Requirements set by Swedish municipalities to promote construction with low climate change impact

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Abstract: This study investigates how Swedish municipalities work to reduce the climate change impact of building construction. It focuses on current practices related to promoting the use of sustainable construction materials and on barriers to environmental requirements in construction, in particular environmental performance requirements based on LCA procedures. Municipalities were surveyed about the existence of municipal policies dealing with environmental issues in construction, the knowledge level about these issues, and the measures and requirements used to promote materials with low climate change impact. The survey was followed by semi-structured interviews about current practices and barriers to environmental requirements in construction. Results show that large municipalities are more likely to have dedicated policies and implement more measures than their smaller counterparts. However, willingness to implement future measures and knowledge of sustainable construction do not vary significantly with municipality population. Efforts are often limited to procurement, municipal construction projects and discussions with stakeholders. When requirements are set, they are almost always based on prescribing a technical solution (e.g. use of timber) rather than assessing environmental performance (e.g. calculating greenhouse gases emissions with a LCA tool). Measures that municipalities can take as public authorities are restricted by the law, which remains ambiguous as to the legality of environmental performance requirements. Legal issues, limited knowledge and resources appear to be the main barriers to environmental performance requirements in construction. A strategy is proposed to overcome these issues. After setting appropriate targets and securing resources, the municipality should establish dialogue with developers and constructors. It should then require them to provide inventory data for new construction projects. The municipality should make sure appropriate guidance and standardized methods are available. Information requirements should be strengthened over time, and practitioners should progressively become familiar with data collection and LCA methods. When data and knowledge gaps are filled, the municipality can set environmental performance requirements for new buildings.

Requirements set by Swedish municipalities to promote construction with low climate change impact

1. Introduction

Emissions of greenhouse gases (GHG) from operational energy use have been cited as the main contributor to the climate change impact of buildings (Adalberth, Almgren, & Petersen, 2001; Sharma, Saxena, Sethi, Shree, & Varun, 2011). However, recent developments show the increasing importance of the impact of construction in proportion to operational energy use (Anand & Amor, 2017; Birgisdottir et al., 2017; Ibn-Mohammed, Greenough, Taylor, Ozawa-Meida, & Acquaye, 2013; Larsson, Erlandsson, Malmqvist, & Kellner, 2017; Liljenström et al., 2015). The construction sector is responsible for 16% of GHG emissions within the European Union (EU) (Eurostat, 2018) and 5-40% in other countries (Yokoo, Oka, Yokoyama, Sawachi, & Yamamoto, 2015).

The main actors who can work towards reducing the climate change impact of building construction are developers, public authorities and constructors. Constructors are defined in this article as actors that carry out construction work. Developers are defined as actors that own or obtain the land and building permit prior to building construction, and ultimately profit from the project. In some projects, a single actor can be both developer and constructor. Developers are responsible for legal matters, such as compliance with building regulations. In particular, construction projects in Sweden must comply with the building code established by the National Board of Housing, Building and Planning (hereafter referred to by its Swedish name, Boverket). Boverket is a central government authority, founded in 1988, that is responsible for regulations and guidance related to planning and construction, the dissemination of related knowledge and the fulfilment of sustainability targets relating to the built environment. While most building codes, e.g. in the EU or the USA, include clear regulations on operational energy use, the climate change impact of construction is not regulated (Birgisdóttir, Houlihan-Wiberg, Malmqvist, Moncaster, & Rasmussen, 2016; Boverket, 2015). National regulation is therefore often an insufficient driver in reducing the climate change impact of construction.

Local actors such as municipalities could be a driving force in reducing the climate change impact of building construction, as they are often more responsive and have better knowledge of the local situation than national administrations (Brilhante & Skinner, 2015; Bulkeley, Castán Broto, Hodson, & Marvin, 2011). Swedish municipalities are often proactive in planning for climate change mitigation and exhibit high levels of ambition regarding sustainability issues (Fenton, Gustafsson, Ivner, & Palm, 2015; Granberg & Elander, 2007; Wretling, Gunnarsson-Östling, Hörnberg, & Balfors, 2018). Regarding buildings in particular, Swedish municipalities are responsible for all phases of urban planning, including land attribution and building permits. In addition, municipalities commission major construction projects such as schools or hospitals. Municipalities are therefore both major developers and key interlocutors for other developers in the planning process.

In their role as authorities, municipalities must enforce the building code. Moreover, they have the opportunity to promote adoption of building products with low climate change impact, by setting additional environmental requirements on new buildings. Municipalities can also provide economic and administrative incentives, offer training, software tools and databases for climate change impact assessments, promote dialogue and innovation, and raise awareness of climate issues among stakeholders (Häkkinen & Belloni, 2011). As property owners, municipalities can directly encourage building practices with low climate change impact through green public procurement (GPP) (European Commission, 2016). Environmental criteria can be used to design technical specifications or as requirements for submitted tenders. They can be used in tender evaluation, although they are often weighted too low against economic criteria to influence the final choice of tender (Michelsen & de Boer, 2009; Varnäs, Balfors, & Faith-Ell, 2009).

Throughout this article, we distinguish between requirements that are *prescriptive* (requiring specific building materials or features, e.g. use of timber), *informative* (requiring the provision of data, e.g. a detailed bill of materials) and *performance-based* (requiring a certain quantitative performance level for the whole building, e.g. climate change impact of construction products or of the building as a whole). Prescriptive requirements are straightforward to implement and monitor, but they may hinder competition and innovation and lead to sub-optimal building solutions (Häkkinen & Belloni, 2011; Meacham, 2010; Selviaridis &

Wynstra, 2015). One such example is mandatory use of timber frames. Although substituting timber for concrete is usually beneficial in terms of climate change impact (Peñaloza, Erlandsson, & Falk, 2016; Salazar & Meil, 2009), concrete could conceivably be a better solution in cases where it is produced with a low clinker content or carbon storage techniques (De Schepper, Van den Heede, Van Driessche, & De Belie, 2014; Razi, Razak, & Khalid, 2016). On the other hand, performance requirements allow for flexibility and innovation and ensure that the desired outcome is reached, but their implementation and monitoring often require dedicated software, staff training or third party experts. Environmental performance requirements related to climate change impact must rely on a standardised method to ensure that results are comparable. For instance, Environmental Product Declarations for buildings in the EU must comply with the core rules described in EN 15804 and the life cycle assessment (LCA) method described in EN 15978. A municipality can decide to set environmental performance requirements based on one phase of the life cycle, e.g. the construction phase, or on the entire life cycle. Setting and monitoring of environmental performance criteria requires the use of specific LCA tools and databases. Therefore, municipal officials need to be familiar with LCA procedures.

The overall aim of this study was to investigate how Swedish municipalities are acting to reduce the climate change impact of building construction. Specific objectives were to investigate current practices related to measures promoting construction materials with low climate change impact; and to identify barriers to implementation of environmental requirements in construction and discuss how current practices could be improved. Particular focus was on environmental performance requirements and the use of LCA tools by municipalities (not necessarily limited to construction materials). The study comprised a survey of Swedish municipalities and semi-structured interviews with representatives of selected municipalities. The following research questions were addressed:

- To what extent and with what instruments do Swedish municipalities promote building construction with low climate change impact?
- What strengths and barriers do practitioners in Swedish municipalities perceive when setting requirements to reduce climate change impact in building construction?

- What practices can enable successful implementation of environmental performance requirements to limit the climate change impact of buildings?

2. Background on the roles of Swedish municipalities related to construction

This section describes the legal context in Sweden regarding environmental requirements on building construction. Municipalities have two distinct roles, as an authority and as a property owner, as illustrated in Figure 1. As a public authority, the municipality handles all matters related to planning, including:

- Developing a comprehensive plan, setting aspirations and strategies for municipal development. This includes areas for new construction and consideration of sustainability and national targets.
- Developing legally binding detailed development plans that regulate development within a specific area in accordance with the comprehensive plan and the national Planning and Building Act.
- Allocating land to developers by granting temporary exclusive right to build in an area owned by the municipality, if the developer respects conditions pertaining to the detailed development plan.
- Setting land exploitation agreements, where the municipality and developer agree on how the detailed plan will be implemented on a parcel of land not owned by the municipality.
- Issuing building permits and enforcing construction requirements.

In land allocation, exploitation agreements and building permits, the municipality follows the Planning and Building Act (SFS 2010:900), as specified in a legal block (SOU 2012:86). It enforces requirements in the Planning and Building Act and the building code (BFS 2011:6 and subsequent changes up to BFS 2017:5) and cannot prescribe additional specific requirements. As property owners, municipalities are not limited by the legal block and can set additional requirements (Svensson & Torbäck, 2016). The processes where the municipality acts as a property owner include:

- Contests for land allocation in specific areas, or for the selection of architects for municipal projects.
- Procurement for the municipality's own construction projects, and owner directives where the municipality states what objectives should drive the municipally-owned real estate company.
- Selling municipal land.

However, the law remains vague on several aspects:

- The exact requirements prohibited for public authorities are not clearly defined. Requirements that hinder free competition or are more ambitious than the building code are prohibited. Requirements on aspects that are not regulated in the building code could be interpreted as legal. For instance, requiring a specific material for the building envelope could be considered an additional ambition on top of energy performance requirements, which is illegal (Svensson & Torbäck, 2016), or it could be argued that materials are not regulated in the building code.

- For certain tasks such as detailed development plans, there is uncertainty as to whether additional requirements may be set. Interpretations of different paragraphs of the Planning and Building Act vary. For other tasks, such as issuing building permits, it is clear that municipalities may only enforce the building code.

- When selling land, the municipality can be seen as abusing its monopoly over planning decisions if it forces the buyer to build in a certain way. Despite the fact that the municipality acts as a property owner, the legality of requirements must be determined on a case-by-case basis.

Previous studies suggest that municipalities often transgress these legal boundaries (Florell, 2016; Svensson & Torbäck, 2016).

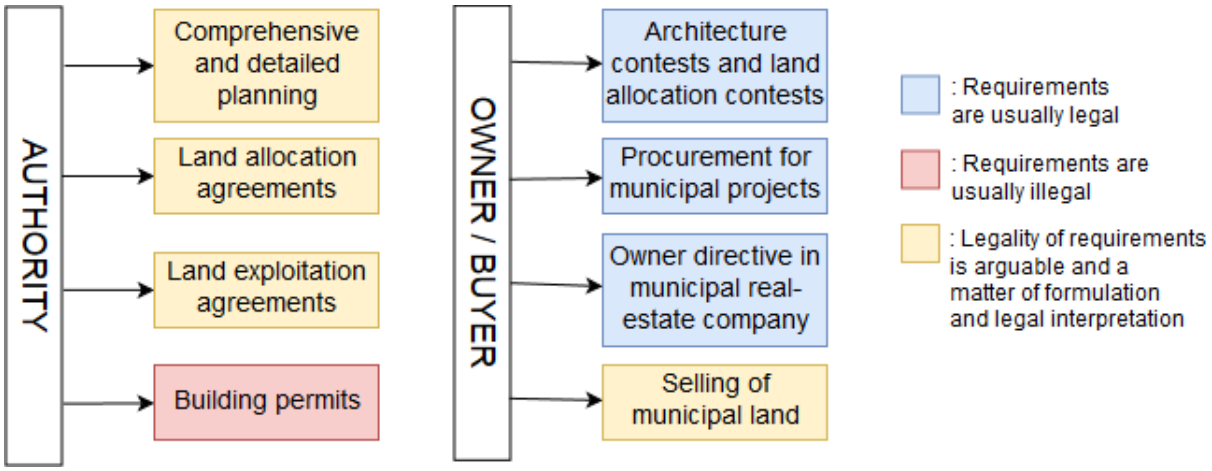

Figure 1: Simplified representation of the various roles of Swedish municipalities, and of legal issues surrounding requirements. Based on Svensson & Torbäck (2016) and our interpretation. Legality in yellow cells depends on the municipality respecting the rules of free competition and not bypassing the building code.

3. Methodology

The first step in the present study was to design a survey to quantitatively investigate the practices of Swedish municipalities in promoting building products with low climate change impact. The results were analysed to identify municipalities providing the most interesting answers and aspects of their practices deserving deeper examination. Semi-structured interviews were then designed, based on insights from the survey, to capture the point of view of municipal representatives, focusing on their experience, their use of LCA tools and perceived drivers and barriers to their practices.

3.1. Survey of Swedish municipalities

3.1.1. Survey overview

Swedish municipalities were surveyed regarding the practices they use to reduce the environmental impact of buildings. The survey focused on the climate change impact of construction materials, as a way to address an often-overlooked aspect of the environmental impact of buildings.

Energy and climate advisors in all Swedish municipalities and previous contacts of the research team were first invited to complete the survey. Energy and climate advisors were contacted because each municipality is required to employ at least one such advisor. They were asked to either take the survey themselves, or forward it to someone with more knowledge. When no response was obtained, the survey was sent to environmental strategists, planners, construction managers or municipal property managers. At most one response per municipality was obtained.

Detailed information on the survey is provided in appendix A1. The first part comprised questions about the respondent's familiarity with environmental issues in construction and related municipal policies. The second part investigated policy instruments the municipality uses, has used, or plans to use to promote

construction products with low climate change impact. The third part of the survey investigated the type of requirements set by the municipality, e.g. prescriptive, information or performance-based requirements.

3.1.2. Quantitative analysis

Some responses mentioned measures unrelated to construction products, such as links to district heating or installation of solar panels. When it was clear that the respondent had misunderstood the question, such responses were ignored. Four respondents were employed jointly by several municipalities, but completed the survey only once. Their answers were duplicated to represent each municipality separately. After these modifications, the responses represented 88 of the 290 Swedish municipalities (30% response rate). The responding municipalities were divided into three size categories (Large, Medium, Small), belonging to the top, middle and bottom population tertile of the set of all Swedish municipalities, respectively[1]. The results were analysed using the Real Statistics Resource Pack for Excel (Zaiontz, 2015). To determine whether survey responses depended on municipality size (in terms of population), the Kruskal-Wallis test was used (Kruskal & Wallis, 1952). It comprises one-way ANOVA performed on ranks, which makes no assumption of continuity or normality about the underlying distribution (this is necessary because survey data are discrete). A positive test indicates that values in at least one category are significantly higher than values in another category. A follow-up with Dunn's test identified where these differences lie (Dunn, 1964).

3.2. Interviews with municipality representatives

Semi-structured interviews give insights into the respondent's own perspective on the interview topic (Kvale, 2007). The semi-structured interviews performed with representatives from municipalities addressed policies related to the climate change impact of buildings, not necessarily limited to construction materials.

[1] It should be kept in mind that Swedish municipalities are small by international standards: "Small" municipalities have fewer than 11 100 inhabitants, "Medium" municipalities between 11 100 and 23 600 inhabitants and "Large" municipalities more than 23 600 inhabitants.

They also focused on the municipality's skills, resources and experience with LCA tools and procedures. The interview template used is provided in appendix B.

Municipality representatives who gave particularly insightful answers in the survey, or with whom the researchers were already in contact, were contacted in the first instance. Between May and August 2017, a total of nine semi-structured interviews were held, in person or via video link, with 11 respondents (see Table 1). Codes were allocated to anonymise the interviewees, with M and L referring to the municipality's size (Medium and Large, respectively), C and N referring to the municipality's surroundings (Conurbation and No conurbation, respectively), numbers differentiating between municipalities, and lower case letters differentiating between different respondents from the same municipality.

Table 1: Occupation of interviewees and information about the municipality they represent

Code name	Population (inhabitants)	Part of conurbation[2]	Occupation
MNa	15 000-20 000	No	Energy expert, Development department. Building permit administrator, Construction council.
MNb			Architect consultant, Development department.
LC1	30 000-40 000	Yes	Project leader, Planning and exploitation department
LN1	80 000-100 000	No	Energy planner, Management department
LC2a	80 000-100 000	Yes	Project leader, Development department
LC2b			Property manager, Municipal real-estate company
LN2	90 000-110 000	No	Energy controller, Municipal real-estate company
LC3a	90 000-110 000	Yes	Director, Department for construction projects
LC3b			Engineer, Department for construction projects
LC4	> 500 000	Yes	Project leader Energy and Environment, Department of municipal real estate and premises.
LC5	> 500 000	Yes	Energy and climate advisor, Environmental department

[2]As classified by the Swedish Bureau of Statistics, there are three conurbations in Sweden, located around Stockholm, Gothenburg and Malmö (Statistics Sweden, 2005).

The results were recorded and transcribed. Interesting quotes were then classified into themes based on the interview template (Miles & Huberman, 1994; Vaismoradi, Turunen, & Bondas, 2013). To explore themes that appeared particularly important in relation to the research questions, the experiences of Stockholm and Växjö were presented in narratives and analysed in more detail. These two municipalities exemplify two different ways of addressing the climate change impact from construction.

4. Results

4.1. Policy documents, visions and motivation

Around half of the responding municipalities have a policy document dedicated to climate or environmental issues related specifically to construction (Figure 2). Statistical analysis showed that municipalities that had a dedicated policy document were significantly larger than municipalities that did not.

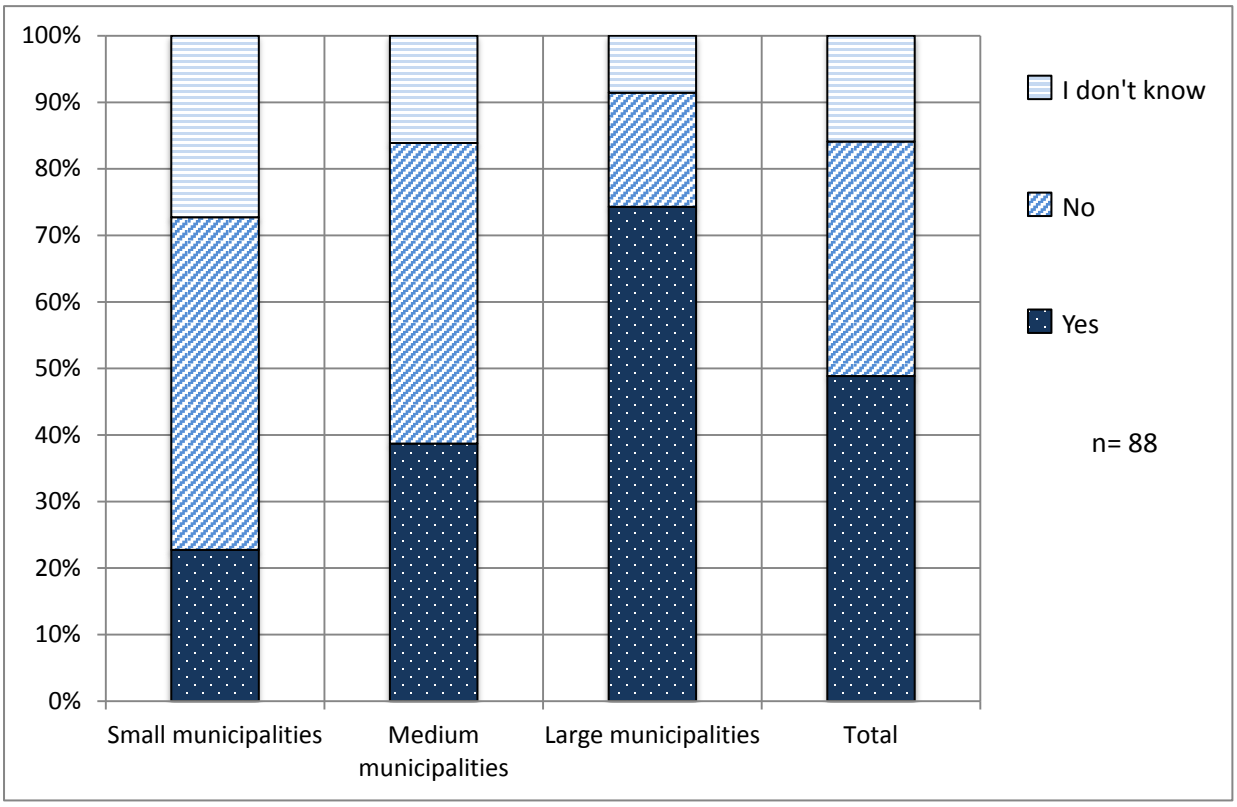

Figure 2: Proportion (%) of small, medium and large municipalities choosing different response options to survey question 3: 'Does your municipality have any kind of policy document for climate or the environment related specifically to construction?'

The interviews provided further information about local goals set by municipalities in relation to the environmental impact of buildings. Some have generic goals covering the climate change impact of all municipal activities, while others specifically address the climate change impact of construction. MN and LN1 reported having objectives or political statements about promoting timber construction, while LC4 and LC5 work on strategies to decrease the environmental impacts of construction in their own procurement practices and in their role as an authority. The responses from other interviewees were sometimes more vague. LC2 mentioned that buildings should be "eco-friendly and climate-smart", but did not specify what this entails. LC3 mentioned using six environmental targets adapted from national targets (including reducing GHG emissions). This seems to be common practice, e.g. in 2011, 60% of municipalities were using local environmental targets adapted from regional or national targets (Swedish Association of Local Authorities and Regions, 2012).

Some interviewees reported that the main driver for municipal interest in climate change issues is the motivation of individual politicians. MNb said:

> We participated [in an intercommunal timber construction programme] precisely because politicians and officials were so engaged.

Similarly, LC2a claimed that the importance given to environmental issues in each project depends largely on who the project leader is. LN1 mentioned mutual agreement across political parties to improve the environmental performance of construction.

The involvement of constructors and developers also affects the extent to which municipalities work with climate change impacts in construction. In many cases, interviewees acknowledged the importance of consulting stakeholders. LC5 pointed out that an accommodating attitude among developers and good collaboration were key aspects of their work with developing environmental requirements in construction.

4.2. Familiarity level and resources

Survey respondents were asked to rate their own level of familiarity about the climate change impact of construction materials, using a scale from 1 to 5. The responses revealed significant differences in

familiarity between large and medium municipalities, but not between large and small municipalities (Figure 3). Therefore it can't be concluded that a municipality's level of familiarity is linked to its size.

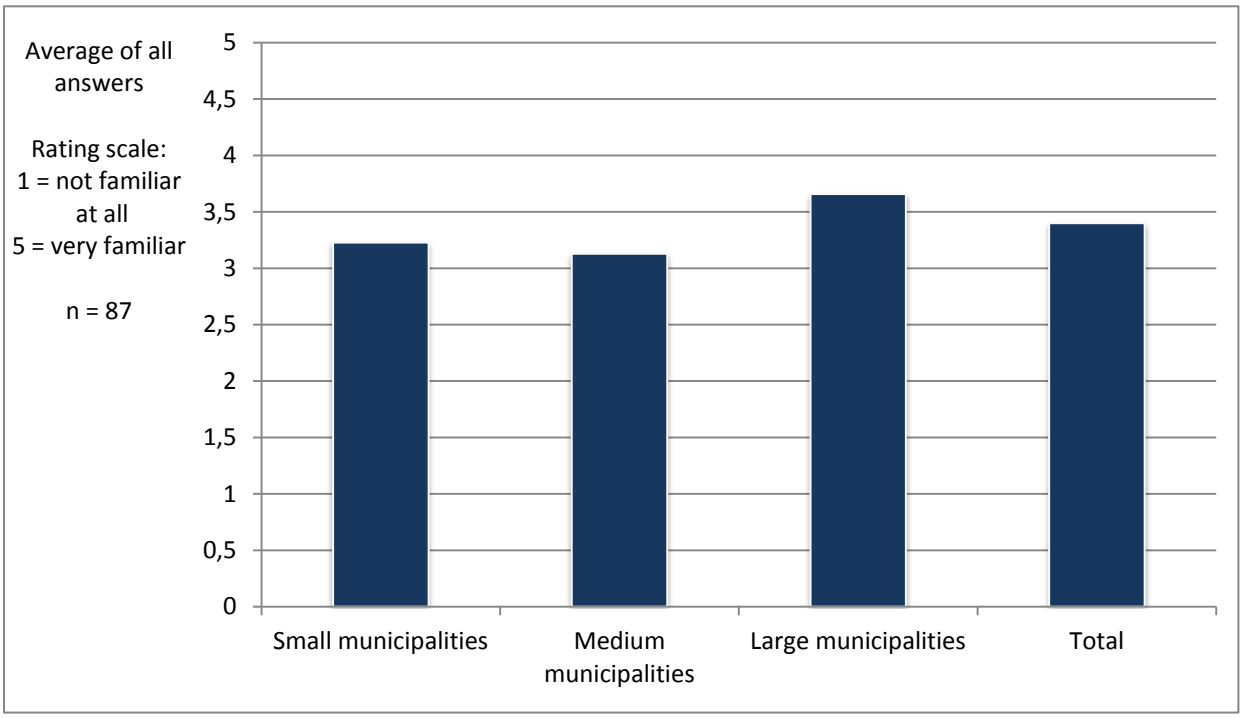

Figure 3: Rating given by small, medium and large municipalities in response to survey question 4: 'The climate change impact of construction materials is becoming increasingly important. How familiar are you with this issue, on a scale from 1 to 5?'

In the semi-structured interviews, the interviewees were asked about their knowledge of LCA tools and procedures, which is usually necessary to set environmental performance requirements. LC4 and LC5 reported having performed LCA with the help of external consultants, but said that knowledge of LCA within their municipality remains limited. Other interviewees reported no such experience.

Available resources dedicated to environmental targets for construction vary between the municipalities represented by interviewees. LC4, LC5 and LN1 reported that resources are allocated specifically to build knowledge and/or reduce the climate change impact of construction, whereas LC1 reported having too little resources to work with environmental matters. LC2a said that their budget dedicated to environmental issues depends on individual project leaders. This means that impact reduction strategies depend on the motivation of a few individuals, and that procurement decisions are not necessarily

in line with political statements. Several respondents wanted more guidance from national institutions such as Boverket. MNb said:

> The way I see it, it would work best if we could get everything from the government, from Boverket; if they could set requirements about environmental performance. Otherwise, it's difficult to handle it ourselves.

4.3. Implementation of measures to promote building products with low climate change impact

According to the survey results, 59% of responding municipalities occasionally use at least one measure to promote construction materials with low climate change impact, while 47% are planning or intend to implement new measures in the future.

The most common measure reported was procurement in municipal construction projects, followed by information and dialogue with stakeholders (Figure 4). The most common environmental requirements cited were prescriptive requirements, i.e. mandatory use of a specific technology or material, followed by requirements to calculate the impact of construction materials for information purposes (Figure 5). The responses indicated that prescriptive requirements are used much more often than environmental performance requirements. Some measures mentioned could contravene the Planning and Building Act (SFS 2010:900) and the legal block (SOU 2012:86) (for instance setting additional technical requirements when issuing building permits).

The sensitivity of the responses to municipality size is illustrated in Figure 6. Statistical analysis revealed that large municipalities use significantly more measures than small municipalities, but with no significant difference between small and medium, or medium and large, municipalities. There was no significant difference between the size categories in the number of measures planned for future use, or the number of measures that have never been considered. The number of measures that have been tested and abandoned was zero for all small and medium municipalities, but greater than zero for four large municipalities. Because question 6 only addressed measures previously mentioned by the respondent, the sample size for each measure was too small to permit statistical analyses for that question.

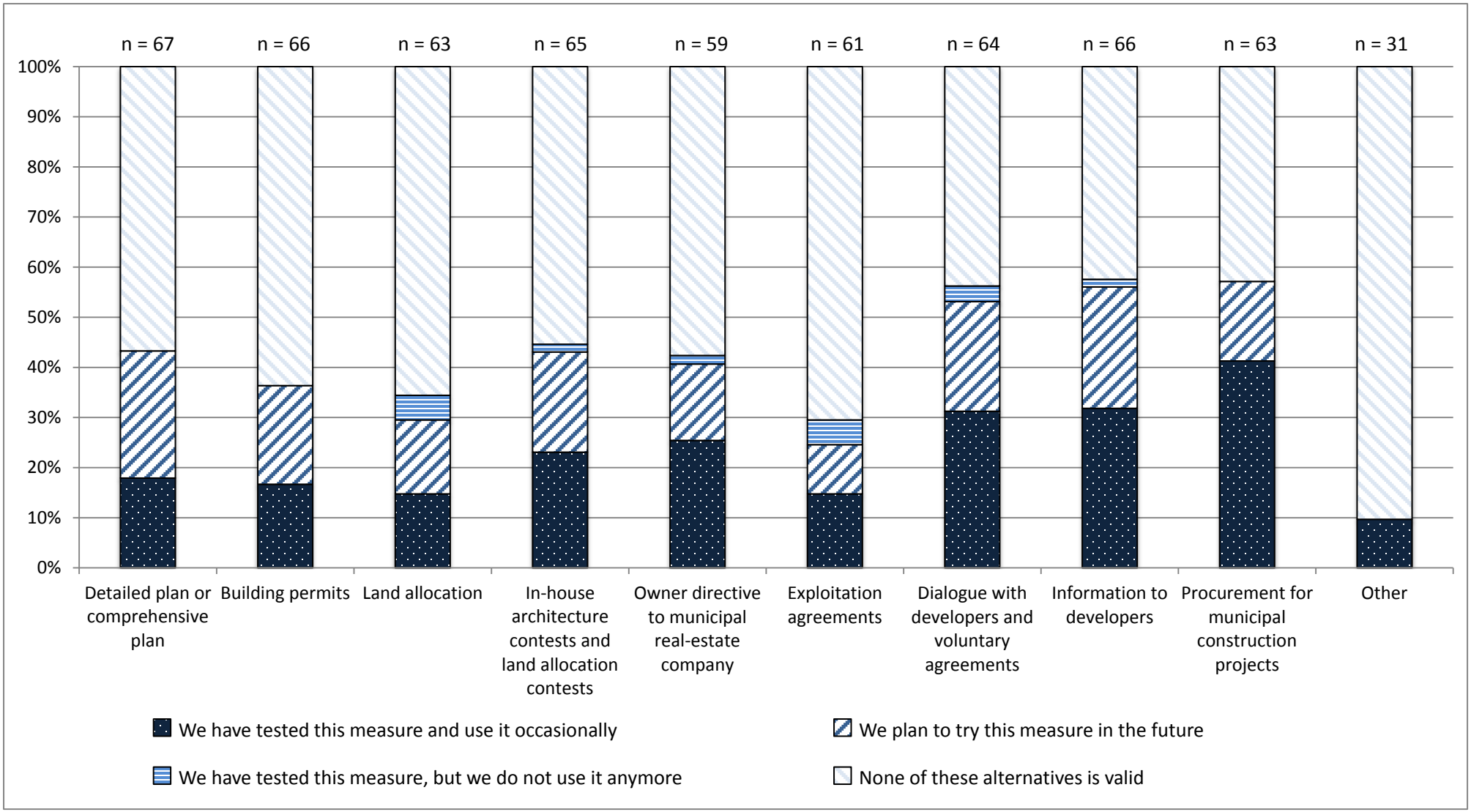

Figure 4: Proportion (%) of municipalities choosing different response options for each policy instrument in survey question 5: 'Which of the following policy instruments does your municipality use to reduce the climate change impact of construction materials in construction projects?'

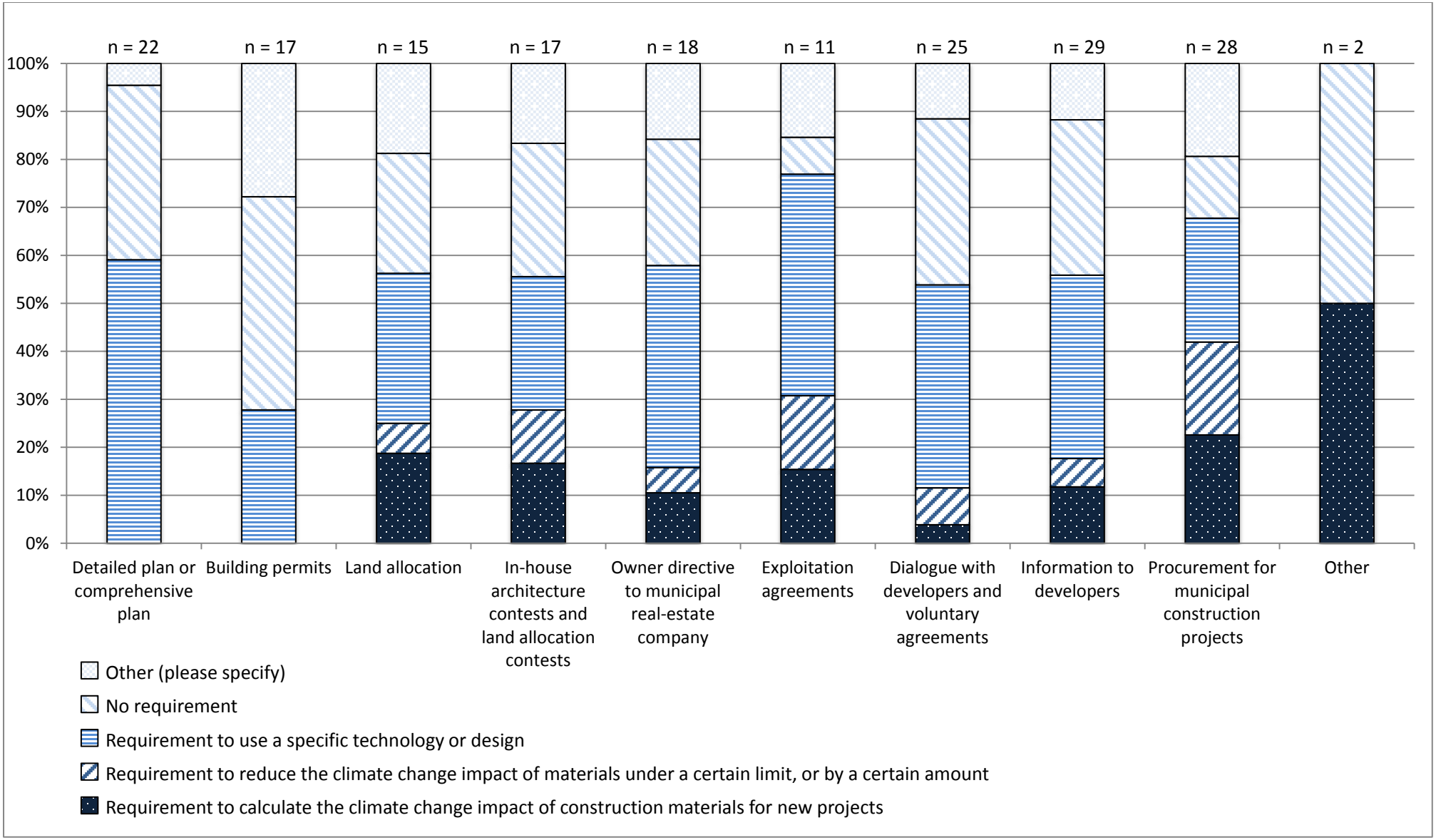

Figure 5: Proportion (%) of municipalities choosing different response options to survey question 6: 'What type of requirement have you used or do you plan to use in relation to each of the following policy instruments?'

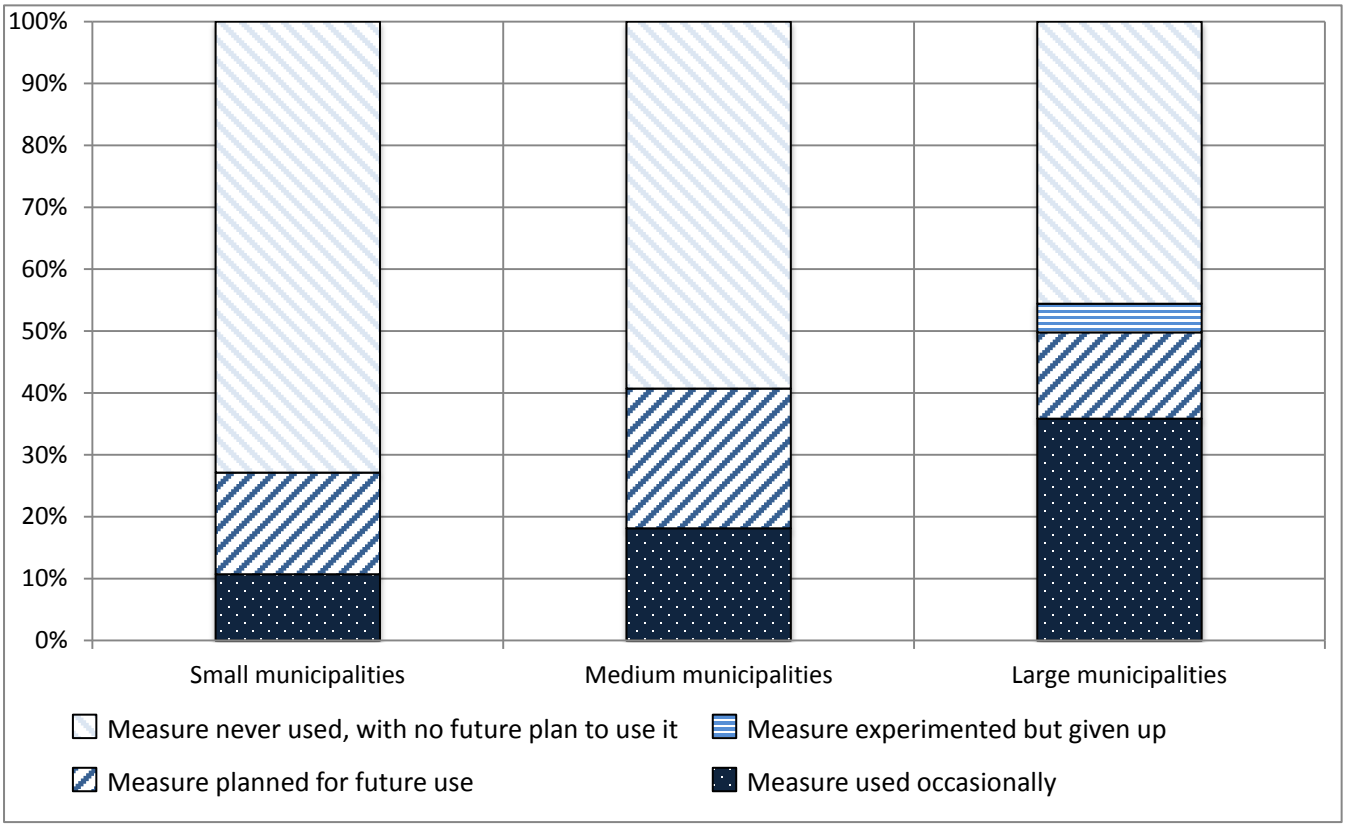

Figure 6: Proportion (%) of small, medium and large municipalities choosing different response options to question 5, summed over all policy instruments.

4.4. Challenges to increased implementation of environmental requirements

This section focuses on challenges encountered by respondents when considering environmental requirements. The experiences of Stockholm and Växjö in their work with performance and prescriptive environmental requirements are first described in depth. Information and environmental performance requirements based on LCA tools and procedures are then scrutinised in more detail and challenges experienced by responding municipalities are divided into four categories: knowledge, guidance, economic and legal aspects.

4.4.1. Case description of two forerunner municipalities

The municipalities of Stockholm and Växjö employ different approaches when implementing environmental requirements for buildings. This section describes insights that can be gained from these cases. In the case of Stockholm, results in Pandis Iverot & Brandt (2011) are used to provide context for interview results.

Development of the district Hammarby Sjöstad, a former industrial site in Stockholm, was initiated in 1996 as a flagship environmental development project. The establishment of environmental requirements was therefore motivated by politics and the city's image. A vision was developed for the district, with the broad aim that the environmental performance of buildings in a life cycle perspective should be twice as good as the present-day state of the art. It was met with broad support from stakeholders, but the environmental programme was introduced late in the design process and some goals proved to be conflicting, vague or unrealistic.

To evaluate environmental performance, the Environmental Load Profile (ELP) tool was used (Brick, 2008; Forsberg, 2003). The ELP was a forerunner in terms of scope, as it covered a full life cycle and several impact categories, with the focus on sustainable consumption at neighbourhood level. However, developers reported that they did not fully understand the results, that the ELP included aspects over which they had no influence or responsibility, and that the reporting feedback was unsatisfactory. The environmental programme lacked guidelines regarding who was responsible for the assessment or what standards it should follow. As a result, developers and constructors did not get involved as intended, and the assessment was entirely carried out by a consultant. The ELP used inventory data from the design phase that should have been followed up with data reflecting actual construction practices. The actual follow-up used the bill of construction materials supplied by the constructors, supplemented with default data on e.g. waste, transport and metrics related to sustainable consumption.

Improvements were achieved, notably reductions in material and energy flows. However, some goals set by the city of Stockholm (e.g. on energy use, renewable energy supply and water use) were either not achieved or not monitored. These shortcomings were partly attributed to an ineffective governing structure, user behaviour and architectural preferences (e.g. large windows facing north increase energy use). Another interpretation mentioned by the respondent is that expectations were too high: the energy performance goal was difficult to achieve at the time and developers were expected to carry out assessments they were not ready for.

New ambitions were set in 2009 for a new flagship project, the Royal Seaport district. The respondent from Stockholm reported:

> The politicians decided to give it another try. There was much that turned out well in Hammarby Sjöstad, but now we have to plan something that is good all the way through.

Building on experience from Hammarby Sjöstad, great attention was paid to collaboration with developers and constructors when setting the environmental programme for the Royal Seaport. The city initiated dialogue with developers, which was met with interest and an accommodating attitude:

> What has greatly inspired us is that no one has complained about our requirements. Instead, [the developers] say that they will do it, although it´s a major challenge.

Once the actors had agreed the terms, an environmental management programme, including information requirements, was applied to land allocation agreements. Since 2012, developers receiving land in the Royal Seaport from Stockholm municipality must perform an LCA to evaluate the choice of building frame materials and suggest possible environmental performance improvements. As in Hammarby Sjöstad, the developers struggled with the assessment process, even though the city provided training seminars and a simplified assessment tool. The developers had trouble gathering data and could not make proper assessments without hiring consultants. The Stockholm respondent identified lack of data as a critical problem and claimed that they do not have the competence to assess the quality of EPDs. Both municipality and developers are therefore still struggling with similar knowledge issues.

In 2017, Stockholm municipality attempted to standardise the assessments. Apart from specific efforts in the Royal Seaport, the municipality developed a holistic process including mandatory use of LCA for all new municipally-owned buildings and land exploitation agreements (Hälleberg & Erlandsson, 2014). The aim with this information requirement is to establish a consistent and standardised assessment procedure, address the perceived lack of data and give developers and constructors time to get used to carrying out assessments before further requirements are set. According to the respondent, Stockholm plans to set performance requirements on climate change impact for construction of residential buildings within two years. However, the respondent stressed the importance of first improving the information requirement,

so that future performance requirements are set with a robust method. The respondent claims that LCA-based performance requirements would not pose legal issues if they respect competition neutrality.

Politicians in Stockholm consider that the municipality has a particular role as forerunner due to its size and political importance and that their practices can influence other municipalities and even national policies. The respondent from Stockholm declared:

> If we succeed as forerunners and show that construction can be changed in favour of a decreased climate change impact, it will be a major breakthrough. […] I am entirely convinced that without municipal requirements, Boverket wouldn't be changing the building code the way they are doing.

The size of Stockholm also makes it an important client for constructors. The respondent explained that this motivates constructors to improve their environmental performance in order to maintain a good relationship with their client. However, constructors will only get involved if the approach is profitable for them. The respondent claimed that improving environmental performance will be profitable for constructors in the long run and will also help reduce construction costs.

Växjö, a municipality of about 90 000 inhabitants, is located in southern Sweden. Like Stockholm, the sustainability strategy of Växjö is driven by political motivation, in this case reinforced by political consensus:

> It has been a strong advantage for us in Växjö to have politicians who want to be at the forefront, and dare take decisions no one had taken before. […] Actually, politicians from the right to the left are unanimous on these environmental issues.

Showcasing a sustainable image is important for Växjö, which markets itself as the 'greenest city in Europe'. Ambitious targets have been set: By 2020, the municipal organisation will be fossil-fuel free and CO_2 emissions per inhabitant will have decreased by 65% compared with 1993. By 2030, all activities within the municipality will be fossil fuel-free. Växjö makes extensive use of prescriptive requirements in procurement. The city joined a modern timber construction initiative from 2010 to 2012. Aims were set for municipal real estate companies: 25% of buildings to be constructed from timber by 2015 and 50% by 2020.

The respondent reported that the goals have been surpassed each year so far. Timber construction is considered an environmentally friendly practice by Växjö municipality, but economic aspects also come into play as Växjö is situated near large forests and favouring timber construction is a way to promote local industry.

Politicians in Växjö are willing to pay for impact reduction measures and accept extra costs if environmental targets are achieved. The respondent explained that compensating for higher costs imposed by the requirements is necessary to motivate stakeholders. The respondent also reported close collaboration between the municipality, the local business community and academia. As in the Stockholm case, stakeholder consultation was stressed as a key strategy.

Växjö municipality applies evaluation criteria for timber in procurement and prescribes use of timber in some of its construction projects. Land allocation competitions evaluate developers as regards various aspects, including timber construction. The 2015 legal block was seen as a limit to the municipality's efforts, since the law focused on limiting their ability to set prescriptive requirements in their role as an authority. However, the municipality has carried on with environmental requirements in procurement and in competitions for land allocation:

> [The 2015 legal block] has been interpreted in different ways. When the law was applied, we had to rein back. But we decided to continue our efforts as far as possible.

Environmental performance assessments with LCA are not currently used by Växjö municipality, but the respondent mentioned that they could be a driving force for sustainable practices:

> It would be useful to be able to set requirements on environmental impact and evaluate options in a rigorous and objective way. […] There's a lot of ongoing work on transitioning to environmentally friendly materials, but often it's just words. If we could get a number showing how much a material is affecting the environment, things could be different.

The two cases described above exemplify how forerunner municipalities in Sweden work with information requirements, performance requirements and/or prescriptive requirements on timber in

construction. In the following sections, interview results relating to perceived barriers to information and environmental performance requirements based on LCA tools and methods are presented.

4.4.2. Knowledge aspects

The interviewees reported a lack of available data of sufficient quality to assess environmental performance using LCA tools. Lack of appropriate EPD data and inability of the municipality to assess the quality of EPDs were mentioned by both LC4 and LC5, which indicates that this problem applies even for larger municipalities. LC4 mentioned a pilot project on fossil-free construction that aims to encourage material producers to publish EPDs and build experience on fossil-free transitions. That interviewee expects data availability and skill levels to improve in coming years.

A related issue is lack of standardised methods for gathering data, performing calculations and documenting and verifying processes. The current information requirement in Stockholm is an attempt to overcome issues of knowledge and standardisation by developing calculation and verification processes. In a later step, the municipality might implement performance requirements with standard methods based on insights from the information requirement.

Learning requires time and resources. Respondents from all but the largest municipalities mentioned that there was no internal knowledge of LCA tools within their organisation. LC1 declared:

> We don't have enough resources, we don't have enough knowledge, and we don't have resources to get this knowledge.

The largest municipalities have ongoing knowledge-building processes, but internal knowledge varies widely between project leaders and these municipalities still rely heavily on hiring consultants. Several respondents mentioned the importance of dialogue and cooperation to foster learning, both among neighbouring municipalities and between municipalities and the construction industry. Municipalities and developers can benefit from cooperating and sharing information, as they often have the same knowledge levels. However, recent experience from the Royal Seaport in Stockholm shows that mutual aid is not enough to solve all knowledge issues, as developers still struggled after the city provided education seminars and an assessment tool.

4.4.3. Guidance aspects

Many municipalities see the issue as too large and complex for them to handle, and consider that current guidance at the national level is insufficient. LC1 declared:

> If significant results are to be achieved, the municipalities cannot be in charge. […] We can't work on the issue the way the largest municipalities do. This must come from the government, and we must get legal support.

Several interviewees thus want Boverket to set up environmental requirements at national level, as well as standards for EPDs. This would address issues of standardisation and lack of data and facilitate efficient coordination between different authorities. On the other hand, LC4 and LC5 believed that the size of their municipalities allows them to act as forerunners and send significant market signals.

4.4.4. Economic aspects

If constructors cannot evaluate additional costs imposed by requirements, they perceive a financial risk and become reluctant to participate in dialogue and procurement. Guarantees can be given to constructors, for instance by accepting higher costs in tender evaluation, as exemplified in Växjö. LC4 believed that promotion of construction with low climate change impact sends a strong signal to the construction industry.

Several interviewees mentioned a conflict between the need to keep construction costs low in growing cities and environmental requirements incurring additional costs. However, LC5 considered that a well-implemented assessment process could decrease construction costs.

4.4.5. Legal aspects

LC4 mentioned a risk of prosecution if municipalities implement environmental performance criteria that cannot be rigorously verified and compared. This is also the case for procurement, where the municipality can be accused of inhibiting competition. Interviewees and survey respondents both reported uncertainty regarding which requirements they could apply. This was apparent from responses such as:

> We can set requirements as developers but not when selling land! The law must change!

Can we really set specific requirements according to the Planning and Building Act?

Some municipalities see the legal block as a setback to their efforts, e.g. LC1 expressed clear frustration:

> It's ridiculous that we can't set requirements on the land we sell! Any other developer can do it, why not us?

This is interesting considering that the legal block is not intended to restrict the municipality's actions as a land owner, as long as they do not abuse their monopoly position. However, the definition of monopoly position in planning is unclear and a matter of case-by-case interpretation. MNb exemplified how wording matters when setting requirements in land allocation competitions:

> We're not allowed to write that houses must be built in timber. Instead, we organise a land allocation competition and write here and there that one must "follow the tradition and character of the town's timber buildings" […] Everyone knows what it implies.

LC5 did not perceive the legal block as an obstacle to their work with environmental performance requirements, as municipalities working to implement environmental performance requirements based on LCA tools should not face legal challenges as long as their requirement does not hinder competition.

5. Discussion

This section addresses the validity and limitations of the study, summarises the main findings and situates them in the fields of green procurement and local planning for climate change mitigation. Finally, it provides recommendations for municipal practitioners on moving towards implementing environmental performance requirements.

5.1. Validity of the study

The survey and interview templates were based on guidelines from Clow & James (2014) and Kvale (2007), respectively. Several issues were identified when analysing the results.

First, the results do not quantitatively represent the set of all Swedish municipalities. In the survey, small municipalities were under-represented (25% of respondents) and large municipalities overrepresented (42% of respondents). In the interviews, all municipalities represented were large except one, which was medium-sized. This was partly due to the fact that respondents with insightful survey answers were prioritised for interviews. Carrying out more interviews could have obtained more diverse answers, but this was limited by time and budget constraints.

Some respondents made mistakes when answering the survey. When comments indicated that the respondent misunderstood the question, the answer was omitted. Interview results are produced during a dialogue between interviewer and respondent, and the behaviour and rhetoric of the interviewer can influence the responses. Social desirability could also play a role in responses in interviews and the survey, as they might reflect personal hopes and opinions rather than factual information about the municipality. Two different interviewers carried out the interviews, to ensure the results were not influenced by the behaviour of a single interviewer.

5.2. Main findings and theoretical contribution

This study examined the use of environmental requirements in construction by municipalities, both as property owners and as public authorities. It is therefore relevant to relate the findings to two separate fields: green procurement and planning for climate change mitigation by local authorities.

5.2.1. Effect of municipality size

The motivation of municipalities to work towards reducing climate change impacts from construction and their level of familiarity with this issue did not depend on their size. However, small municipalities appeared to have significantly less resources to dedicate to such work, were less likely to have dedicated policy documents and had implemented fewer measures than their larger counterparts. The effect of an organisation's size on its involvement with environmental issues is complex. In the present study, this issue was addressed in the specific context of setting requirements on new construction. In the field of local climate change mitigation policies, Wretling et al. (2018) found that size influenced the probability of a

municipality having up-to-date policy documents related to energy and climate, while Fenton et al. (2015) found that size influenced the choice and scope of measures in energy and climate strategies, but not the organisational style (e.g. stakeholder involvement, top-down or bottom-up processes, etc.). A comprehensive study of local climate plans at European level also found that size plays a significant role in adoption of such plans (Reckien et al., 2018). In the field of procurement, size has been found by some studies to significantly affect adoption of green procurement in the public and private sectors (Appolloni, Sun, Jia, & Li, 2014; Michelsen & de Boer, 2009; Testa, Iraldo, Frey, & Daddi, 2012). However, other studies suggest that the size of a public organisation does not influence its adoption of sustainable procurement (Testa, Annunziata, Iraldo, & Frey, 2016) or its internal knowledge about environmental issues (Michelsen & de Boer, 2009).

5.2.2. Measures used by municipalities and national regulations

The most common measures used by Swedish municipalities to reduce climate change impacts from construction are procurement, dialogue and guidance for developers. Measures linked to the municipality's role as an authority are rarely used. This is unsurprising, considering that the 2015 legal block focused on restricting the type of requirements that municipalities can set as authorities. However, some survey respondents mentioned using technical requirements that could be considered illegal. This might be due to municipalities deliberately transgressing boundaries or misunderstanding the law, or the respondents may have misrepresented the situation. A previous investigation involving 42 Swedish municipalities found that 57% were using special requirements that clash with the legal block (Svensson & Torbäck, 2016). Some municipalities remain uncertain as to what kind of measures they can take and respondents expressed a desire for clarification and better guidance at national level. In the field of local planning for climate change mitigation, Wretling et al. (2018) found that inappropriate legal context at national level hinders strategic work by municipalities on energy and climate issues. Within green procurement, Walker, Di Sisto & McBain (2008) found that compliance with EU regulations on competition was perceived as a threat, while Thomson & Jackson (2007) cite examples of government policies that are either significant drivers or barriers to green procurement in local authorities. Regarding the role of national guidance, Faith-Ell, Balfors

& Folkeson (2006) highlighted poor communication between national and local authorities as one of the main barriers to environmental requirements in road maintenance contracts. Reckien et al. (2018) concluded that local authorities are less likely to develop plans for climate change mitigation and adaptation when they are not pushed by national regulations. The present study showed that work by municipalities on environmental sustainability is heavily dependent on compliance with national law and guidance from national authorities when setting requirements in construction.

5.2.3. Use of environmental performance requirements

The use of environmental performance criteria by municipalities is currently very rare and almost exclusively limited to procurement. It is more common for municipalities to prescribe specific materials or designs. The following barriers to environmental performance requirements were identified:

- Skills related to LCA tools and methods are lacking among municipalities and developers.
- Quality data about material inventories and environmental impacts are lacking.
- The process of establishing standardised procedures and training staff is long and costly.
- Perceived risks of additional costs limit buy-in from stakeholders.
- Municipalities fear legal prosecution. The law is perceived as unclear regarding the types of requirements that can be set and practices to follow to avoid legal issues.
- Some municipalities consider that environmental performance requirements are too complex to be handled locally and want more guidance and standardisation at national level (e.g. from Boverket).

Similar barriers can be found in green procurement and planning for climate change mitigation. Raising awareness and knowledge is commonly mentioned as a key measure to promote green procurement (Testa et al., 2016, 2012; Walker et al., 2008). Cost issues have been pointed out as a barrier to local energy and climate strategies (Wretling et al., 2018) and to green procurement (Appolloni et al., 2014). Current barriers are also largely similar to barriers to implementation of LCA tools among construction practitioners which were identified in Stockholm ten years ago (Brick, 2008). Much has happened since then on the

methodological side, e.g. in development of assessment standards (EN15804, EN 15978), but organisational barriers remain.

Some municipalities have been trying to overcome these difficulties by collaborating with developers and constructors to implement appropriate tools and guidance. Such collaboration has been described as essential to overcome barriers related to lack of trust and commitment (Appolloni et al., 2014; Walker et al., 2008). The present study showed that the commitment of some municipalities to work with environmental requirements depends largely on the motivation of specific politicians or project leaders. Similar observations have been made for municipal energy and climate policymaking (Fenton et al., 2015; Wretling et al., 2018) and green procurement (Appolloni et al., 2014; Walker et al., 2008).

The most advanced LCA-based environmental performance requirements in public procurement linked to construction in Sweden are those set by the Transport Administration in 2015 (Swedish Transport Administration, 2016). Contractors must perform LCA and decrease their impact for all projects costing more than €5 million. To aid standardisation and simplification, the Transport Administration has developed a calculation tool with data, templates etc. Information and performance requirements are also evolving in other European countries. At the EU level, a voluntary reporting framework called Level(s) is being developed to standardise sustainability assessments in the building sector (Dodd, Cordella, Traverso, & Donatello, 2017). In the Netherlands, assessment of environmental performance using an LCA tool is compulsory when seeking a building permit (Scholten & van Ewijk, 2013), and environmental performance is evaluated and valued in public procurement (Rietbergen & Blok, 2013). In France, since 2017 newly constructed public buildings must meet new environmental standards. Among other criteria, their life cycle GHG emissions must be lower than a given threshold (French Ministry of Environment, Energy and the Sea & French Ministry of Sustainable Housing, 2017). In addition, all buildings in France that are advertised as environmentally friendly must prove their claims with an LCA declaration verified by a third party.

6. Concluding recommendations and implications for policymaking

This final section proposes an overarching strategy to overcome the barriers to environmental performance requirements. Environmental performance requirements have several advantages over

prescriptive requirements, e.g. they result in a holistic understanding of environmental impacts, avoid suboptimal solutions and allow for a wider palette of sustainability strategies (Häkkinen & Belloni, 2011; Meacham, 2010; Selviaridis & Wynstra, 2015). However, performance requirements are complex and require more time, resources and skills to implement. An implementation strategy that seeks to overcome these barriers is illustrated in Figure 7.

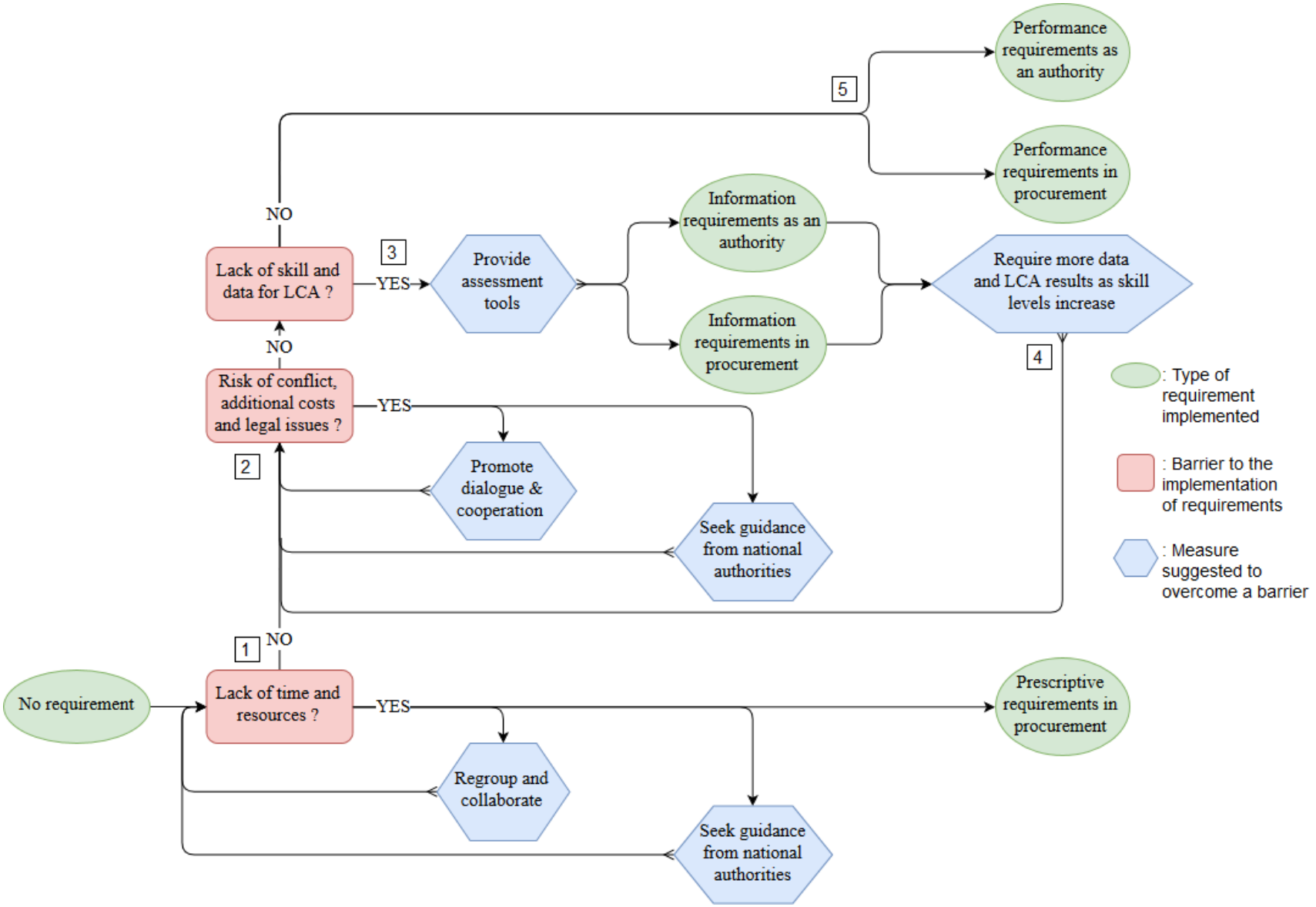

Figure 7: Flowchart of a suggested implementation strategy for environmental requirements in construction. Numbers refer to steps in a typical implementation strategy, described throughout Section 6.

The first step is to decide an appropriate level of ambition and secure support and resources to build knowledge and establish the implementation strategy. Large municipalities might be able to dedicate time, staff and resources to environmental issues, but many smaller municipalities consider their resources insufficient to deal with environmental performance requirements. One possible solution is to seek guidance and resources from national authorities. Boverket should actively provide guidance, possibly in the form of tools, data, examples of suitable requirements, or a national forum for municipalities to exchange experiences about successful practices. Another solution for small municipalities is to collaborate with neighbouring municipalities sharing similar goals. Resources, skills and data could be shared and staff could be jointly employed. They could also initiate processes of dialogue and cooperation with other stakeholders, which are of great importance in later steps. Finally, some municipalities might have too limited resources to establish performance requirements. In such cases, it is appropriate to set only prescriptive requirements in procurement, as this is a less demanding alternative, until well-established tools and procedures are available.

The second step is to establish dialogue and cooperation between all relevant stakeholders. Without proper dialogue, conflict can arise about legal issues surrounding requirements, or about additional costs and constraints that requirements can impose for developers. Maintaining good communication is important throughout the implementation process. Besides avoiding conflict and misunderstandings, this also ensures that all actors are in agreement regarding objectives, strategies and individual responsibilities. Politicians and officials should reach out to:

- Developers and constructors, to ensure they understand what is asked of them and that there are available tools adapted to their practice.
- Other municipalities, to seek opportunities for cooperation and standardisation at regional level.
- National actors such as Boverket, to seek guidance and clarify uncertainties about the law.

Risks of additional costs for stakeholders should be transparently assessed by the municipality and possibly mitigated through financial incentives. In procurement, the municipality can value environmental criteria

when reviewing tenders. The implementation of requirements should nevertheless avoid increases in construction costs, particularly in cities experiencing rapid urbanisation.

The third step is implementation of information requirements, along with guidance and specification of the method for data gathering and assessments. Assessments of environmental impacts need to be reliable, verifiable and comparable, but LCA data are often found to be lacking or of low quality, and non-standardised methods yield results that cannot be compared. Therefore, it is necessary to first improve data quality and ensure that all stakeholders use a standardized method for reporting data and carrying out LCA. Requiring developers and constructors to conduct data collection processes ensures that they provide inventory data, which is the basis for any further assessment. It also gives stakeholders and municipality officials time to build competence and acquire LCA-related knowledge by learning through experience. The municipality should start by making sure that easy-to-use, standardised methods and tools are available. The dialogues started in step two should ensure that these tools are appropriate and well understood by developers, constructors and municipality officials.

The fourth step is to make the information requirements more demanding as stakeholder skill levels increase, and move from basic to more exhaustive material inventories. Once developers can routinely provide inventories of sufficient quality for an LCA, the municipality can require them to perform the assessment themselves and provide LCA results. Assessments should progressively move from using generic default environmental data to using EPDs of the specific materials used, and from assessing only the construction phase to assessing the entire life cycle. Whenever requirements are strengthened, the municipality should ensure that no conflict arises, that all actors are still in agreement and that stakeholders have access to appropriate tools and support. Steps two and three are repeated and the implementation proceeds in the following cycle: ensure dialogue and collaboration – ensure appropriate tools are available – strengthen information requirements. This continues until data gaps are filled and all stakeholders are familiar with data gathering and assessment procedures.

The fifth and final step is to implement requirements on environmental performance once it becomes easy to carry out assessments that can be compared and verified. There is a trade-off between setting

requirements in the municipality's role as an owner or as an authority. Acting as an authority (when establishing plans, land allocation and exploitation agreements) has a large effect on the building sector, but this entails thorough involvement of the municipality. Legal boundaries are sometimes unclear, and it is impossible to set requirements in some cases (e.g. when issuing building permits). Restricting requirements to procurement and the management of municipal assets limits both how complex and how impactful the process can be. It can be seen as a low-risk strategy, or as a first step to build experience before implementing requirements as an authority. The municipality can learn from information and performance requirements in test procurement projects, without taking the risks associated with large-scale implementation. It can then generalise the requirements in its role as a public authority, based on the experience gained in procurement. However, it should be kept in mind that municipalities face different legal contexts as authorities and in procurement, so the requirements might need to be formulated differently.

Although this study only investigated Swedish municipalities, the suggested strategy based on cooperation and filling knowledge gaps is also relevant in other countries. The legal context, size and resources of municipalities and relevant national actors may vary, however.

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Appendix

Appendix A1 – Online survey

Page 1

(1) **What municipality do you work in?**

(2) **What role do you have within the municipality?**

(3) **Does your municipality have any kind of policy document for climate or the environment related specifically to construction?** Please specify.

(4) **The climate change impact of construction materials is becoming increasing important. How familiar are you with this issue, on a scale from 1 to 5?** (where 1 = Not familiar at all and 5 = Very familiar)

Page 2

Introductory text to question 5:

A municipality can use various measures to reduce climate change impacts, as land owner, physical planner or developer. For instance, municipalities could require an assessment of climate change impact in a life cycle perspective before land allocation. In the municipality's role as developer, it can set environmental requirements for procurement linked to construction projects.

(5) **Which of the following policy instruments does your municipality use to reduce the climate change impact of construction materials in construction projects?** Tick the option/s that apply and give details. You can skip rows if you cannot answer, or do not want to answer. Matrix:

Rows:

- Detailed plan or comprehensive plan
- Building permits
- Land allocation

- In-house competitions for land allocation in a specific area or to select an architect for a municipal project.
- Owner directive to municipal real-estate company
- Exploitation agreements
- Dialogue with developers and voluntary agreements to use materials with low climate change impact, for instance as part of a land exploitation agreement
- Information to developers
- Procurement for municipally-owned construction projects
- Other

Columns:

- We have tested this measure and use it occasionally
- We have tested this measure, but we do not use it anymore
- We plan to try this measure in the future
- None of these alternatives is valid

Page 3

(6) **What type of requirement have you used or do you plan to use in relation to each of the following policy instruments?** Tick one or several options and give details. You can skip rows if you cannot answer, or do not want to answer. Matrix:

Rows: The rows are similar to those in Q5, but only rows where the respondent chose any alternative other than "None of these alternatives is valid" in Q5 carry over to Q6.

Columns:

- Requirement to calculate the climate change impact of construction materials for new projects

- Requirement to use construction materials with low climate change impact (max. emission quota to reach or required improvement compared with present)
- Requirement to use a specific technique or design
- No requirement
- Other (please specify)

Table 2 details key dates for the survey.

Table 2. Summary of information about the survey of Swedish municipalities

Respondent group	First message sent	Reminder sent	Closed	Answers gathered
1	03/9/2017	03/14/2017	03/22/2017	28 complete, 19 partial
2	03/22/2017	03/28/2017	04/4/2017	16 complete, 11 partial
3	04/4/2017	04/11/2017	04/21/2017	9 complete, 5 partial
Whole survey	03/9/2017	-	04/21/2017	53 complete, 35 partial

Appendix A2 – Semi-structured interview template

1) Introduce the study, its objective and the research questions.
2) Background questions:
   a) Please describe your role in the municipality, in general and specifically in relation to construction projects.
   b) Does the municipality have a specific vision or objective related to climate and sustainability, in general and specifically in relation to construction projects?
   c) How would you describe your organisation's competence with LCA tools and methods?
3) Please describe situations in which you set/have set environmental requirements in construction. Describe in detail the process you followed, the requirement and its scope (e.g. was it applied in procurement for a specific project, in a contest, etc.).

   Possible follow-up questions:

a) Why did you choose to set the requirement this way? In hindsight, what are the advantages and drawbacks of the solution you chose?
b) How do you wish you could set requirements in the future? What is needed to go forward?
c) Did you have dedicated resources to establish and monitor compliance with the requirement?
d) How do you monitor environmental performance in relation to the requirement?
e) Are LCA tools used at any level by your municipality? If yes, what standards do they follow? Do you have an in-house tool for the assessment?
f) Have you collaborated with other actors within the municipality? With external consultants? With private sector stakeholders?

4) How do you perceive ongoing efforts at structural/national level to work towards environmental performance requirements? How do you perceive your municipality's role?

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