,8].

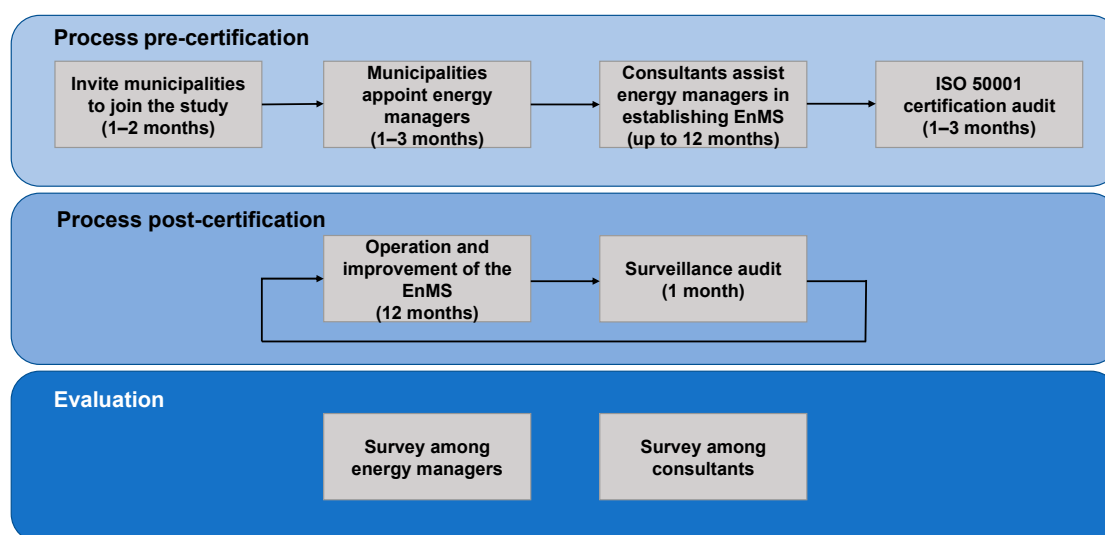


Figure 1. Activities during the study.

To evaluate the process of establishing the EnMS two surveys were conducted: one among the energy managers, the other among the consultants supporting the municipalities. Originally it was planned to only conduct the surveys in the post-certification phase. Due to delays in some municipalities, their energy managers and consultants were surveyed in the pre-certification phase.

### 2.1. Consultant Support

The day-to-day work of municipal workers, combined with their lack of experience with EnMS, makes the support of an external consultant desirable [21]. In addition, an external and independent view allows for a better design of the procedures that make up the EnMS. The municipalities were supported in the process of establishing an EnMS in several ways:

- A guidebook on EnMS gave detailed information on the requirements an ISO 50001 EnMS has to fulfil as well as how to implement and operate one.
- Municipal energy managers and their energy teams were supported in developing an energy policy, with the energy review including the identification of significant energy-using sites (e.g., street lighting or large municipal buildings) and the definition of baseline values, and determining targets and actions for the energy improvement period. Street lighting has been identified as an energy use that allows for retrofits that are relatively easy to implement and promise relatively large decreases in energy consumption [25]. Regarding improving the energy efficiency of public buildings, earlier studies found information and awareness about energy use in public buildings an important prerequisite, although not necessarily sufficient [26].
- All of this information and related procedures were combined in the EnMS manual, compatible with the ISO 50001:2018 standard.
- An internal audit was conducted with a standardized template developed for the study. This internal audit encompassed a detailed questionnaire with which the energy managers and energy teams could check whether they had taken all the important steps before the certification audit. The questionnaire could also be used after the certification audit to monitor the continuous adherence to the standards.
- An online energy monitoring platform that was adapted to national requirements facilitated the monitoring and analyses of municipal energy consumption by providing a standardized method and reducing the effort associated with energy monitoring. That proper software facilitates energy management was already found in earlier studies [19].
- Municipalities were assisted in certification cost assessment and the evaluation of the offers received by certification bodies. Energy managers and their teams were supported in preparing the certification audit and during the certification audit itself, if necessary.

In short, we ensured that external assistance was continuously available to the energy managers and their teams both before and after the certification audit.

### 2.2. Survey among Energy Managers

Once the EnMS were implemented and operational, an online survey was conducted among the energy managers responsible for the energy management system between May and October 2020. In most cases, an interviewer walked the respondent through the questionnaire. In some cases, the respondent entered the responses by themselves. Respondents were not asked to name the municipality they were working for based on the assumption that this would make it easier for them to give honest assessments even when they were critical of the resources their superiors gave them. The survey had the following goals:

- Collect data on the municipality's motivation to establish an energy management system. Respondents were first asked to name the three important motives. Afterwards, we showed them possible motivations and asked them to rate their importance on a five-point scale from "not important" to "very important." We phrased the items based on the results by Marimon and Casadesús [17]. The motivations we named referred to social requirements (e.g., demands by councilors, legal requirements, the project Compete4SECAP), ecology and economy drivers (e.g., reducing energy costs,



mitigating GHG emissions), and something akin to competitive advantage (e.g., being a role model for local companies, rationalization of inefficient workflows).

- Collect data on challenges in establishing an energy management system. Again, respondents were asked to spontaneously name the three challenges that were hardest to overcome. Afterwards, respondents rated how hard it was to overcome certain challenges on a five-point scale from “not at all” to “extremely.” The items we used were based on topics discussed in the literature [17] and ranged from data collection (e.g., missing historical data, too few meters) to organizational difficulties (e.g., co-operation between a large number of departments, little political support) to benefit uncertainty (i.e., possible energy cost savings are seen as negligible). Organizational difficulties such as limited cross-departmental cooperation [27] and getting energy-related projects on the political agenda [28] were identified as major barriers in the scientific literature on municipal energy and climate policy.
- Several questions and items were aimed at assessing the benefits and impacts of the energy management system as energy managers see them. Items referred to, for example, the monitoring of energy data before the establishment of the EnMS, whether the EnMS motivated the municipality to set more ambitious energy-saving targets, and whether the EnMS led to greater consideration of the role of energy efficiency in making procurement decisions. Respondents were asked to state their level of approval on a five-point scale from “strongly disagree” to “strongly agree.” Furthermore, respondents also estimated whether and how the EnMS changed the probability of certain events happening on a five-point scale from “much lower” to “much higher.” Here we named, for example, regular training on energy conservation behavior for employees. Possible benefits named in the survey reflected that energy management should not only address technologies, but also administrative and staff-related practices [24]. Additional items for this question were the prioritization of investments based on their energy-saving potential and a higher budget for energy efficiency. A study of Swiss companies with high energy consumption showed that better energy management made it more likely that a company would approve an investment in energy efficiency [29]. The importance of adequate resources for energy efficiency retrofits of public buildings was emphasized in the relevant scientific literature [26].
- In addition, we queried data on the size of the team responsible for the EnMS and some other factual statements, for example, whether the EnMS had already been certified and regarding the energy performance improvement period.

Respondents answered closed assessment questions on a five-level scale. We assumed the levels to be equidistant and therefore treated the answers as interval scaled. We converted the answers to numerical values as defined in Table 1. Accordingly, we report the arithmetic mean  $\bar{x}$  and standard deviation  $s$  for each item in the Results section. The data was analyzed and figures were created with the tidyverse collection for R [30]. Because of the small size of the sample, we could not perform an exploratory factor analysis similar to Marimon and Casadesús [17] to identify possible latent variables [31].

**Table 1.** Scales used in the survey and respective numerical values.

	Motivation	Challenge	Statement	Change
1	Not important	Not at all	Strongly disagree	Much lower
2	Slightly important	Slightly	Disagree	Lower
3	Moderately important	Moderately	Undecided	About the same
4	Important	Very	Agree	Higher
5	Very important	Extremely	Strongly agree	Much higher

### 2.3. Survey among Consultants

An additional online survey among the consultants supporting the municipalities in establishing an EnMS was conducted in November and December 2020. The goal was to also obtain an outside perspective on the municipalities' energy management. Given that

the consultants were not employed by the municipalities, we reasoned that they might be more impartial in their assessment. Consultants were asked to give their assessment of various topics:

- the state of the energy management before the process to establish an EnMS began and how surprising the results of the energy review were;
- how hard it was to overcome the challenges in the consultants' view;
- whether they believed the municipality would have introduced the EnMS without their support;
- the scope and boundaries the municipalities chose for their EnMS;
- the ambition of the municipalities' energy targets and action plan;
- the likelihood of attaining the targets for the energy performance period; and
- the likelihood that the municipality would commission the recertification audit.

Consultants gave their assessment for each municipality they supported individually. Wherever we used five-point scales, the answers were converted to numerical values using the conversion factors from Table 1.

### 3. Results

#### 3.1. Results of EnMS Establishment

By the end of our study (end of 2020), 20 of the 28 municipalities aiming for an ISO 50001 certified EnMS had achieved certification. This equals 71%. Two municipalities had completed the certification audit, but were still waiting for the certificate. Furthermore, 15 of the 28 municipalities (54%) had already completed the second management review by the end of December 2020. The 28 municipalities had an annual energy consumption of nearly 187 GWh, within the scope and boundaries of the energy management systems. Energy consumption of the 28 municipalities within the boundaries and scope of the EnMS was already lower by 15 GWh in 2019. By the end of 2019 not every municipality had achieved certification, but every municipality had started the process to establish the EnMS. The year 2019 is the latest year for which data are available. The savings we found hinted at the process of establishing an EnMS in itself, allowing not only for saving potential to be identified, but also already facilitating some savings to be realized.

In total, the action plans in the 20 municipalities that had achieved ISO 50001 certification by the end of 2020 encompassed at least 92 actions. Of these actions 55% were technical measures, 30% organizational/institutional measures, and 15% educational measures. This shows that the EnMS established within our study simultaneously acted on technological, non-technological, and support aspects, as urged in the scientific literature [24]. Technical measures comprise the replacement of equipment, organizational measures enable a better monitoring and control of energy consumption, and educational measures lead to greater awareness about energy-use behavior and educating municipal employees. Table 2 gives an overview of the type of actions the EnMS action plans contain.

**Table 2.** Measure categories and examples of actions in the EnMS action plans.

Category	Subcategory	Examples of Actions	Share
Educational measures	Raising awareness and education	Trainings, energy saving competition, information campaigns, motivational workshops	15%
	Energy efficient appliances	Replacement of inefficient appliances	
Technical measures	Heating, ventilation and air conditioning (HVAC)	Replacing air conditioning (AC) or ventilation system, installation of thermostatic valves, building automation	55%

Table 2. Cont.

Category	Subcategory	Examples of Actions	Share
	Lighting	Replacing incandescent light bulbs with light-emitting diodes (LED), refurbishment/replacement of street light control systems	
	Refurbishment of buildings	Refurbishment of doors and windows, insulation, green roofs	
	Renewable energy	Installation of solar panels	
Organizational measures	Monitoring and control of energy consumption	Operational procedures, use of energy monitoring platform, analysis of energy-use patterns	30%

### 3.2. Four Cases from France, Italy, Latvia, and Spain

The following section presents four cases of local authorities that established an ISO 50001 certified energy management system within our study. Table 3 summarizes core data for the four cases.

Table 3. Data for the case studies.

Scope and Boundaries						
Municipality	Energy Team Members	Public Buildings	Street Lighting	Municipal Fleet	Annual Energy Consumption within Scope (MWh/a)	Reduction of Energy Consumption Year 1 (MWh/a)
Cieza, Spain	4	4	Included	-	2180	207
Rubano, Italy	12	24	Included	-	5444	56
Saldus, Latvia	6	90	Included	180 vehicles	12,970	779
Montauban, France	10	3	Partly included	-	1600	263

Cieza is a Spanish city with about 35,000 inhabitants. The EnMS that was set up within our study has four public buildings and a street lighting system within its scope and boundaries. The process to establish the energy management system began in February 2019. Certification was achieved by December 2019. The most important challenges we encountered during the process were complying with regulatory provisions because of the old facilities of the municipality, the lack of human resources for the establishment of the equipment, and the lack of economic resources for planning measures in the EnMS, which is something that has become even more difficult during the COVID-19 pandemic. Measures that were implemented within the energy management system's action plan were converting incandescent bulbs to LED, raising awareness, and obtaining energy certificates for the four buildings included in the EnMS.

Rubano is an Italian city with about 16,500 inhabitants. Its EnMS comprises 24 public buildings, a street lighting system (2500 lamps), eight photovoltaic plants, and three solar thermal plants. The municipality began monitoring the energy consumption of its assets as early as 2010. The activity was launched after joining the Covenant of Mayors initiative signed by the municipality in 2009. The monitoring continued over the years and was presented in the Sustainable Energy Action Plan (SECAP) and in the subsequent biennial monitoring of this plan. In September 2018 the municipality began the process of establishing an EnMS and achieved certification by September 2019. By the time the process to establish EnMS was started, Rubano already had an ISO 9001 quality management system in place. During the process of establishing the EnMS, the main challenges were to set up an internal group dedicated to the activity of the EnMS (energy team) that could guarantee continuity in the long term, guarantee a periodic and timely control of



energy performance and deviations, integrate the constant presence of top management representatives to the working group, and being able to integrate two parallel systems for quality and energy management without excessively changing internal procedures and organization within the municipality. The measures that were realized as part of the EnMS action plan included lighting retrofit with transition to LED technology in sport facilities, installation of mechanical ventilation systems for changing rooms and gyms owned by the municipality, operational and management control of public lighting, and closing a procurement and construction (EPC) contract aimed at improving the efficiency of the systems. Furthermore, information and training campaigns on energy-use behaviors in schools and municipal libraries were conducted.

Saldus is a Latvian municipality with about 22,000 inhabitants. The municipality's energy management system has 90 public buildings, street lighting, and the municipal fleet within its scope and boundaries. Saldus initiated detailed energy data collection as early as 2015, and the process to establish a standardized energy management system started in August 2018. It obtained the ISO 50001 certificate in June 2019. The main challenges in this process were historical data gathering, involvement of the energy users to collect and submit actual monthly energy data, and the introduction of daily routines according to the standard. Among the measures that were implemented as part of the EnMS were the replacement of incandescent light bulbs with LED, adjusting and optimizing the settings of HVAC systems in several buildings, and actions to raise awareness about the importance of user behavior and incentivize energy conservation behavior.

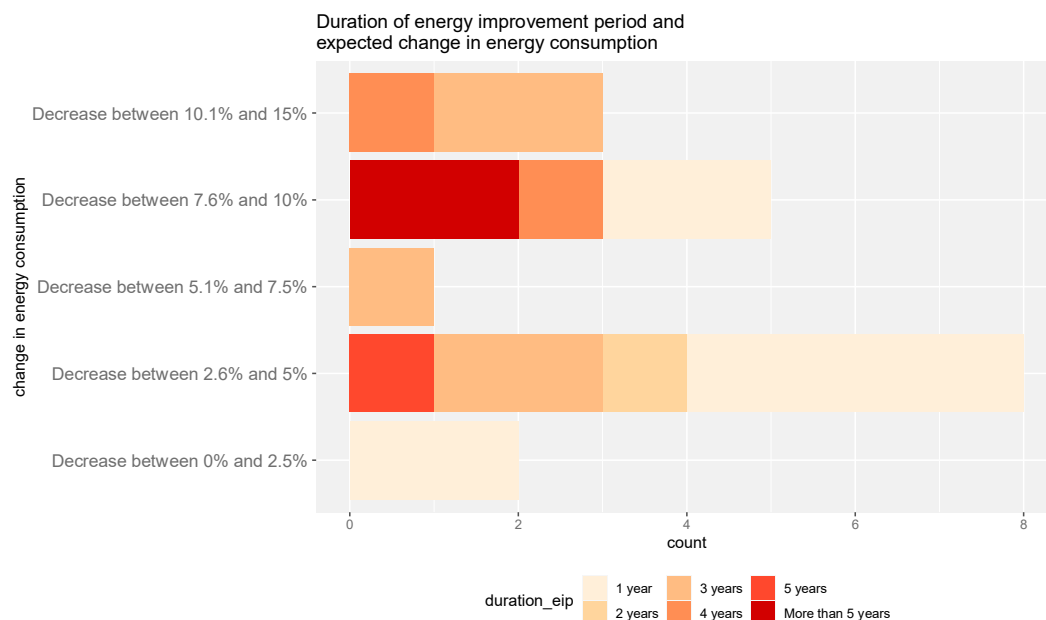
The City of Montauban and Grand Montauban (city and conurbation of 77,000 inhabitants) hesitated to implement an ISO 50001 EnMS. The energy team was unsure how much time they could devote to it, knowing that their schedule was already busy. By weighing the pros (formalized management method, identification of actions, etc.) and cons (time, financial costs, etc.), Montauban finally committed to establishing an EnMS with limited scope and boundaries. This solution enabled them to adopt the ISO 50001 method without major investments in terms of internal resources, and with the aim of subsequently expanding the scope of the EnMS. The initial perimeter corresponds to three buildings spread over two sites of the local authority and four public lighting cabinets comprising 843 light points (8% of the total). The total energy consumption within the EnMS's scope and boundaries amounts to approximately 1600 MWh (8% of the municipality's total).

The team responsible for setting up the EnMS consisted of two employees (the energy manager and an economist responsible for optimizing the energy consumption). If necessary, they involved other employees (responsible for street lighting, buildings, resources, communication, etc.). This inter-departmental cooperation was crucial because municipalities offer various services that have an impact on energy performance. In addition to the technical aspect of the EnMS, the energy team showed a particular interest in raising awareness by mobilizing the agents of each site of the perimeter (called "energy referents") and by organizing regular meetings. One of the main difficulties was understanding the distribution of meters as many renovations have taken place without systematically updating the plans and diagrams. During the first year of implementation of its EnMS (2019), Montauban carried out 11 actions to achieve their objectives, which enabled the municipality to save 263 MWh of energy. In addition to the actions implemented within the scope of the EnMS, this approach set in motion new procedures that extend to the entire community (systematic performance of energy audits before work is carried out, integration of energy skills during all recruitment, etc.). The EnMS finally allowed Montauban to have a clear organization in terms of energy management, including roles, reporting, and projections, and to identify numerous improvement actions.

### 3.3. Results of the Survey among Energy Managers

In total, we received responses from 23 energy managers. Given that 28 municipalities were working on establishing an ISO 50001 energy management system during the project, this equals a response rate of 82%. It has to be noted that some energy managers filled in

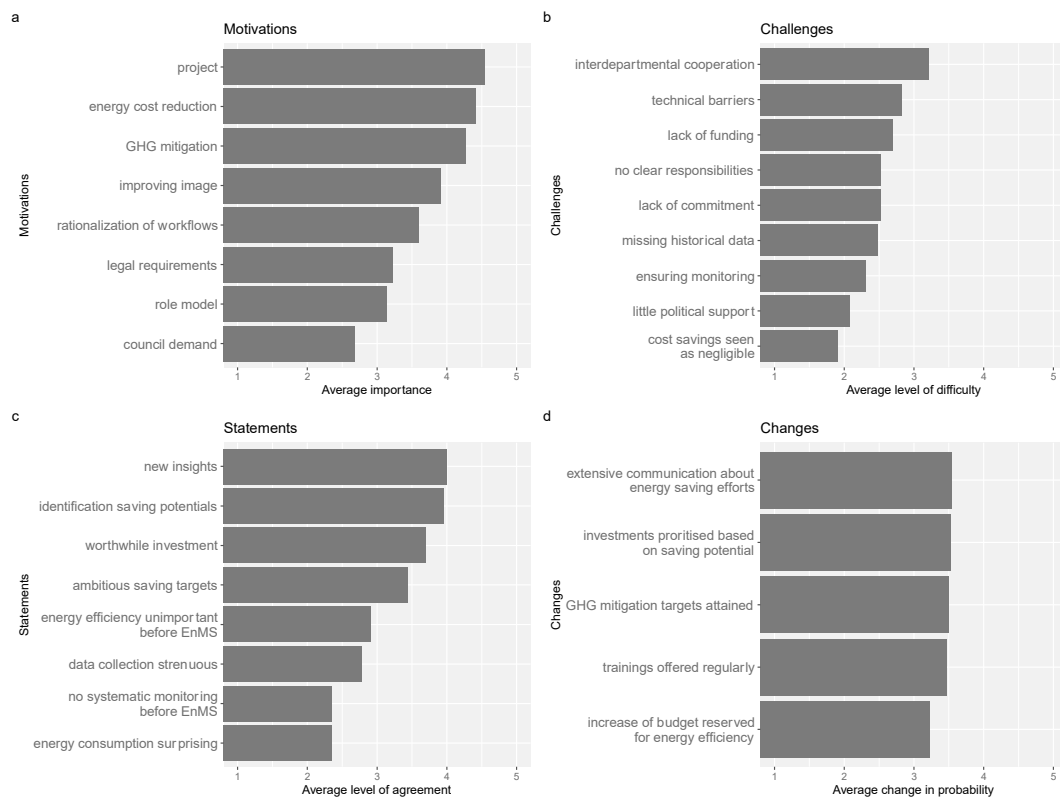
the survey before the energy management system was certified. At the time of the survey, 83% of the responding energy managers were working for a municipality that already had their EnMS ISO 50001 certified. When asked whether they believed that the municipality would commission the recertification audit after three years, 19 energy managers, that is, those from municipalities that already held an ISO 50001 certificate at the time of the survey, answered. Of those, 21% responded that the municipality would definitely commission the recertification audit. Forty-seven percent answered that it probably would. This means that for more than two-thirds of municipalities the EnMS is a long-term investment and left us hopeful that even in the cases in which establishing the EnMS was mainly motivated by the project, the activities will be carried on after the project has ended. On top of this, 26% believed that recertification was at least possible. Every municipality with an ISO 50001 certified EnMS also defined targets for the energy improvement period. Figure 2 shows the expected change in energy consumption within the scope of the EnMS depending on the length of the energy improvement period. Every respondent expected the municipality's energy consumption to decrease. In general, higher decreases are expected when the energy improvement period is longer.



**Figure 2.** Duration of energy improvement period and expected change in energy consumption ( $n = 19$ ).

When respondents were asked to name the three most important motives for introducing the EnMS, the most frequent answers were getting better data on energy consumption and saving energy. Some respondents stated energy savings as a goal in itself, whereas others referred to energy cost savings or GHG emission reduction. Other motivations named by the respondents were raising awareness, both among decision makers and co-workers, more efficient workflows, and prioritization of investments and measures. Furthermore, more than one respondent mentioned the local authority being a role model. With the exception of raising awareness, these motives were among the items of the closed question. Figure 3a shows the motivations sorted by level of importance.

The project was named the most important motivation with an average importance score of 4.55 ( $s = 0.51$ ), followed by energy cost reduction ( $\bar{x} = 4.41$ ,  $s = 0.80$ ), the mitigation of GHG emissions ( $\bar{x} = 4.27$ ,  $s = 0.83$ ), and improving the municipality's image ( $\bar{x} = 3.91$ ,  $s = 1.15$ ). Being a role model was seen as moderately important ( $\bar{x} = 3.14$ ,  $s = 1.04$ ), whereas the least important motivation was a demand by the council with an average importance score of 2.68 ( $s = 1.04$ ).



**Figure 3.** Energy manager assessment of (a) motivations for establishing the energy management system ( $n = 22$ ), (b) challenges in establishing the EnMS ( $n = 23$ ;  $n = 22$  for the item “cost savings seen as negligible”), (c) statements regarding the EnMS ( $n = 23$ ), and (d) changes due to the EnMS ( $n = 23$ ;  $n = 22$  for the items “GHG mitigation targets,” “communication,” and “increase in budget”).

When asked openly about challenges in establishing the EnMS, respondents mentioned several challenges. Numerous energy managers named data issues. These extended both to historical data needed for the energy review as well as the continuous monitoring of energy consumption data. Other challenges that were cited frequently were organizational issues (e.g., getting employees to support the efforts), ensuring the necessary commitment from important decision makers (administrative and political), and lack of resources (especially financial and human resources).

Figure 3b shows that respondents experienced interdepartmental cooperation as the challenge that was hardest to overcome ( $\bar{x} = 3.22$ ,  $s = 0.90$ ). Dealing with technical barriers (e.g., too few meters) was seen as second most challenging ( $\bar{x} = 2.83$ ,  $s = 1.15$ ). Lack of funding ( $\bar{x} = 2.70$ ,  $s = 1.22$ ), no clear assignment of responsibilities ( $\bar{x} = 2.52$ ,  $s = 1.16$ ), a lack of commitment ( $\bar{x} = 2.52$ ,  $s = 1.20$ ), and missing historical data ( $\bar{x} = 2.48$ ,  $s = 1.34$ ) were given a similar level of difficulty by the respondents.

We presented several statements regarding energy management systems to the energy managers and asked to what extent they agreed with these statements (Figure 3c). The statements with the highest level of agreement were that establishing the EnMS led to new insights ( $\bar{x} = 4.00$ ,  $s = 0.67$ ), that it allowed the municipality to identify energy-saving potential ( $\bar{x} = 3.96$ ,  $s = 0.83$ ), and that the EnMS had already been a worthwhile investment at the time of the survey ( $\bar{x} = 3.70$ ,  $s = 1.02$ ). On average, respondents were undecided about whether the EnMS was a motivation to set ambitious energy-saving targets ( $\bar{x} = 3.43$ ,  $s = 0.90$ ). Based on the energy managers’ impressions, establishing the EnMS was not a change as substantial as we would have expected. Respondents on average were undecided about the statements that energy efficiency was unimportant in investment decisions before the EnMS ( $\bar{x} = 2.91$ ,  $s = 1.20$ ), and disagreed that there was no systematic monitoring of

energy consumption before the EnMS ( $\bar{x} = 2.35$ ,  $s = 1.56$ ) and that the municipality's energy consumption was surprising ( $\bar{x} = 2.35$ ,  $s = 1.23$ ).

We also asked energy managers to assess whether the EnMS made certain events more or less likely (Figure 3d). The average assessment of the probability of the events being realized was similar for all events and between "about the same" and "higher." The events were the municipality communicating extensively about its energy conservation efforts ( $\bar{x} = 3.55$ ,  $s = 1.01$ ), a prioritization of the municipality's investments based on their energy-saving potential ( $\bar{x} = 3.52$ ,  $s = 0.85$ ), the municipality attaining its GHG mitigation targets ( $\bar{x} = 3.50$ ,  $s = 1.10$ ), the municipality training its employees on energy conservation behavior regularly ( $\bar{x} = 3.48$ ,  $s = 0.99$ ), and the municipality increasing its budget for energy efficiency ( $\bar{x} = 3.23$ ,  $s = 0.97$ ).

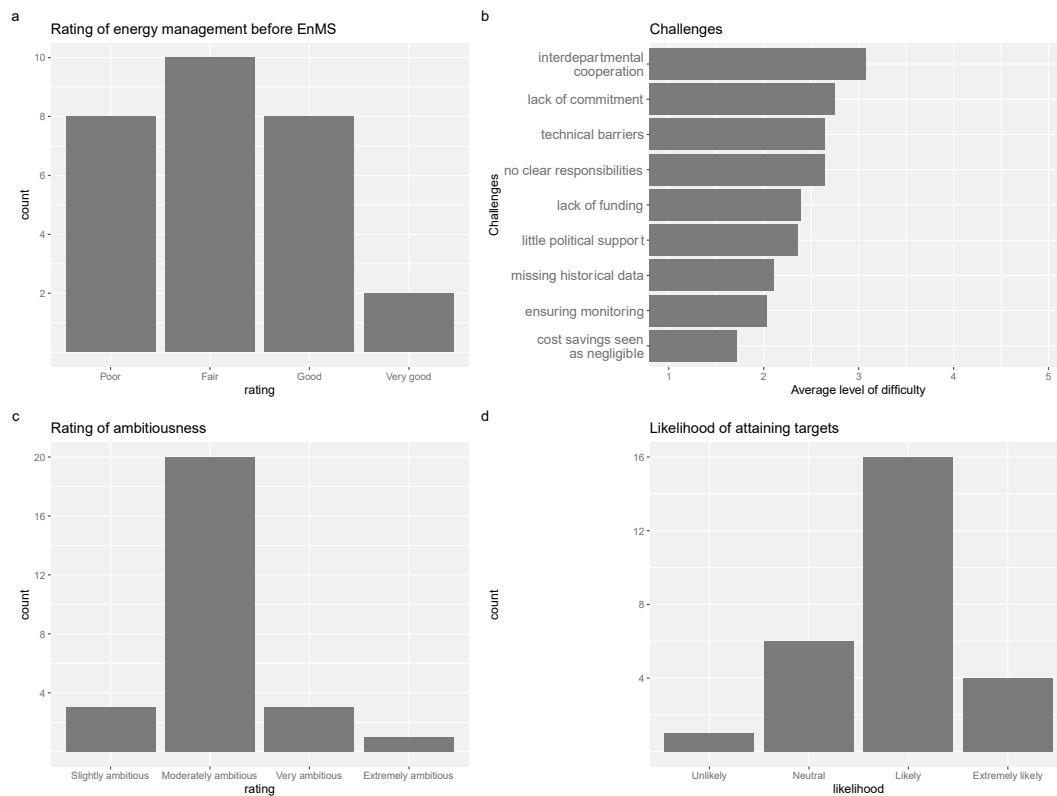
Answering an open question, energy managers could state what needed to happen for the EnMS to have a marked impact on the municipality's energy consumption and carbon emissions that did not happen at the time of the survey. Several topics stood out among the answers. Some energy managers indicated that more financial and human resources were needed to implement the measures identified during the certification process. A durable commitment by decision makers to the EnMS was also named more than once as a prerequisite. Furthermore, changes in employee behavior were seen as needed. This reiterates the point made in earlier studies that changes in user behavior are even harder in the workplace, as financial incentives are nonexistent [28].

### 3.4. Results of the Survey among Consultants

In total, all seven consultants supporting the 28 municipalities establishing an ISO 50001 EnMS filled in the questionnaire. When reporting number of observations, we treated each response for an individual municipality as a separate observation. This means that each consultant provided four observations.

Seventy-one percent had achieved certification by the time of the consultant survey. Given that on average energy managers disagreed with the statement that there was no systematic monitoring of energy consumption before the introduction of the EnMS, we asked consultants to rate the municipalities' energy management before the process to establish an EnMS began. The energy management of 36% of the municipalities was rated as either having been good or very good before the study began. Consultants thought that the energy management of 29% of the municipalities was poor before introducing the EnMS (Figure 4a). For 79% of the municipalities, consultants believed that they would not have introduced an energy management system without the project's support. As a reason for this, they named the financial and human resources the project contributed to the process.

When asked which were the most important challenges the municipality had to overcome, several consultants referred to human resources issues, especially finding qualified personnel or getting the personnel sufficiently qualified. Other challenges named more than once involved decision makers and ensuring their commitment as well as data collection problems. We also asked consultants to rate how hard it was to overcome certain challenges on the same scale the energy managers used and compare the consultants' assessment to the energy managers' assessment. One caveat in this interpretation was that energy managers only gave their assessment for 23 municipalities, whereas consultants gave a rating for all 28 municipalities (Figure 4b). Consultants agreed with energy managers that getting interdepartmental cooperation to work was the hardest challenge to overcome ( $\bar{x} = 3.07$ ,  $s = 1.22$ ) and that technical barriers were among the three hardest challenges ( $\bar{x} = 2.64$ ,  $s = 1.22$ ). In contrast to the energy managers, consultants saw a lack of commitment among the three challenges hardest to overcome ( $\bar{x} = 2.75$ ,  $s = 1.24$ ). Still, even these three challenges were, on average, only moderately hard to overcome. Consultants and energy managers also agreed that energy costs being perceived as negligible ( $\bar{x} = 1.71$ ,  $s = 0.81$ ) and ensuring continuous monitoring ( $\bar{x} = 2.04$ ,  $s = 1.10$ ) were among the three least hardest challenges.



**Figure 4.** Consultant assessment of (a) the energy management before the EnMS ( $n = 28$ ), (b) challenges in establishing the EnMS ( $n = 28$ ), (c) the ambitiousness of targets ( $n = 27$ ), and (d) the likelihood of attaining the targets ( $n = 27$ ).

When asked what the most important things they learned about municipal energy consumption were, the management consultants reiterated some points that were already discussed:

- Collecting and analyzing data can be a challenging task, especially for small municipalities;
- Energy consumption is often seen in terms of costs. Observed cost increases can be a stronger incentive for action than potential, but notional, cost reductions; and
- Interdepartmental cooperation is a problem that becomes especially pertinent if more than one department is responsible for activities within the scope of the EnMS.

Defining the boundaries and scope of an EnMS is an important task during the process of establishing the system. For municipalities this is not as straightforward as might be the case for companies. Some municipalities decided not to include every building they owned or excluded street lighting or their fleet of vehicles. Therefore, we asked the consultants how satisfied they were with the scope and boundaries of the EnMS they helped to introduce. For 57% of the municipalities, the consultants were very or extremely satisfied with the boundaries and scope. They were only slightly satisfied or not satisfied at all in the case of 29% of the municipalities. If consultants were not satisfied with the scope and boundaries of the EnMS, it was often caused by municipalities excluding some of their buildings. Based on the consultants' assessment, 74% of the municipalities have a moderately ambitious energy target and action plan (Figure 4c). The number of observations was 27 for this and the next two questions because one consultant could not give an assessment for one of the municipalities. Fifteen percent of municipalities have a very or extremely ambitious energy target and action plan. The consultants were optimistic that the municipalities will attain their targets (Figure 4d). For 74% of the municipalities, they rated this as likely or extremely likely. Only in the case of one municipality did consultants consider it unlikely that they would fulfil their targets. Consultants also



believed it likely or extremely likely that 78% of the municipalities would commission the recertification audit. This points to the project having a long-term impact and can be interpreted as a sign that once the municipalities receive help in establishing an EnMS they are able to sustain it without external help.

#### 4. Discussion and Conclusions

Regarding the first objective of our study, we found that municipalities are able to establish ISO 50001 certified energy management systems with the help of external assistance. Given that the energy consumption of municipalities is non-negligible and that energy savings of more than 10% were achieved in some of our cases within one year, energy management should become an important component of local energy and climate policy.

Regarding the second objective of our study, we provided data on motivating factors, but also challenges that municipalities face when aiming to establish an EnMS. In both regards, our results for municipalities are not very different from the results earlier studies found for companies [15–18]. As in the case of companies [18,24], external support from consultants was often important and energy-related and environmental impacts were strong motivators [17]. Organizational difficulties (cooperation between a large number of departments), limited resources (financial, human, and technical), and insufficient leadership support were the most important challenges we identified. Regarding the ranking of challenges, municipal employees and consultants largely agreed in their assessment. Although collecting historical data and the continuous monitoring of energy data were named as important challenges in the literature [23], they were not among those hardest to overcome in our study. A large majority of municipalities that had established an EnMS within our study aim to keep operating it and also plan to commission its recertification. This lets us assume that the one-time investment in energy management will have long-term impacts in many cases.

Based on the results of our study, utilizing energy management systems in municipalities seems advisable and can contribute to energy and climate policy. The following points summarize the lessons we learned regarding the process to establish municipal EnMS:

- The impetus given by the study was a crucial motivator for municipalities to establish an energy management system. This support can be institutionalized by setting up an agency that supports municipalities in establishing energy management with money and expertise. A driver for wider application and implementation of EnMS in local authorities would be the introduction of mandatory energy management in national and regional legislation.
- Once an EnMS is up and running, a large majority of the municipalities participating in our study planned to keep it. This means that such an agency's short-term support can have long-term impacts in many cases.
- When helping municipalities to set up an energy management system, it was crucial to involve all departments that managed activities consuming considerable amounts of energy (e.g., every building owned by the municipality, street lighting, the fleet of vehicles, etc.). Achieving functional interdepartmental cooperation was among the hardest challenges in our study, corroborating results from earlier studies for other areas of local energy and climate policy [27].
- A strong commitment by decision-makers, including local politicians, is needed to facilitate interdepartmental cooperation. Support programs for EnMS introduction should incentivize this commitment from administrative heads and local politicians through its terms and conditions.
- Human resources can be a limiting factor, especially for smaller municipalities. Therefore, a program supporting municipalities in establishing EnMS should foresee resources for training. It was also helpful to not task a single person with working on the EnMS, but rather to form an energy team. This confirms results from research on companies using EnMS that also stressed the role of energy managers and training [29].

- Defining the boundaries and scope of the energy management system is a topic that should be addressed early on. Some of the municipalities in our study were very cautious and chose very narrow boundaries and scope.
- Adequate tools that support collecting, analyzing, and presenting data can greatly reduce the administrative burden of the EnMS. Within our study, municipalities had access to an online energy monitoring platform, which 62% of the municipalities used. A program for EnMS introduction should entail access to a tool that supports data collection and analysis.
- To attain energy-saving targets, the energy-use behavior of employees cannot be neglected. The survey among energy managers showed that motivating colleagues to change their behavior was challenging in some cases. Gamifying this by holding an energy-saving competition may be a helpful approach in this case [32].

Our study has several limitations, which point to future research needs. Although we were ultimately successful in establishing ISO certified energy management systems in a majority of the municipalities by the end of our study, supporting municipalities on their way to certification needed more consultant resources and often took longer than anticipated. Due to the comparatively low number of municipalities in our study, the survey results are exploratory in character and do not allow us to explain which municipalities are more likely to successfully establish an energy management system. Furthermore, our study does not permit us to explain differences in energy savings after establishing the energy management system. Since the municipalities only established the energy management systems recently, we cannot evaluate their long-term impacts. A relevant research question is whether the experience and know-how acquired by establishing and running the EnMS carries over to other fields of local climate policies and thereby helps to improve and increase the number of measures (e.g., from the SECAP) implemented. This would imply that municipal EnMS can have impacts even beyond the EnMS's scopes and boundaries. To study this question, future studies should collect data from a larger number of municipalities over a longer timeframe. Future research could also build on studies that apply maturity models to the energy management of industrial companies [4,24] and transfer this approach to municipal energy management. This would also help to answer the requirement of continuous improvement foreseen in the ISO 50001 standard.

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