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Public procurement for carbon reduction in infrastructure projects – an international overview

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Abstract. Carbon emissions emanating from infrastructure construction projects are substantial and stem primarily from production of construction materials and use of energy for construction transport and site activities. In recent years, public infrastructure clients world-wide have begun to include carbon reduction goals in their procurement requirements. This is however a new and complex field where practices vary and are still developing. In this paper, we compare models for carbon reduction requirements in infrastructure construction projects based on case studies of large projects in Australia, USA, the Netherlands, Sweden and UK. We found that open, functional carbon reduction requirements were considered innovative but entailed costs for calculating baselines and risks for speculation. Also, high time pressure in projects limits contractors' opportunities to explore reduction opportunities. Thus, specific, prescriptive requirements may play an important role in client-led, long-term innovation processes. Organizational competence and resources on the buyer side are essential, and policies for carbon reduction should aim to increase client capacity. Further, procurement practices are developed in mutual interaction between clients and suppliers over longer periods of time, which limits possibilities to transfer procurement policies and requirements between contexts.

1. Introduction

The construction sector causes a substantial part of all carbon emissions, primarily carbon dioxide. Traditionally, the focus has been on improving the energy efficiency of buildings, while it is only recently that the considerable carbon emissions arising from the manufacturing of construction materials and components, and from construction processes and transport, have been acknowledged [1]. Consequently, the infrastructure construction sector is now recognized as a major source of carbon

emissions and there is increasing awareness that these emissions need to be significantly reduced if the international and national carbon reduction targets are to be met. In the UK, the Green Construction Board has estimated that emissions from the construction, maintenance and operations of infrastructure assets account for 1/6 or 16 % of the nation's total carbon dioxide emissions.

In the European Union as well as in the OECD countries, the focus on public procurement as a policy instrument has increased in recent years [2]. In particular, ecological and social sustainability and innovation procurement have been promoted. Large public buyers are pointed out as key actors in driving development especially in sectors where they stand for a high share of total demand, such as construction [3]. This allows them to not only influence emissions stemming from their own purchasing, but also to create lead markets for new products and services.

In the infrastructure sector, large public buyers such as road and railroad administrations, state-owned companies, municipalities and county councils represent a large proportion of the total demand. Their procurement models and requirements not only define the assets constructed but also the incentives and motivation of contractors, designing engineers and material manufacturers to develop competencies and new innovative solutions [4] also in the field of sustainability [5]. In recent years initiatives have been taken world-wide to include sustainability criteria in infrastructure construction procurement. Sustainability assessment schemes (CEEQUAL, BREEAM Infrastructure, the IS rating system, Envision), sustainability frameworks (SUNRA) and carbon management frameworks (PAS 2080, CO2 Performance Ladder) have been developed. Recent guidelines such as those by UK Green Building Council [6] and IISD and i24c [7] address the role of public procurement in this field and provide best practice examples.

Still, it is not evident how to design and implement procurement models and incentives that efficiently contribute to carbon emissions reductions in infrastructure construction projects. The measures to achieve reductions in the infrastructure projects are multifaceted: they involve new construction materials, optimizing designs to use less materials and energy over the life cycle, coordinating use of masses within and between projects, minimizing emissions from transport and site operation, as well as documentation, reporting and verification of requirements [8, 9]. Thus, similar to green public procurement in the construction sector in general, a wide range of project functions and supply chain partners are affected [10].

This research project provides a cross-country overview of how public infrastructure clients use procurement requirements to support carbon reduction goals in large construction projects. This paper describes the different types of procurement requirements used and briefly discusses experiences, developments over time and policy context. The countries covered are Australia (New South Wales), The Netherlands, Sweden, the UK and the US (California).

2. Previous research

2.1. Research on green and sustainable procurement

There are few research-based studies on carbon requirements in infrastructure projects and the number of studies on green public procurement (GPP) or Sustainable Public Procurement (SPP) in construction is also limited. However, the body of literature on GPP and SPP often covers wider areas which also may include construction. More generally, Cheng, Appolloni, D'Amato and Zhu [11] showed that GPP is a growing research field with 50 % of the articles published between 2013 and 2016. Low carbon procurement emerged as a subset of GPP around 2010. Often, the ambition is to map practices, drivers and obstacles. For example, Brammer and Walker [12] report results of a survey of GPP/SPP practices in all sustainability dimensions and in all sectors in 20 countries. They found that procurement policy and practices vary significantly between regions, and that the national policy context has a high influence on the use of SPP as well as on focus areas and measures [12]. Such cross-country studies are however rare and repeatedly called for [8, 12].

Studies focusing on public procurement for innovation show that change processes are complex and dependent on mutual interaction between demand-side requirements and supply-side development over

longer periods of time [12, 13]. The need for organizational awareness, competence and capacity on the buyer side to craft and implement successful policy measures is emphasized [13-17]. Collaboration between the purchasing department and environmental units is another success factor [16], and many studies find that individuals are important [18]. Front-runner suppliers play a key role since a lack of green products and services on the market is one of the main obstacles to innovation-oriented green public procurement [10, 12, 14].

2.2. Green procurement and procurement requirements in construction

Research has shown that green requirements are becoming increasingly common but there are only few studies on how criteria are formulated and developed [15, 19]. Further, there are different types of requirements. First, sustainability may be used in the tendering process, as pre-qualification or award (MEAT) criteria [5, 20]. Other requirements regard the product or asset to be built and these may be project-specific specifications or embedded in standards or rating systems. There are also requirements that specify processes, documentation and competence. In construction, award criteria and style of specifications are strongly related to the chosen delivery model. Prescriptive requirements and price-based selection are associated with traditional, or design-bid-build, models, where the client specifies the design. Design-build contracts are based on performance requirements, and place more of the design responsibility on contractors. The general trend is towards design-build contracts [21]. In many countries there is also increased use of integrated strategies where contractors are involved earlier in the process and collaborate with the client and the design consultants to jointly define the design [22].

In our case study descriptions and discussions, we classify requirements using the following four categories:

- Selection and award criteria (qualification and MEAT criteria)
- Technical specifications and other requirements pertaining to the finished asset, the production process or organizational and individual competence. An important distinction is between prescriptive/specific/closed and functional/performance/outcome specifications.
- Rating systems/Sustainability Assessment Schemes, where the infrastructure asset may receive a certification or label provided that certain product and/or process criteria are fulfilled.
- Carbon reduction requirements, which specify or reward percentage reductions of emissions in relation to a baseline. Such requirements are sometimes referred to as “functional” or “performance”, since they leave it open to contractors how to achieve the reduction goals.

3. Method

The study has been designed and conducted in collaboration between partners from academia and industry. Interviews were performed with client representatives as well as with other parties in the supply and value chains, primarily contractor and consultant representatives but also manufacturers of construction materials. Interviewees were selected with the aid of local WSP and SKANSKA connections who were involved in the projects. Depending on project phase and availability, different combinations of roles were interviewed in different projects. In general, interviews lasted for 2-3 hours. Most interviews included more than one interviewee. The Swedish case study was coordinated with a project to follow-up the experiences from a new model to incentivize carbon reduction in construction supply chains, and there was a higher number of interviews. All interviews were voice-recorded under permission of the interviewees, and transcribed.

For a summary of interviews see Table 1. The interview guideline questions were organized under six headings aiming to capture information about procurement requirements used in the case study projects as well as personal experiences and views. The headings were:

1. Sustainability procurement requirements for reduction of carbon emissions in the project
2. Basis for/origin of requirements, such as policies, standards or certifications
3. Organization and processes for implementing and following up requirements
4. Mechanisms for learning and improvement
5. Results

6. Perceived key success factors and barriers

Case summaries were developed and fed back to interviewees for fact-checking and comments. As a basis for the analysis, a description of the policy context of each case was developed based on literature and input from local representatives.

Table 1. Cases and interviewees

Country	Project	Actors interviewed (no of individuals in parenthesis)	Number of interviews
Australia	Sydney Metro Northwest	Client (3), Contractor (1), Designer (2), Steel Supplier (1)	4
Australia	Newcastle Light Rail	Client (1), Contractor (1), Designer (4)	2
The Netherlands	A6 Almere	Client (2), Contractor (1)	1
Sweden	3 projects and other interviews	3 project interviews + interviews with clients (23), consultants (16), contractors (22) and suppliers (15).	17
UK	Anglian Water, Grafham WTW Resilience and Dalton Piercy WTW	Client (2), Contractor (1), Designer (1), other (1)	1
UK	HS2	Client (3), Contractor (1)	2
USA	California High-Speed Rail	Client (4), Contractor (1), Designer (1), Supervisor (1), Steel supplier (1)	5
USA	SFO AirTrain Extension	Client (1), Contractor (2), Designer (2)	3

4. Results

This section gives an overview of policies, procurement requirements and experiences.

4.1. Policy context

The general policy structures for the procurement requirements for carbon reduction were influenced by the national culture for policy development. Fundamental differences concerned the governance structure: Australia and the US both have a state level with high power while in the Netherlands, UK and Sweden the national level is the most important. Further, some countries and organizations (Australia/NSW, NL, UK) have a longer tradition of carbon management in infrastructure construction while in others (Sweden, US/California) such ambitions are more recent.

Some clients and projects have implemented a national policy while others have taken a role to push policy and practice forward. For very large mega-projects such as CHSR in California and HS2 in the UK, the client management teams perceive an obligation to align project ambitions with higher national and international goals despite that explicit directives to clients or projects were in fact vague or lacking. In the UK, the water company Anglian Water has served as a role model for the whole industry, demonstrating that it is possible to achieve a 50% reduction in capital carbon and also that carbon reduction is often associated with cost reductions. In the CHSR project, the explicit ambition was to use its volume and drive market development. In several cases, such as Sydney Metro, CHSR and Anglian Water, individual champions have played key roles in raising ambitions. In the Netherlands, HS2 and Sweden, the development is more policy-driven. We can also see that governments, clients, projects and industry networks take different roles in driving development. In Sweden there is a relatively clear top down approach by the Swedish Transport Administration whereas in the two US cases it is more up to the clients and projects to drive development. In New South Wales in Australia, clients have been the primary change agents, while in the UK and the Netherlands industry collaborations and partnerships

with active support by government have also been important. Suppliers as well may act as front runners and set more ambitious goals than those of the client. In Sweden, some large contractors have been ahead of the client in implementing carbon reduction measures.

4.2. Procurement requirements

A summary of the types of procurement requirements with relevance to carbon reduction identified in the cases is provided in Table 2.

Table 2. Types of requirements and examples in the cases

Type of requirement	**Examples in cases**
Selection and award criteria	Tender discount based on organizational capabilities (NL: CO2 Performance Ladder) Tender discount based on carbon footprint calculation/reduction (NL: DuboCalc, see also under reduction req. below) Organizational environmental competence based on staff CVs Organizational competence evaluated based exemplar low carbon designs (UK: HS2) (Award criterion)
Technical specifications and other specific requirements	Requirements for competence, roles and processes: - req. for carbon manager, carbon management plans - carbon footprint calculations and documentation - PAS 2080 compatible (UK), SUNRA (SW) Carbon performance and documentation requirements: - Carbon performance for selected products/material - Renewable fuels/energy - EPDs Technical requirements: - Cement clinker replacement, Recycled ballast - Steel production req. - Asphalt, LED lightning
Rating systems/Sustainability assessment schemes (SAS)	LEED, BREEAM, Green Star (buildings) BREEAM, ISCA, CEEQUAL, Envision (Infra)
Carbon reduction requirements	Reduction in embodied or capital carbon in relation to baselines calculated for reference designs (AU, NL, SW, UK) or in relation to business as usual (US).

Following the general trend in construction procurement towards performance specifications, the case studies show that there is a preference in several countries (UK, NL SW) for open requirements that do not specify in detail which measures should be employed by contractors to reduce carbon emissions. The ambitions are to provide incentives for carbon reduction and reward contractors that invest in carbon reduction competence. Two types of requirements are used for such purposes: MEAT award criteria and requirements for carbon reduction in relation to a baseline. The UK cases have set ambitious goals of 50% reduction levels and emphasize collaboration within the supply chain: Anglian Water uses a long-term alliance contract while HS2 uses a two-stage Early Contractor Involvement contract. The Swedish Transport Administration has recently begun to include carbon reduction

requirements in all projects above 5 MEUR, starting with targets around 15% which are to be raised over time. In the Netherlands, the DuboCalc tool has been developed to calculate environmental impact of construction projects, including carbon. In large projects, DuboCalc is used as an award criterion in combination with the Competitive Dialogue process. In New South Wales in Australia, reduction requirements are included in the ISCA Rating System, which is compulsory for projects of a defined size and significance. Requirements for conformance with rating schemes are applied also in the UK. In the Netherlands, the certification system CO2 Performance Ladder for carbon management is used in tender evaluation.

4.2.1. Experiences

As for MEAT award criteria, several interviewees said that the main difficulty was that there are many aspects to consider when procuring a contractor and that each area will account for a small share of the total score. In several cases studied, award criteria were used not so much to produce sharp incentives but as a means to raise awareness of the importance of carbon reduction activities and ensure that contractors include staff with high carbon competence in their teams.

Regarding reduction requirements, setting a baseline was seen as a fundamental challenge. The main points were:

1. Uncertainty in defining the reference case: on what design should the baseline be based (what project stage and on worst-case or state-of-the-art design)?
2. Uncertainty as to when the baseline should be updated, as well as which changes should be counted as savings (or increases) in relation to the baseline and what should be counted as a scope change leading to adjustment of the baseline.
3. Calculating and re-calculating baselines is costly and competes for personnel resources and management attention with actual activities to reduce carbon emissions.
4. There is a risk that incentives for carbon reduction either do not influence behavior or produce speculation and a focus on creative calculation.
5. There is limited time in a construction project to involve sub-contractors and material suppliers in low carbon design activities.
6. The development and testing of new products and materials require a longer time and need to be managed with a long-term perspective that stretches over several projects.

To some extent, these uncertainties are related to inexperience: certainty as to how to set baselines is expected to increase as standard practices develop. However, setting relevant reduction levels calls for high client competence and market knowledge, and sharp incentives may increase transaction costs for both clients and contractors. More collaborative models carry a higher potential for knowledge integration and innovation [23], but the UK experiences show that strong client leadership and commitment is essential both to legitimize collaborative contracting models and to achieve more fundamental behavioral change within such schemes. Rating systems as well are only used in the more mature contexts. In general, client carbon competence and active engagement is seen as important success factors. To speed up innovation processes and reach out in the supply chain, clients in Australia and NL use specific requirements while in the UK, innovation and learning between projects is addressed by national initiatives.

5. Discussion and conclusions

There is a high belief on the policy level in procurement as a driver of change and innovation, especially in a highly government-dominated and outsourced industry such as infrastructure construction. This study points at the complexity involved in designing and implementing procurement requirements for carbon reduction in this context. In general, it is not just a question of including certain requirements and incentives in the tendering documents, but a lengthy process that includes development of industry competence and institutions as well as clients with a long-term perspective and deep understanding of how innovation may be driven in this complex, project-based industry. Goals and measures for carbon

reduction are new to many actors, and both clients and industry partners need time to adjust and develop new competencies [14].

Regarding style of requirements, specific/prescriptive requirements are often associated with conservatism while performance/functional requirements and MEAT award criteria are believed to encourage innovation. In practice, however, it is more complicated. Any single award criterion will hardly achieve enough weight to be a strong driver, and both time and resources for developing and evaluating tenders are limited. Carbon emissions in construction have many sources, and all of them are not possible to consider at the tendering stage. Functional carbon reduction requirements in relation to a baseline were used in all countries except the US. However, these were found to entail numerous implementation issues, including time and costs for calculating baselines, risks to produce a work-to-rule speculative mindset and need for independent institutions. Moreover, high time pressure limits contractors' opportunities to explore reduction opportunities during the design stage, especially if suppliers need to be involved [24]. This implies that functional requirements are less useful to leverage innovation in a project-based context than in sectors with more continuous demand and production. In effect, the case studies show that specific, prescriptive requirements may play an important role in long-term innovation processes by transferring new knowledge between projects. However, such processes have to be led by competent clients and require effective collaboration between their environmental and technical experts, procurement functions and project managers. Thus, in line with previous studies [14-17], this study emphasizes the importance of organizational awareness, competence and capacity on the buyer side.

Implications for policy-makers and client top management are that policies for carbon reduction should encompass measures to increase client capacity and incentives to drive innovation, including development of transparent systems for updating standards. Further, in countries with a longer history in carbon management, development of procurement strategies and requirements has been aligned with information and training initiatives, tool kits and guidelines for the entire supply chain. Since there is a close relationship in infrastructure construction between carbon reduction and cost reduction, and because so many project processes and participants need to be involved, policies should address the general competence of public clients to procure and manage infrastructure projects, including collaborative delivery models and strategic alliances.

Altogether, the results demonstrate that opportunities to transfer procurement policies and requirements between contexts are limited. Procurement requirements are developed in mutual interaction between clients and suppliers over longer periods of time [12, 13, 16]. Thus, policy and procurement strategy taken out of context will seldom work in a new setting that differs from the original one.

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