LOW-CARBON INNOVATION FOR SUSTAINABLE INFRASTRUCTURE: THE ROLE OF PUBLIC PROCUREMENT

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## ABBREVIATIONS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>AMP</td>
<td>Asset Management Plan</td>
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<tr>
<td>BREEAM</td>
<td>Building Research Establishment Environmental Assessment Method</td>
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<td>CEEQUAL</td>
<td>Civil Engineering Environmental Quality Assessment and Award Scheme</td>
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<td>EAFIP</td>
<td>European Assistance for Innovation Procurement</td>
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<td>EC</td>
<td>European Commission</td>
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<td>ECI</td>
<td>Environmental Cost Indicator</td>
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<td>EU</td>
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<td>GDP</td>
<td>Gross Domestic Product</td>
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<td>GGBS</td>
<td>Ground Granulated Blast-furnace Slag</td>
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<td>IISD</td>
<td>International Institute for Sustainable Development</td>
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<td>IP</td>
<td>Innovation Partnerships</td>
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<tr>
<td>LCA</td>
<td>Lifecycle analysis</td>
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<td>LEED</td>
<td>Leadership in Energy and Environmental Design</td>
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<td>MEAT</td>
<td>Most Economically Advantageous Tender</td>
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<td>ODA</td>
<td>Olympic Delivery Authority</td>
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<tr>
<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
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<td>PCP</td>
<td>Pre-Commercial Procurement</td>
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<td>PPI</td>
<td>Public Procurement of Innovation</td>
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<td>PPP</td>
<td>Public-Private Partnership</td>
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<td>R&amp;D</td>
<td>Research and Development</td>
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<td>RWS</td>
<td>Rijkswaterstaat</td>
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<td>SME</td>
<td>Small and Medium Enterprises</td>
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<td>VfM</td>
<td>Value for Money</td>
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The opportunity

Public procurement is “not a back-office function anymore, but a crucial pillar for delivering government services, and a strategic one for tackling climate change.” This was the message from the European Union EU Commissioner for Internal Market, Industry, Entrepreneurship and SMEs Elżbieta Bieńkowska and Organisation for Economic Co-operation and Development (OECD) Secretary-General Angel Gurría at a joint high-level event on strategic public procurement in Paris on June 2, 2017.

Public procurement is a powerful tool for driving markets towards more sustainable production patterns, and for creating markets for sustainable goods, services and infrastructure. Public procurement represents, on average, 12 per cent of the GDP in OECD countries (OECD, 2017). Despite the changes in recent years to international frameworks governing public procurement, the instrument is not yet being utilized to its full potential.

Good public procurement is about delivering the best value for money (VfM) for taxpayers. All too often the meaning of VfM is reduced to “cheapest price.” Not only is this incorrect, it is also a missed opportunity to use public money to deliver on the goals governments are pursuing on behalf of citizens: low-carbon transition, employment, sustainable development. To enable this function of public procurement, VfM needs to be defined as VfM across the life cycle of the asset. The emphasis should be on value, not price only.

To be able to tackle pressing challenges like climate change, job creation and sustainable economic growth, support from the European Commission (EC) using public procurement as one of the pillars to meet these strategic objectives is welcome in times where governments have to strategically rethink the way they are spending taxpayers’ money. It gives policy-makers and public procurement agencies a mandate to reform public procurement laws, policies and processes towards delivering VfM across the life cycle of the goods, services and assets they purchase.

Moving towards strategic public procurement means that public procurers introduce strategic thinking at all stages of the public procurement cycle: from needs identification, to engagement with the market, to the design of the tender specifications, to final award of contract based on VfM throughout the life cycle of the asset. This is illustrated in the following figure:
This research outlines the changes that are needed at an EU policy level, and at the level of the EU member state stage to leverage the full potential of public procurement for driving innovation and deep decarbonization of the infrastructure and construction industry. The case studies investigated focused on the cement industry, but the ideas and best practices are applicable across the construction industry.

A strong legal and policy framework will allow and encourage this change. More and better information, best practices on how to value sustainability and information on how to bring that value into the procurement cycle will also help to make public procurement a strategic tool. Only then will public procurement serve as a true enabler of the much-needed innovation for a transition towards a low-carbon economy.

The construction industry

The construction industry is a key candidate for increasingly using strategic public procurement: infrastructure assets are the largest area of public spending and their carbon impact is significant during all the stages of the life cycle. To date, public procurement is not used to its full potential to generate sustainable value for society and incentivize the sector to invest in deep decarbonization.

Change and stronger support are needed at an EU level and at the level of EU member states to better leverage the full potential of public procurement to drive innovation and deep decarbonization of the infrastructure and construction industry.

Innovation within the construction value chain is crucial to facilitate deep decarbonization and to enable the deployment of low-carbon infrastructure. Reduction of carbon emissions can be achieved
At different stages in the value chain of construction materials—this ranges from composition of construction materials with low-carbon impacts during raw material extraction and processing (such as low clinker cements or the use of recycled materials); innovation in processing steps and manufacturing technologies (carbon capture and storage/utilization; material processing at lower temperatures); utilizing renewable energy during manufacturing; low-carbon impacts of materials during subsequent manufacturing steps or during construction stage, as well as carbon absorption capabilities of materials during the use phase of infrastructure projects. Moreover, the design stage of a project can trigger low-carbon innovation with respect to the scope of suitable materials, timeline of infrastructure construction with respective impacts on material handling, access to low-carbon transport modes, opportunities to encourage recyclability of materials and eased deconstruction of infrastructure for reuse of materials in future projects, among other examples.

To seize that opportunity, procuring authorities and their staff should be empowered to use the intervention points along the procurement cycle as a means to better manage, reduce and share risks associated with the procurement of low-carbon infrastructure solutions.

**European context**

The EU's comprehensive legal policy framework enables and encourages the use of strategic and innovative procurement of low-carbon innovation.

The 2014 revised EU public procurement directive emphasizes the strategic function of public procurement. It points to awarding contracts based on the most economically advantageous tender (MEAT) principle. MEAT means going beyond awarding based purely on lowest price, but takes into account other cost components or quality criteria (such as a product's carbon footprint). The directive outlines five different procurement procedures each, with flexibility to engage with the market at some point in the acquisition process so the authorities are better informed about the best available technologies (i.e., prior to and/or during tendering). Finally, it promotes the use of functional specifications as a means to focus on desired outcomes instead of narrowly determining an already known technology or solution (e.g., FutureBuilt Standard for public buildings in Oslo Municipality. In this case, the carbon footprint resulting from transport, energy and materials use is required to be reduced by at least 50 percent compared to existing regulations and common practices). This is a very powerful lever for providing market space for innovation.

The competitive procedure with negotiation and the competitive dialogue are the procedures outlined in the public procurement directive that provide structure and certainty for the procurement of (market-ready) innovations. Beyond that, the innovation partnership procedure allows for procurement of research and development services (goods and services that are at early stages in the innovation pipeline) and the subsequent procurement of developed solutions within one procedure.

Finally, the EC launched a guidance package for public procurers in October 2017 that emphasizes the strategic role of public procurement and encourages member states, among others, to adopt a greater uptake of innovative, green and social criteria when awarding public contracts (EC, 2017). Also this framework boosts a move towards strategic public procurement.
What is needed to implement strategic public procurement?

There are various conditions, planning measures and tools that could serve to increasingly foster procurement of low-carbon, innovative construction materials:

1. Encourage and scale private sector investment into low-carbon building materials through:
   a. Sector-specific low-carbon targets
   b. Supply chain collaboration
   c. The bundling of demand for low-carbon infrastructure

Through setting priorities, maximum carbon footprints or low-carbon targets in public tenders signal prospective public demand for low-carbon solutions to the market. Policy documents, such as city development plans for different sectors (e.g., Development Plan of Dublin City Council; FutureBuilt initiative for municipal buildings in Norway) can define low-carbon development targets as well as recommend the use of low-carbon construction materials for future public construction investments.

To better build trust between the procurer and the supplier, multistakeholder initiatives, such as the Green Deals in the Netherlands, that involve all the actors in the construction supply chain can facilitate this. The initiative is based on continuous dialogue between the public and private sector stakeholders in the chain. When this dialogue reiterates the continued focus and priority on low-carbon performance of construction projects, it generates private sector commitment to increasingly invest in low-carbon solutions.

Central purchasing or coordinated tendering among municipalities/cities for homogenous infrastructure projects creates the necessary scale for suppliers to seriously consider low-carbon solutions. This is also referred to as the “bundling of demand” to provide more certainty to the market that there is a legitimate opportunity for scaling the use of their innovative low-carbon solutions. It also helps to discover new collaborative business models as a means to standardize and achieve economies of scale for low-carbon solutions, as the Anglian Water @One Alliance case in the UK demonstrates.

2. Engage with the market early on to identify low-carbon innovation and stimulate collaboration throughout the construction supply chain

Procurers do not necessarily have all the available information to identify the best available technologies in the low-carbon construction field. This is why early engagement with the market is so crucial: it is key to demand information on where the industry stands with its latest low-carbon innovations and to provide information on the needs that procurers are seeking to satisfy. The needs identification stage, market research and market engagement (such as tender-specific or regular market fairs and meetings) executed by city staff (or in cooperation with consultants—i.e., innovation brokers) are important pre-tender activities for procuring authorities to identify the current state-of-play on construction materials that can address their low-carbon priorities. Such activities are decisive for defining (technical) tender specifications and setting realistic but ambitious priorities for infrastructure projects.

As governments contract with contractors or consortia, public agencies do not purchase construction materials directly; hence, material suppliers usually do not participate themselves as bidders during the tendering phase. This is why it is important that market consultations, including with material suppliers that can offer materials with lower carbon footprints, take place in the pre-procurement stage. As in the case of the City of Eindhoven, pre-tender activities such as fairs and competitions can be used to not only identify market-ready innovations, but also to facilitate consortia building as a
means to generate low-carbon innovation capacities along construction supply chains and enable the integration of innovative small and medium-sized enterprises (SMEs) that could otherwise not bid for large infrastructure projects. Timely publishing of a Prior Information Notice is important to inform the market about low-carbon priorities for planned infrastructure projects. This allows for sufficient lead time to invest in innovation and stimulate supply chain collaboration for the development of effective solutions.

3. Use tender specifications that ask for low-carbon materials (technical specifications) or use performance-based specifications that refer to the carbon performance of a building material or infrastructure asset

When procuring authorities have sufficient knowledge and are aware of various low-carbon building materials on the market, they may opt for technically specifying particular types of materials, based on accepted standards. These specifications can promote emission- and sustainability-related aspects that proposed materials need to comply with. For example, technical specifications for cement materials can be formulated as follows:

Only the following two cement types are allowed for respective infrastructure projects because they guarantee (a) sustainability (70% less CO2 emissions than Portland cement) and are (b) resistant to Alkali-Silica Reaction:

a. CEM III with a percentage of slag higher than 50%; or
b. Portland-fly-ash cement CEM II with a percentage of fly-ash higher than 25%.  
(Rijkswaterstaat, 2015)

Alternatively, if procuring authorities have certain expertise and experience in terms of environmental superiority of construction materials for certain infrastructure applications, but want to incentivize best possible performance, technical advancement and innovative solutions, outcome-based and functional specifications on a pre-defined material level can be defined. The following example from Noord Brabant illustrates the use of performance indicators as tender evaluation criteria to assess offered solutions for a concrete bicycle lane:

a. Re-use of secondary products (concrete granulate and secondary sand) in concrete material in %;
b. Calculated CO2 footprint of concrete production (per m3)—this includes emissions from stage of extraction and production of all materials, storage and transport to production site until the concrete mix is ready for transportation.

The performance of materials suggested by bidders on criteria a) and b) is integrated into the award methodology: A table, included in the tender, explains how much monetary value can be deducted (virtually) from the bidding price depending on the percentage of secondary materials used in the concrete mix, and based on the achieved level of CO2 emissions. (Provincie Noord Brabant, 2017)

Thirdly, if procurers lack technical knowledge about available low-carbon construction materials or are unsure how to achieve low-carbon performance of infrastructure projects, they may choose to use performance-based and functional specifications that leave room for suppliers to present solutions meeting the criteria. The national FutureBuilt standard in Norway includes such functional specifications for public buildings as a pre-condition to qualify as a project. These specifications are used in public
tenders: “Reduction of greenhouse gas emissions from transport, energy and materials. The carbon footprint must be reduced by at least 50% compared to existing regulations and common practices. This is measured by a climate gas accounting tool for buildings” (FutureBuilt, 2016).

4. Use holistic award methodologies and tools that make low-carbon performance a competitive element of the bidding process

Procuring authorities increasingly develop and make use of methodologies and assessment tools (e.g., the Dutch environmental cost indicator tool, DuboCalc; the Norwegian carbon calculation tool, Klimagassregnskap) to integrate carbon and other environmental performance indicators into the tender evaluation phase. Such tools can be applied for construction materials and/or at project-level assessment. Using such tools increases transparency on low-carbon performance, decreases risks concerning the carbon impact of procured infrastructure solutions and incentivizes suppliers to compete on other dimensions than price.

5. Use innovation brokers to increase capacities among public and private sector actors to engage in procurement of innovation and the deployment of low-carbon infrastructure solutions

For the realization of public procurement of innovation, a third party often assists in setting up the procurement process, creating awareness and capacities of suppliers (including SMEs) to engage with public sector clients, moderating dialogues with procuring authorities internally as well as with the market, and facilitating the writing of tender documents and/or evaluating bids. This role can be taken up by specialized innovation brokers, be it in the form of independent organizations/consultants (as in the case of Oslo Municipality) or agencies that sit within a local, regional or national government institution and are specialized in different approaches to public procurement of innovation (e.g., local level: experts in the City of Amsterdam for the Startup in Residence Programme; regional level: a publicly funded organization named Zenit dedicated to supporting public procurement innovation in the state of North-Rhine Westphalia in Germany while increasingly offering nation-wide services; national level: PIANOo as a specialized agency under the Ministry of Economic Affairs in the Netherlands).

Best practice examples of strategic public procurement

- Sector-specific planning and policy documents for guiding public procurement objectives for low-carbon cement in Ireland.
- Multi-stakeholder initiatives for defining and driving implementation of sector-specific sustainability targets in the Netherlands (Green Deals).
- Public sector engagement and support for start-ups that address public sector needs (such as low-carbon development) in the City of Amsterdam.
- A new collaborative business model of a public sector water utility company in East England, the Anglian Water @One Alliance, with ambitious low-carbon objectives and low-carbon product standardization strategies for construction materials.
- Utilization of pre-procurement market engagement and a tender award methodology that facilitates supplier consortia building in the City of Eindhoven for accelerating low-carbon objectives and implementation capacities along construction sector supply chains.
- Definition and use of technical specifications for determining the procurement of low-carbon construction materials for infrastructure projects in the Netherlands, for public buildings in the
Irish health care sector and for the London Olympic Games.

• Definition and use of functional specifications for facilitating the procurement of innovative low-carbon concrete for a bicycle lane in Noord Brabant (Netherlands), and for the procurement of low-carbon materials for a public school building in Oslo Municipality (Norway).

• Utilization of sustainability certification schemes for the procurement of buildings with strong sustainability performance (including low-carbon construction materials) during the London Olympic Games (BREEAM and CEEQUAL) and in Oslo Municipality (FutureBuilt Standard, Norway).

• A tender award mechanism called DuboCalc, developed and applied by the Ministry for Infrastructure and the Environment in the Netherlands, for incentivizing bidders to identify and use low-carbon construction materials.

• The use of innovation brokers to support procuring authorities in their innovation procurement ambitions while establishing better interaction between the public and private sectors to accelerate the dissemination of low-carbon innovation.

How to achieve it?

To use the public procurement process to its full potential and introduce low-carbon and innovation performance throughout the public procurement cycle, a number of actions can be implemented at both the European and national/regional levels. Optimizing the public procurement process will provide EU citizens optimal VfM for its tax contributions and will secure the EU’s long-term competitiveness of its construction and infrastructure industries in a low-carbon economy.

Recommendations for the European Commission

The implementation of the new industry strategy for Europe, launched in September 2017, will be a key process for the EC to support member states and cities in their procurement of infrastructure to ensure the sector’s future competitiveness. The relevant EC Directorate-Generals—DG GROW, DG Environment and DG Connect—could foster the implementation of the following recommendations as a means to encourage, support and reduce the risks of procuring authorities in EU member states when procuring low-carbon infrastructure solutions:

i. Promote best practices
Engaging and negotiating with market parties is key when determining low-carbon priorities for infrastructure projects and for encouraging potential contractors to identify and integrate respective solutions in their offers. Any engagement is always subject to the principles of transparency and fair competition. This is essential for strategic, sustainable public procurement. To facilitate market engagement and negotiation effectively, public procurers need EU-level support in becoming negotiators and decision-makers to secure VfM for low-carbon infrastructure solutions. In short: there is a need for support for capacity building and professionalization of the procurement profession. We recommend promoting best practices and lessons learned from awarded tenders and executed projects (originating in member states) that focus on low-carbon infrastructure procurement and low-carbon innovation. This can be done at various forums available for capacity building: international forums, conferences, workshops, online platforms, news alerts as well as case studies and reports.

ii. Provide dedicated funding schemes
The EC can play an important role as convener of these forums and encourage knowledge sharing.
The EU Horizon 2020 program is an instrumental funding scheme to promote the potential for public procurement on enhancing innovation. Moreover, we recommend the provision of EU funding to national and local procuring authorities for innovation procurement as it is an effective approach for risk-sharing between different governance levels and can encourage procuring authorities to engage with new approaches to innovation procurement, including low-carbon innovation. These recommendations are in line with the 2017 EU Procurement Package that supports the professionalization (business skills, technical knowledge and procedural understanding) of public buyers in member states and advancing public procurement of innovation through facilitating exchange of good practices and innovative approaches.

iii. Support the development and dissemination of tools that operationalize VfM and low-carbon performance across the life cycle of assets

The perception that demand for low-carbon (and other environmental) requirements entails comparatively higher expenses for infrastructure projects is caused by a continued focus on the upfront cost of the project (design and build), little transparency about negative and positive externalities resulting in aggravated risk management, as well as limited knowledge about the applicability of life-cycle costing instruments for infrastructure projects. To operationalize the public sector responsibility of ensuring VfM across an asset’s life cycle, we strongly recommend the development of suitable life-cycle costing instruments for infrastructure projects, modelling tools to quantify (long-term) external costs and benefits of low-carbon solutions and methodologies to make environmental product declarations comparable. We recommend the building of regional and national life-cycle assessment (LCA) databases, and data sharing at the EU level, supported by the EC, as this will have the most widespread impact across EU member states and allows knowledge sharing across jurisdictions.

iv. Facilitate priority setting and decision making on low-carbon solutions

Overcoming the institutionalized tradition to interpret VfM as “lowest price” necessitates concerted efforts. Public procurers need relevant and timely assurance for implementing MEAT (such as including low-carbon performance into tender award criteria), so that public budget holders and auditors do not question (the basis of) their award decisions. Auditors also need to understand the beneficial implications of these procurement priorities and the value of an increased degree of risk taking in procurement. Auditors’ primary task must be to check procedural compliance rather than investigating whether tenders were awarded to the lowest bid price. We recommend that the EC engages in and promotes the training of auditors in member states, in parallel to public procurement officials.

v. Provide technical assistance for low-carbon tenders

Low-carbon priorities can be operationalized in public tenders through defining performance-based requirements (e.g., carbon dioxide life-cycle footprint; degree of material reuse, etc.), using technical specifications that ask for low-carbon materials, and employing assessment and award methodologies that are based on full LCAs and take into account carbon performance. We recommend knowledge sharing and assistance to national and local procuring authorities in preparing, writing and evaluating public tenders for low-carbon infrastructure projects. Offering such professionalized services is meant to be temporary until sufficient capacities are established internally and/or until collaboration/joint procurement among local authorities is mainstreamed or innovation brokers are established as a measure to overcome time and capacity constraints of procuring authorities.

vi. Promote the proliferation of innovation brokers

The Executive Agency for Small and Medium-sized Enterprises of the EC launched a call for proposals to promote the concept of using and establishing an innovation procurement broker. This is a welcome development. An innovation broker can also support and facilitate the procurement of low-carbon innovation for infrastructure projects. We recommend that the EC launch more similar calls...
and likewise help to determine, mainstream and institutionalize innovation brokers in EU member states, especially in regions where (small) procuring authorities have limited internal capacities. Innovation brokers can be established in different organizational structures: dedicated departments or employees within municipalities (e.g., dedicated staff for City of Amsterdam’s Startup in Residence Programme), in national- or regional-level support agencies (PIANOo in the Netherlands, Zenit in the state North-Rhine Westphalia in Germany), research institutes with specific expertise or as private consultancies. EU bodies and appointed research projects could support identifying the national-level status quo of available innovation brokers in each member state, as well as proposing context-specific solutions for mainstreaming such innovation support infrastructure.

vii. Facilitate policy coherence
A low-carbon economy is an important ambition of the EU. Likewise, the EU has positioned strategic public procurement as one of the core pillars for delivering their industrial innovation and sustainable development goals. This suggests the need to more strongly promote low-carbon objectives and low-carbon innovation through public procurement. In this regard, we recommend that the EU demonstrate a leadership role throughout their activities (directives, communications, funding schemes, calls for proposals, conferences, etc.) for shifting public procurement from an administrative function to a more strategic function within public authorities in EU member states. This will help to strengthen the confidence of procurement officers in member states in prioritizing low-carbon performance of procured solutions.

**Recommendations for national and regional procuring authorities in European Union member states**

**National and regional procuring authorities in EU member states’ actions**

Procuring authorities are challenged to use procurement as a strategic instrument in better prioritizing low-carbon objectives, which presupposes empowerment, a change in their mind set and adjustment of procurement practices. To this end we recommend the following:

i. Make optimal use of capacity building and EU funding opportunities
The support measures provided by the EU, as well as nationally and regionally established service providers (e.g., innovation brokers), naturally have to be utilized by procuring authorities in order to make an impact. Therefore, we recommend that procuring authorities better inform themselves about support opportunities and that higher hierarchy levels in authorities encourage (and provide budget for) the interest of procurement and/or legal staff to take part in capacity-building workshops and in identifying, becoming familiar with and utilizing value-adding resources.

ii. Centralize/bundle demand to create scale and incentives for low-carbon investment
We recommend that procuring authorities pursue exchanges with other authorities prior to designing and launching a tender. Collaboration among public bodies and among municipalities can establish standardization procedures for similar infrastructure projects and scale demand for low-carbon solutions. This increases the volume and value of public tenders, and provides more certainty/predictability and economies of scale for market actors. At the same time, it can reduce transaction costs for procuring authorities prior to and during tendering.

iii. Facilitate cooperative business models
When public tenders are large enough in volume and/or provide long-term contractual arrangements, this can also incentivize cooperation and consortia building throughout the value chain. This can
in turn lead to cooperative business models (facilitated through legal entities and/or contractual arrangements concerning responsibilities and profit sharing) that unite the expertise of different value chain actors to share risks among them, making it more appealing to integrate innovative solutions and also invest in determining standardized solutions where appropriate. Research findings show that not all details can be covered by contractual clauses, but trust and collaborative mind sets are crucial elements for these business models (e.g., One Alliance integrates different value chain actors and disciplines, and therefore seeks to standardize and streamline new solutions that ensure efficiency while improving public services). To foster the emergence of such elements, we recommend that procuring authorities introduce and facilitate consortia building during pre-procurement dialogues and reward the integration of various value chain actors. Moreover, to allow sufficient lead time for value chain actors to advance low-carbon solutions, we recommend publishing respective infrastructure plans on national or even EU-wide information platforms significantly prior to a request for proposals.

iv. Encourage the procurement procedures that enable dialogue
To plan tenders efficiently and quickly, and to determine suitable low-carbon materials for complex and innovation-oriented infrastructure projects, transparent market engagement and dialogue are decisive. We recommend that procuring authorities engage with the market continuously to have access to market intelligence, to use third-party facilitated project-specific market consultations prior to tendering, and to make use of dialogue-enabling procurement procedures (i.e., the competitive procedure with negotiation or the competitive dialogue). These third parties can take the role of an innovation broker.

v. Encourage the procurement procedures that enable functional-based procurement
We also recommend the use of functional- or performance-based specifications with a low-carbon focus where feasible. This enables procuring authorities to promote design thinking for low-carbon objectives (among others) while not having to have expertise about available solutions for complex infrastructure projects. At the same time, performance-based specifications will allow market actors that were not involved in early planning stages to apply their expertise in suggesting technical solutions and innovations. Finally, the performance focus facilitates the identification of best available technologies in the market. A pre-condition for all these efforts is the professionalization of the procurement process, as recommended above.

vi. Apply publicly available tools for carbon and environmental footprint calculations
It is important to mainstream the application of tools that calculate the carbon or environmental footprint of materials proposed for infrastructure designs and/or to apply LCAs on a project level. We recommend procuring authorities to utilize such available tools by requiring bidders to use them and, if necessary, by providing information sources and supplier trainings. Through widespread and continuous application, there will be an increasing number of product environmental (and carbon) footprints performed, which will gradually improve the underlying databases of such tools. This increases the credibility and encourages the use of such tools as they become more informative for all parties. For example, in the Netherlands, after introducing DuboCalc (calculation of the environmental cost indicator of proposed construction materials) almost 10 years ago, the market is now confident in using it for designing ambitious low-carbon projects. Contractors of infrastructure projects are incentivized to start innovating and collaborating with their supply chains, and use the available databases to identify low-carbon material alternatives. LCA databases must contain country-/region-specific information, and submitted data need to be verified by third parties (certified environmental product declarations). Databases need to be managed by independent organizations that are recognized as trustworthy by the private and public sectors.
INTRODUCTION
The Paris Agreement under the United Nations Framework Convention on Climate Change has set the ambition for global actions to reduce greenhouse gases. As signatories of the Paris Agreement, European governments must start showing the way through a better alignment of their policies with the climate imperative. This also means leading by example in their everyday actions and investments.

The purchasing power of the public purse has the potential to support Europe’s low-carbon industrial development. The estimated total government expenditures for the procurement of goods, services and works amount to an average of almost 14 per cent of the gross domestic product (GDP) in the EU, with an increasing trend (EC Directorate General for Trade, 2015). Being the largest single client for this industry, the public sector has the capacity to utilize public procurement as a strategic and high-impact policy instrument for achieving deep decarbonization. Therefore, public procurement can facilitate lead markets in Europe for low-carbon materials and corresponding services. Although it features as an important element of the European Commission’s (EC) Single Market Strategy, public procurement is currently underused as a policy instrument to drive low-carbon innovation.

The cement sector’s global emissions account today for approximately 5 per cent of anthropogenic carbon dioxide emissions (CEMBUREAU, 2013). The reform of the cement sector can therefore have a significant impact on Europe’s climate change mitigation ambitions, as well as on its innovation and growth aspirations. This research took the developments in the cement industry and dialogues between the public sector and the industry on public procurement as a starting point because of this. The lessons learned from the ongoing projects where public procurement has been used as a driver for innovations in the cement industry apply to other energy-intensive industries as well, and the examples discussed will provide inspiration to take to other industries that are in transition to embed sustainability into their practices.

This research paper contributes to better position public procurement laws, policies and practices as a strategic driver of low-carbon innovation in the construction industry.¹ The paper starts in Section 2 with a brief explanation of the potential of public procurement as a demand-side instrument, the EU legal framework on public procurement, and the relationship between public procurement and innovation and how these are linked through the EU policies of public procurement of innovation, pre-commercial procurement and innovation partnerships. Section 3 gives an overview of the challenges that were identified by the public and private sectors around the procurement of low-carbon infrastructure. Section 4 addresses these challenges and goes through the different intervention points and strategies in the public procurement cycle that the research identified as most effective for driving low-carbon innovation in the infrastructure and construction materials sector. The paper concludes with a series of recommendations to the EU and EU member states for using public procurement to its full potential for driving a low-carbon economy.

¹ For this report, a qualitative research approach was taken while employing several methods for data collection. A range of EU policy documents, recent sector reports and case study documentation focusing on the intersection of public procurement and climate change mitigation trends in the construction sector were reviewed. These sources were used to complement and contextualize empirical data that were collected through 19 in-depth, qualitative, semi-structured interviews with procurement, policy and industry experts in the space of low-carbon infrastructure solutions. Interviewees included representatives from manufacturing industries (especially cement), construction companies, industry associations, national and local public procurers in Europe as well as intermediate organizations responsible for capacity building and knowledge brokering (innovation brokers). Additionally, the authors of this report were involved in several expert round tables on public procurement of innovation and low-carbon industry development. After the empirical data collection and analysis period, the authors co-organized an expert round table to discuss research findings with interviewed and further stakeholders and to refine policy recommendations based on new insights.
LOW-CARBON INFRASTRUCTURE: THE ROLE OF PUBLIC PROCUREMENT IN THE EU
2 LOW-CARBON INFRASTRUCTURE: THE ROLE OF PUBLIC PROCUREMENT IN THE EU

2.1 The purpose of public procurement

“Public procurement is the process whereby public authorities—including all levels of government and public agencies—buy goods and services or commission work” (EC Directorate General for Internal Market, Industry, Entrepreneurship and SMEs, 2014). Public authorities in the EU spend approximately 14 per cent of the GDP for the government’s procurement of goods, services and works (EC, Directorate General for Trade, 2015). Next to this purchasing power, making public procurement a demand-pull policy instrument for incentivizing the product portfolio and product characteristics of different sectors, the EU has defined a range of environment-related policy objectives (e.g., EU climate change mitigation policies: EU 20-20-20 targets) that can be implemented through public procurement and can therefore influence procurement priorities.

Altogether, it is apparent that public procurement is recognized as an important policy instrument for achieving EU (environmental) policy targets, as it provides significant leverage for shaping economic activity, steering development of solutions according to public needs and spurring innovation. This is particularly true for sectors where public demand accounts for a large share of the overall market demand, including construction (and operation) of infrastructure projects as well as waste management and recycling (Directorate General for Internal Market, Industry, Entrepreneurship and SMEs, 2014). Especially in these sectors, public demand can contribute to setting environmental performance benchmarks, hence removing poor performers from the market; trigger and influence the development of environmentally superior goods and services; enable economies of scale for innovative suppliers; increase market competition through procuring from small and medium-sized enterprises (SMEs) and start-up companies; demonstrate functionality of new construction materials and/or solutions as a launch customer in pilot projects; engage in innovation deals with the entire sector of a country; and facilitate wider economic, environmental and societal benefits from improved public services.

Therefore, the role and value of the EU’s legal framework for public procurement in general, and for innovation procurement in particular, are presented in the following.


### 2.2 The legal framework for public procurement

In 2014, the EC introduced a new set of Public Procurement Directives (Directive 2014/23/EU, Directive 2014/24/EU, Directive 2014/25/EU) that apply for all public procurement contracts in EU member states above a defined financial threshold. All EU member states were obliged to transpose the new directives into national law until April 18, 2016 (Directive 2014/24/EU).

The public procurement directives highlight a range of valuable measures referring to the procurement cycle that will be introduced at a later stage of this report. They also outline several public procurement procedures that can be used for procuring goods, services and works, while certain preconditions need to be fulfilled and procedural rules need to be followed. Figure 1 provides an overview of the procurement procedures. These provide procedural certainty and a secure legal framework about how and when to engage with the market, means for tender specifications and approaches for awarding a contract next to considering solely the upfront price. These procedures encourage market engagement but in a regulated, transparent manner and therefore in line with good public procurement principles of integrity, efficiency and value-for-money (VfM).

#### Figure 1. Overview of EU procurement procedures

<table>
<thead>
<tr>
<th>Procedure</th>
<th>No dialogue during tendering = preprocurement phase decisive for tender design</th>
<th>Desired solutions can be defined or functionally described</th>
<th>Any interested bidder may submit a request to participate in response to a call for competition</th>
<th>Offers are assessed against award criteria published upfront</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Restricted Procedure</strong></td>
<td>No dialogue during tendering = preprocurement phase decisive for tender design</td>
<td>Desired solutions can be defined or functionally described</td>
<td>Any interested bidder may submit a request to participate in response to a call for competition</td>
<td>Offers are assessed against award criteria published upfront</td>
</tr>
<tr>
<td><strong>Open Procedure</strong></td>
<td>No dialogue during tendering = preprocurement phase decisive for tender design</td>
<td>Desired solutions can be defined or functionally described</td>
<td>Any interested bidder may submit a request to participate in response to a call for competition</td>
<td>Offers are assessed against award criteria published upfront</td>
</tr>
<tr>
<td><strong>Competitive Procedure with Negotiation</strong></td>
<td>Negotiation necessary for contract award</td>
<td>Definition of procurer’s needs + characteristics and minimum requirements of desired solutions to be provided</td>
<td>Prior published selection criteria are applied to qualify interested bidders to submit an offer for negotiation stage</td>
<td>Final offers (after negotiation) are assessed against fixed minimum requirements &amp; award criteria published upfront</td>
</tr>
<tr>
<td><strong>Competitive Dialogue</strong></td>
<td>Dialogue during tendering necessary bc of complexity or legal &amp; financial circumstances</td>
<td>Desired solutions cannot clearly be defined upfront or technically specified</td>
<td>Any interested bidder may submit a request to participate</td>
<td>Dialogue stage to discuss technical parts of proposals &amp; define new tender requirements</td>
</tr>
<tr>
<td><strong>Innovation Partnership</strong></td>
<td>Successive stages of negotiations for purchasing R&amp;D and application to government needs</td>
<td>Need cannot be met by product, service or works already available on the market</td>
<td>Partnership can be set up with one or several partners</td>
<td>Performance levels and maximum costs of the procurement are being agreed upon with the partners</td>
</tr>
</tbody>
</table>
2.3 Public procurement and innovation

Public procurement can be employed to spur different types of innovation. Innovation can be distinguished by four categories according to the OECD Oslo Manual (OECD & Eurostat, 2005):

1. **Product Innovations**: These involve significant changes in the capabilities of goods or services, including both entirely new goods and services and significant improvements to existing products.

2. **Process Innovations**: These cover significant changes in production and delivery methods.

3. **Organizational Innovations**: These comprise the implementation of new organizational methods such as: business practices, workplace organization, external relations of companies.

4. **Marketing Innovations**: These refer to the implementation of new marketing methods such as: changes in product design and packaging, product promotion and placement, methods for pricing goods and services.

In particular, public procurement as a demand-driven mechanism can incentivize product innovations (goods and services), but it is also considered as a lever for process innovations as well as some further sub-categories such as business practices (business models) and product design. Self-evidently, such innovations can explicitly aim to reduce the carbon footprint of goods and their manufacturing processes as well as the carbon footprint of services.

It is decisive to note that the term “innovation” needs to be distinguished from invention. The latter are non-commercial outcomes of research and development (R&D) activities, whereas (product) innovations can be defined as such when they are launched on the market and hence are successfully commercialized. This distinction is important for discussing a variety of public procurement approaches that are associated with triggering innovation. Generally, three different approaches can be distinguished: pre-commercial procurement (PCP), public procurement of innovation (PPI) and innovation partnership (IP), where the latter is a distinct procurement procedure within the EU procurement directives (see Figure 1).

Depending on the maturity of an innovation, public procurement can pursue different objectives and fulfill respective roles. In this regard, the three different public procurement approaches used in the EU for enhancing innovation are displayed in Figure 2. The red-rimmed text boxes indicate what type of infrastructure procurement can serve for applying and incentivizing innovation.
PPI is a broad concept that utilizes public demand for enhancing and diffusing innovative solutions that are market-ready or commercially available in small quantities but have not yet reached their full commercial potential. Procuring authorities either procure such solutions to fulfill their own responsibility to address public needs—and as a side effect, advance the diffusion of innovative solution—or the procuring authorities intentionally perform a catalytic and coordinating role through PPI for the benefit of the broader public or end-users that exist outside the procuring agency (Edquist & Zabala-Iturriagagoitia, 2012). Respective solutions are likely to be delivered within a reasonable time, as they are in an advanced R&D stage and either close to being commercially available or already available but not yet widely diffused. Procuring authorities act as launch customers and “signal the intention to buy a significant volume of solutions to encourage suppliers to invest in bringing the solution to the market” (European Assistance for Innovation Procurement [EAFIP], 2016a). PPI can take place as a step subsequent to the PCP engagement of a procuring authority but can also be entirely disconnected from it if R&D has already happened sufficiently.

Public procurement procedures that are applicable for operationalizing PPI are meant to ensure competitive market development. Basically, each public procurement procedure offered by the EU procurement directives (Directive 2014/24/EU, Articles 27-30, 32; Directive 2014/25/EU, Articles 45-48, 50) to buy goods and services, except the available procedure for conducting IP, can be applied to facilitate PPI.
PCP is defined as “a process by which public authorities in Europe can steer the development of new technologically innovative solutions that can address their specific needs” (EC, 2006, p. 2). PCP addresses a product life cycle at early R&D stages and, significantly, before the commercialization of solutions (EAFIP, 2016b). The PCP concept is outlined in the EU Communication entitled Pre-commercial Procurement. Driving innovation to ensure sustainable high quality public services in Europe (EC, 2007). PCP is not covered by the EU procurement directives and also falls outside of the World Trade Organization agreement on government procurement as long as PCP is restricted to original development. This gives rise to the observation that PCP is not an ordinary procurement procedure that instantly results in procurers’ exclusive need satisfaction. Rather, R&D services from private suppliers are being procured with the objective to align product development with public needs and increase the market availability of promising solutions that would otherwise not be developed (due to lack of private investments) or would need a much longer time to reach the market (EC, 2006). It is not part of PCP to procure the developed solutions within the same procurement process. As a consequence, some voices claim that PCP is not a demand-pull but a supply-push innovation policy instrument (Edquist & Zabala-Iturriagagoitia, 2012).

However, engaging in PCP enables procuring authorities to reduce the risk of failure in a larger scale PPI, allowing the PCP to acquire and diffuse innovative solutions that have been developed throughout the PCP procedure. In that case, insights of the PCP can be utilized to define requirements and technological specifications unambiguously (EAFIP, 2016b). Moreover, engaging in PCP enables the procuring authority to avoid supplier lock-in. By creating a competitive market environment with positive impacts on product price and quality, it allows them to gather knowledge about technological capabilities as well as advantages and disadvantages of different solutions, and enables them to set interoperability and product inter-changeability requirements during the development phase (EAFIP, 2016a; EC, 2006).

From the perspective of suppliers, PCP can also be considered valuable since it facilitates early customer feedback and signals promising prospects for the deployment of innovation. Therefore, PCP can also help to attract further private investments for R&D phases (EAFIP, 2016a; EC, 2006). Moreover, a phased PCP approach can facilitate the participation of innovative SME in public procurement since PCP phases can be adjusted to their innovation capacities and their respective growth path. So far, 71 per cent of funded PCP contracts in the EU were awarded to SMEs (EC, 2015).

IP combines PCP and PPI and is a procedure that, to date, has not yet been fully exploited in EU member states. Few innovation partnerships have been implemented, but it is expected that, with the implementation of the EU Directive, more will be put in place.
CHALLENGES TO POSITIONING PUBLIC PROCUREMENT AS A DRIVER OF DEEP DECARBONIZATION
The research identified the following challenges as reasons why public procurement to date has not yet been fully utilized as a driver of deep decarbonization and the transition to a low-carbon economy:

1. **The sustainability premium**: The procurement of infrastructure still all too often happens based on lowest capital cost of construction and does not sufficiently take a long-term life-cycle perspective. The promoted EU principle to award tenders to the most economically advantageous offer still lacks full implementation. Interviewed private sector representatives frequently highlight that even though sustainability criteria are sometimes set, there is no willingness to pay (more upfront) for these additional benefits. Cases were even reported where cement materials with a lower carbon footprint have been price competitive with ordinary cement but were still not prioritized.

2. **The lack of focus on life-cycle performance**: Public tenders for infrastructure projects today are not designed to demand better life-cycle performance, including in terms of life-cycle greenhouse gas emissions. Tenders predominantly address energy efficiency and emissions-related issues during the construction and operational phases of infrastructure projects. However, most tenders do not address these matters during upstream supply chain phases or end-of-life and/or remanufacturing phases. This lack of focus on the entire life cycle of solutions impedes the opportunity to set holistic, low-carbon design incentives through public procurement.

3. **The skillset to design tenders with low-carbon priorities**: Low-carbon (life-cycle) performance is still a new subject for many procuring authorities and their staff. Capacity building remains an important task for the future. However, today, procurement officers responsible for writing tenders may lack the necessary expertise to design low-carbon performance criteria. A balance of various performance parameters is decisive in public tenders to avoid negative quality impacts and additional expenses during the operational phase of infrastructure projects.

4. **Incoherent priorities and the lack of communication among departments**: It is important to integrate priorities and knowledge of different departments into the early stages of infrastructure planning and design—including stakeholders that are not directly concerned with tender design and procurement processes (e.g., facility management for infrastructure projects; user groups). By targeting effective communication among departments and crucial stakeholders, a life-cycle approach can be implemented, potential conflicts identified and timely budget reallocation decisions taken.

5. **The political leadership**: Political leadership is important to underwrite the importance of strategic public procurement and the importance procurement officers will attach to using public procurement for driving innovation towards a low-carbon economy. This political leadership is growing at the EU level, but needs to trickle down to the various national and municipal levels to sufficiently encourage public procurers to set priorities towards low-carbon tenders.

6. **The risk-averse mind-set of public procurement agencies**: The responsibility of procurers to safeguard taxpayers’ money, the interest in smooth due diligence processes and the often limited (human and time) resources result in risk-averse decisions and little appreciation for innovative solutions. Rather, public procurers tend to design tenders (in a technical and prescriptive way) that allow them to rely on established standards and select known and proven solutions. This facilitates little opportunity for low-carbon materials and solutions that have not
yet been applied and tested in many projects. A more innovation-friendly approach is to focus on (outcome) performance and desired functions and design tenders accordingly.

7. **The lack of verified data and evaluation tools:** Conservative decision making is reinforced by a lack of reliable and verified data on carbon performance of materials as well as limited real-life testing data about their technical performance in infrastructure projects. Moreover, holistic valuation methodologies and tools that assess the life-cycle performance of materials on a project level are difficult to apply, need time-intensive customization and are not yet readily available. This uncertainty often prevents public procurers from adopting a low-carbon focus in infrastructure projects.

8. **Supply chain interaction and transparency:** Usually, the public sector will not contract with raw material providers and manufacturing companies but rather with construction companies and project developers (especially for civil infrastructure projects). A public procurer does not necessarily control the material selection process but only sets respective requirements and criteria that contractors are expected to apply (see also Figure 3).

**Figure 3. Supply chain pathways for cement use in infrastructure projects**

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Explanation under Figure 3:

The contracting party is at the top of the supply chain and will select materials to be used. Hence, this party must have clear obligations (incentivized through the established contract with the procurer) to specify the sourcing of cement/concrete in such a way that the lowest possible carbon footprint of materials is achieved (e.g., lowest carbon footprint for ready mix concrete) while satisfying other quality requirements. The contractor will stay responsible for choosing the best solutions for reducing carbon emissions and needs to provide proof of this (e.g., verified life-cycle analysis [LCA] results) and increase supply chain transparency. Carbon performance should become a selection criterion for sub-suppliers and their products (trickle-down effect). The supply chain where a cement manufacturer delivers bulk cement either to a ready-mix concrete or pre-cast concrete supplier that delivers to the contractor is most common for large infrastructure projects. This direct interaction facilitates collaboration between specific material suppliers and designers/construction companies to optimize resource efficiency (e.g., amount of cement used for structures, increased use of recycled materials, etc.). Another pathway for cement is through merchants that buy bagged cement from manufacturers and sell these to smaller scale customers.
The combination of the above listed challenges causes a vicious cycle of proven technologies for infrastructure projects, which is depicted in Figure 4. In essence, the risk-averse mind set of procurers combined with limited expertise and little communication with knowledgeable stakeholders leads to the prioritization of well known, proven and standard-compliant technologies in public tenders. Consequently, new materials will rarely get the opportunity to be integrated in infrastructure projects and tested under real-life conditions. This has a reinforcing effect, as the market entry for these materials is aggravated and procurers will not be aware of them and/or will avoid tendering for such rarely applied materials.

Figure 4. Vicious cycle of proven technologies
4 SOLUTIONS AND OPPORTUNITIES FOR LOW-CARBON INFRASTRUCTURE PROCUREMENT: INTERVENTION POINTS IN THE PROCUREMENT CYCLE THAT WILL DRIVE LOW-CARBON INNOVATION

Through different intervention points in the procurement cycle (Figure 5), the procuring authority can prioritize and stimulate the selection of low-carbon solutions and trigger private sector investments into respective innovation. At the same time, components throughout the procurement cycle can be utilized for risk mitigation and risk sharing between the public and the private sectors. The following sections present the various intervention points across the public procurement cycle.

Figure 5. Procurement cycle and opportunities to demand for low-carbon infrastructure
4.1 Infrastructure and procurement planning

Stage 0 of the procurement cycle concerns the overall infrastructure and procurement planning and related policies within a country or region. Several measures can be taken to improve the overall conditions for integrating low-carbon solutions into infrastructure projects.

4.1.1 Policies and the importance of strategic planning

To channel investments into research and development and bring innovations to the market, it is crucial for both established material manufacturers and start-up companies to be able to rely on a stable policy environment with coherent and long-term targets. If responsible ministries and authorities have established sector-specific targets for climate change mitigation (reduction of carbon dioxide emissions by a certain percentage within a specific timeline), there are clear incentives for manufacturers to design and invest in solutions, as well as good reasons for cooperation among actors at different stages of the value chain.

Box 1. Examples of policy documents for low-carbon and sustainability requirements

Dublin City Council (Ireland), Development Plan 2016–2022:
“In order to reduce energy consumption, the following key design considerations should be considered at an early stage in the design process and incorporated, where feasible: The use of green building materials: low embodied energy products such as low carbon cement and recycled materials” (Dublin City Council, 2016).

South Dublin County Council (Ireland), Development Plan:
“The Council supports the use of CEM III/a cement classification, or equivalent, in development proposals for new buildings. The use of green building methods such as BREEAM (Building Research Establishment Environmental Assessment Methodology) and LEED (Leadership in Energy Efficiency and Design) ensure a whole-life cycle approach to building design including operational carbon and embodied carbon. This holistic approach results in low energy demand buildings with a significantly reduced carbon footprint and a higher commercial value” (South Dublin City Council, 2016).

Dun Laoghaire Rathdown County Council (Ireland), Development Plan 2016–2022:
“Other approved certification methods such as BREEAM, LEED, PHPP or equivalent standards will be deemed as acceptable in lieu of IS 399 2014. Where possible, building materials with low embodied carbon should be used” (Dublin City Council, 2016).

FutureBuilt Certification Project for Municipal Buildings (Norway):
“There are specific criteria for being a FutureBuilt pilot project. The carbon footprint must be reduced by at least 50 per cent compared to today’s regulations and common practice. This is measured by a climate gas accounting tool for buildings. The projects must: reduce greenhouse gas emissions from transport, energy and materials and be located near major transport hubs” (FutureBuilt, 2016).
Responsible authorities need to realize that public procurement is not solely a relevant procedure (or necessary burden) on a project-by-project level—it is a strategic policy instrument that can contribute to a variety of policy targets. Strategic public procurement provides access to private sector innovation capacities for long-term public objectives. Strategic policy targets provide grounds for procuring authorities to engage with the market, and these targets can be translated into functional specifications for single infrastructure projects.

Likewise, responsible authorities for infrastructure planning are advised to communicate plans for large infrastructure projects (infrastructure pipeline) and related design competitions transparently and much in advance before tendering (2–3 years) to prepare the market and allow sufficient lead time for potentially beneficial innovations. Another worthwhile example of initiatives is multistakeholder agreements, such as the Green Deal on Concrete or the Green Deal on Circular Procurement (www.greendeals.nl) in the Netherlands. These do not only communicate government targets to market actors but also involve the latter (and other stakeholders such as procuring authorities) to develop sustainability targets, pathways along supply chains and concrete projects. Such approaches can trigger cooperation and commitment among different actors.

### 4.1.2 Innovative Procurement Programs

As described in Section 3, several challenges exist within procuring authorities that impede the procurement of low-carbon infrastructure solutions. An approach to address these barriers is the introduction of innovative procurement programs within municipalities. Such initiatives can address the current or future sustainability needs of a municipality, and frame these as market challenges and design competitions (e.g., development of low-carbon building materials). They can even offer accelerator programs to SMEs and start-ups that are keen to provide new solutions that are not yet market-ready and that have little experience engaging with public sector clients. Setting up such programs requires considerable preparation and human resource capacities. However, they trigger valuable interaction among different municipal departments, an interest to engage with the market and new insights about available materials and business models for sustainable infrastructure solutions.

Several cities in the Netherlands recently launched a Startup in Residence program that allows procuring authorities to engage with innovative start-ups while a training and mentoring program is offered to companies that have applied successfully. Box 2 presents an overview about the Startup in Residence program in the City of Amsterdam.
4.1.3 Demand bundling: innovation and standardization at the right level

Demand bundling among several municipalities or through utilizing central procurement agencies can be an appealing approach for small municipalities to overcome capacity limitations while engaging in innovation procurement. At the same time, joint procurement initiatives and/or the procurement of long-term services (instead of one-time product procurement) with tenders of significant financial volumes signal considerable demand to the market, which makes it more appealing for companies to invest in R&D and to hand in competitive offers.

The bundling of demand by several agencies, combined with the intention to procure large volumes of new solutions with improved sustainability performance, provides incentives for companies to invest...
in low-carbon innovation while not having to design unique solutions for a single application. Rather, they design solutions that are standardized to a certain degree. Standardization of solutions is crucial to facilitating resource-efficient production and economies of scale. Even though finding the right level of standardization (e.g., level of fixed materials composition and prefabrication) necessitates real-life testing cases, a large volume of assured public demand incentivizes companies to consider standardization potentials early in their solution design process.

A supportive process for identifying at which level standardization is (economically and technically) desirable and necessary is communication and collaboration among different value chain actors. Procuring authorities can contribute to this by facilitating consortia building during pre-procurement phases and/or by requiring a specific consortium profile within their request for proposals. Alliance business models with associated revenue and risk-sharing modes can be established with the different value chain actors. It is important to remember that it is not the procurer’s task to predefine the level of product standardization; they should define their desired functions while making use of the suppliers’ expertise to design well performing solutions. Figure 6 provides an overview of how procuring authorities can incentivize a fruitful balance between innovation and standardization within public procurement.

**Figure 6. Balance between Innovation and standardization**

- **Objectives:**
  - High CO2 savings, (transaction) cost savings for procurer, creating competitive markets

- **Standardization in Procurement:**
  - (modular) construction elements with low embodied carbon content to be used in multiple projects
  - Signalling significant demand to the market
  - Level of standardization to be defined by procurer or contractor?

- **Room for Innovation:**
  - Functional/ outcome-based criteria: functionality, durability, recyclability, carbon performance etc.
  - No prescription of (raw-) materials for standardized construction elements
Box 3. Examples of standardized sustainable building solutions

Anglian Water @One Alliance:

Background

Anglian Water is a water company that operates 1,257 water and water recycling treatment plants in East England (and Hartlepool), where they serve more than 6 million domestic and business customers. It is regulated under the United Kingdom Water Industry Act 1991. Several public bodies oversee the operation, such as the Water Services Regulation Authority (WSRA), the Drinking Water Inspectorate and the Environment Agency. One operation cycle lasts 5 years (= Asset Management Plan) and attainable prices are determined at the beginning by the WSRA based on offers (business plans) that have been handed in by water companies. The performance of all companies is monitored and compared by WSRA every year.

Business Model

To improve the quality, efficiency and sustainability of its infrastructure assets as a means to meet customer requirements and stay competitive when delivering the capital investment program for the new asset management plan (AMP6), Anglian Water decided in 2005 to adopt a collaborative business model that unites the expertise of diverse supply chain actors. The @One Alliance is a virtual joint venture that contractually links Anglian Water Asset Delivery (the internal team responsible for the capital delivery process) with six key partners. Other companies of the wider supply chain are involved through framework agreements. Eighty per cent of the alliance business model is structured by framework contracts or partnerships. During each operation cycle (AMP), the alliance designs and builds approximately 800 infrastructure projects for Anglian Water with a total value of GBP 1.2 billion.

Key success factors of the @One Alliance business model:

• Supply chain collaboration instead of (project-based) competition, operationalized through the organizational structure and revenue system: each partner contributes to the @One Alliance in proportion to its individual share and receives a respective share of the joint profits.

• Collaborative nature leads to: integrated teams, trust, vast experience and expertise, introduction of digital technologies that are new to the sector and a reduction of information asymmetry between value chain actors. New ideas and innovations are the result.

• The alliance adopts a holistic and long-term view beyond single infrastructure projects due to a huge customer base, many projects and promising outlooks for long-term cooperation. These conditions make it appealing to invest in innovation on one hand but also to design product-focused, standardized solutions due to similar projects and repetitive tasks. Large efficiency gains, simplified and automated procurement, and continuous quality/service improvements are the result.

• The alliance structure is not static but evaluated regularly to exclude underperforming partners and welcome newcomers with value-adding solutions. Performance is measured against defined baselines.
Anglian Water @One Alliance:

Sustainability Performance

In the period from 2010 to 2015, the @One Alliance managed to reduce embodied carbon by 54 per cent (carbon dioxide emissions related to the construction phase, including transport of materials and installation) and operational carbon by 41 per cent (carbon dioxide emissions during operation). These achievements serve as a benchmark for the infrastructure sector in the UK.

Examples for Improved Carbon Performance

Anglian Water had to refurbish and replace 50 water quality stations at reservoirs. The scale of the task and their carbon performance targets induced them to develop a product-focused, standardized solution with less embodied and operational carbon. The @One Alliance developed a space-optimized booth that is powered by solar energy. The new foundation consists of a metal base rather than carbon-intensive concrete, and it is prefabricated off-site and can be installed quickly. The embodied carbon is reduced by 11 per cent and the operational carbon is now zero. Moreover, production and installation costs have been reduced by 23 per cent compared to the 2005 baseline. Reinforced nylon air valves replaced metal-made components. The new valves weigh 24 kg less, have 90 per cent less embodied carbon, have a longer lifetime due to corrosion resistance and cost 36 per cent less.

By 2020, 67 per cent of capital spending is expected to be on standard products, and 90 per cent of projects will include at least one standard solution. Moreover, @One Alliance is in communication with other water service providers about best practices and cost-saving opportunities through joint standard products and industry-wide product catalogues.

Lessons for Public Procurement

Even though the business model and resulting benefits for public services did not occur due to a public procurement strategy that incentivizes Anglian Water to innovate, there are still a few lessons for public procurers that are important for creating conducive conditions for innovation and sustainability:

• Overcome silo-thinking (within organizations and in between sectors) and build up trust to encourage the introduction of new ideas and innovation
• Facilitate collaboration along supply chains (e.g., by integrating consortia building into procurement procedures) to include suppliers and contractors from the early planning and design phases
• Apply a long-term time horizon for multiple projects (through framework agreements and/or joint procurement of several municipalities with similar needs) while allowing contractors to find a value-adding balance between innovation and standardization
• Focus on performance evaluation rather than prescribing detailed technical specifications

Sources: World Economic Forum, 2017; personal communications with @OneAlliance; Anglian Water, 2015.
4.2 Needs identification and pre-procurement activities

Stage 1 of the procurement cycle concerns the procurement for the specific infrastructure asset. Prior to launching a request for proposals, procuring authorities are advised to invest sufficient time into needs identification, project planning, design, information activities and market engagement, as these components determine the sustainability potential of an infrastructure project. The tender design should be informed by pre-procurement activities shown in Figure 7 and presented in the following sections.

Figure 7. Pre-procurement activities provided by Directive2014/24/EU
4.2.1 Design phase: identifying needs and predefining tender content

The design of an infrastructure project and the translation of that design into the tender will define opportunities for the scale and type of materials to be used (opportunities for using less materials and/or more sustainable materials with lower carbon footprints), potential benefits of materials during construction (e.g., less energy and transport needs) or during the use-phase (e.g., better insulation properties), potential for repurposing assets, decommissioning impacts as well as outlooks for dismantling and remanufacturing and/or recycling of building components. Market research can provide initial insights about new building solutions in addition to the internal knowledge of public agencies. During the design phase, the preparatory stages of the procurement process can be utilized as an enabling mechanism to reconsider the needs of the public sector as well as evaluate the needs of the final beneficiary of infrastructure projects. This includes assessing whether desired functions can be procured differently by focusing on long-term services while leaving ownership with the supplier (changing models of ownership sometimes will provide better VfM).

4.2.2 Information activities and market engagement

During the design phase, it is important to not make isolated decisions solely based on experience, but also through exchange with diverse stakeholders and engagement with relevant market actors to draw on their contemporary expertise for reducing carbon emissions. Procuring authorities have the option to publish a prior information notice a significant time before the actual tender notice (request for proposals) as a means to inform the market early about procurement intentions and public needs.

The prior information notice offers market players sufficient preparation time and provides public agencies with feedback from the market to prepare the tender. The details that must be included in a prior information notice are regulated under the Directive 2014/24/EU.

Market engagement prior to launching a request for proposals facilitates several benefits:

- Informing market actors of procurement plans and low-carbon (functional/ performance) requirements.
- Identifying state-of-the-art solutions and/or whether there is considerable innovation potential for solutions with desired (functional/performance) requirements.
- Validating whether minimum requirements can be served by the market, whether there are numerous (experienced) bidders and what kind of market actors are able to supply. This can also help to decide whether to split up the contract into lots.
- Providing an opportunity for the procuring authority to receive feedback about the defined assumptions of a business case for the desired solution (costs, benefits, [technological] risks, time-to-market).
- Cross-checking market experience and acceptance of envisaged contract set-up as well as intellectual property rights challenges.
- An open market consultation can also give rise to which procurement procedure (Directive 2014/24/EU) will be most appropriately applied (depending on market readiness and the need for a communication-intensive procurement approach).
Altogether, pre-procurement activities serve to increase transparency, overcome information asymmetries between the procuring authority and market actors, and lay a foundation for risk sharing between them. Beyond that, procuring authorities can also facilitate suppliers’ receptiveness to risk sharing between different market actors along the supply chain. It is crucial to balance incentives for competition on the one hand and collaboration on the other, to facilitate VfM, risk-sharing and transparency (for innovation investments) among supply chain actors. Figure 8 summarizes elements of competition and collaboration that are crucial for ensuring low life-cycle emissions in infrastructure projects.

Figure 8. Elements of competition and collaboration approaches

One promising approach during pre-procurement phases is to facilitate consortia building among diverse supply chain actors and communicate that subsequently submitted tenders have a competitive edge if they are designed and executed by a project consortium (or vertically integrated corporations).

The procurement of renovation works and energy management services for several public buildings in Eindhoven Municipality provides a prime example for market engagement and facilitation of consortia building during pre-procurement stages and throughout the tendering process (see Box 4).
Box 4. Best value procurement for building refurbishment in Eindhoven Municipality, Netherlands

Context

Eindhoven Municipality is utilizing public procurement to contribute to the goal of making it a sustainable, inspirational and energy-neutral city by 2045. The need for a large-scale procurement of renovation works and energy management for public buildings was identified in the course of a cancelled small-scale procurement project for renovating the town hall tower. By referring to Eindhoven’s 2045 targets, the Buildings & Maintenance Department of the municipality recognized the need to involve the market proactively for identifying new material and larger-scale service solutions for several municipal buildings. Among others, the aim was to consider three types of innovations for building renovation and subsequent operation:

- Proven innovations that had already been tested in practice on a small scale and are commercially available.
- Promising innovations that are developed but not yet tested in practice and not yet launched on the market.
- Speculative innovations: Inventions that need further development and can only be proven in the long term, necessitating a test environment during building operation.

Procurement Steps

Given the complexity of the procuring authority’s request (the large-scale but provisional project scope, and the undefined and largely intangible nature of required building solutions), the competitive dialogue procedure was selected as the most suitable procurement procedure. Pre-defining technical requirements and mandatory solutions were neither feasible nor intended. Dialogue with bidders and subsequent tender adjustments were necessary components throughout the procurement process to award a value-adding contract in the end.

The following steps were applied:

1. Pre-Procurement Activities:

The municipality conducted several market engagement activities to prepare for tendering:

- **Market research** about available innovative building solutions and its diffusion barriers. Insights to be applied for the intended procurement project comprised: applying a long-term perspective, a collaborative approach between procuring authority and suppliers (as well as among suppliers), a systems integration approach and a greater project scope beyond a single building to facilitate sustainability of city districts.
- **Informing the market** about procurement objectives and identifying innovative market solutions by asking suppliers to develop ideas (technologies, products, processes, conceptual ideas, methods) and share these on an online platform.
- **Knowledge sharing and formation** of supplier consortia: Several events took place to facilitate knowledge exchange and consortia building among all interested suppliers. The consortia approach enabled SMEs to participate in the subsequent tender process despite their limited implementation capacities for huge projects.
2. Definition of Functional Requirements and Tasks Indicated in Tender Notice:

The procuring authority did not prescribe any technical solutions, technical minimum requirements or technical specifications, service solutions or financial models. To the contrary, suppliers were expected to develop and provide innovative solutions in any direction that would maximize added value for the municipality in terms of sustainability and energy efficiency of municipal buildings. Hence, only functional objectives and a range of tasks for several buildings were defined that needed to be addressed by offered solutions. By integrating these tasks, it was the procuring authority’s intention to receive a complete business case in a single procurement scope, including renovation work and material solutions, energy management, maintenance and facility management. Through this bundling and the long-term perspective, the procuring authority applied a total cost of ownership approach, enabling the procurement of innovation and sustainability.

The contract term has been fixed at 10 years, with a possible extension for another five years. The option for additional investments during the contract period was issued in case of new innovations developed by the contractor during the operational period.

3. Pre-Selection of Supplier Consortia:

Several criteria were defined to decide which suppliers qualify to take part in the competitive dialogue stages. The pre-selection phase assessed: minimum requirements (formal commercial registration, professional competences, financial and economic capacity), technical and organizational skills, competency for system-based approaches and organizational flexibility for complex assignments. Altogether, 17 bidders submitted documentation for the pre-selection phase, whereas 15 of them were consortia (representing 75 companies) and two bidders were large enterprises.

4. Competitive Dialogue Stages:

A two-step dialogue process took place to assess how the legal-financial, organizational and technical solutions of each offer addressed effectively the functional requirements and tasks of the tender. The dialogue procedure ensured that the bidding consortia understood what kind of information and documentation they needed to provide for the evaluation procedure. The best three candidates were invited to submit an offer. The evaluation methodology and award criteria were based on the best value procurement approach to ensure selecting the offer that delivers the highest added value to the procuring authority. Four award criteria were defined:

- Scope of the offer (based on defined tasks) and its sustainability performance
- Opportunities for added value associated with the realisation of project objectives
- Identified risks that are beyond the contractor’s power of influence and the quality of proposed control measures
- Measurable competencies (at the individual level: key personnel) of the proposed implementation consortia for project implementation and contract execution

The authority defined further sub-criteria to operationalize the evaluation procedure. Bidding consortia were expected to respond to the four award criteria by preparing an integral plan as part of their offer, comprising a solid business case (life-cycle cost perspective for all suggested solutions) that generates maximum value for money and hence provides for a given budget, the highest possible added value for the procuring authority.
4.3 Low-carbon infrastructure tenders, evaluations and contract awards

This section discusses the interventions that are possible from stages 2 to 8 of the procurement cycle in Figure 5.

4.3.1 Tender specifications and criteria

Four types of criteria are applied at different stages of the tendering process and can serve to procure low-carbon solutions:

- **Pre-selection criteria** for pre-selecting suppliers that applied for participation in the tendering process by submitting required formal documentation.
- **Project-specific criteria** (technical or functional specifications) that are listed in the public tender as (mandatory) requirements and are often a baseline for the award decision.
- **Award criteria** that are applied to evaluate the final bids (often segmented into sub-criteria to operationalize the evaluation of bids).
- **Contract performance criteria** that are used to monitor and evaluate contractors during the project execution and potentially subsequent life-cycle phases (operation, end-of-life) and hence hold them liable for performance/solutions promised within their bids.

In the following section, the four criteria categories are discussed in detail and concrete examples are provided to exemplify their role for procuring low-carbon infrastructure solutions.

4.3.1.1 Pre-selection criteria

Procurement authorities can restrict the number of participating bidders for dialogue and evaluation phases to reduce time and human resources, by applying low-carbon-related pre-selection criteria such as:

- Environmental, energy and/or carbon management systems (e.g., proof through ISO and/or EMAS certification) as well as sustainable supply chain management implemented.
- Technical expertise and capacity within a bidding consortium (executing team) concerning low-carbon solutions for different project life-cycle phases (manufacturing/material sourcing, logistics, construction, operation and maintenance, upgrading, dismantling, etc.). This may be evidenced by the track record of consortium members (e.g., Building Research Establishment Environmental Assessment Method [BREEAM] and/or Leadership in Energy and Environmental Design [LEED-certified] construction projects implemented).
- Ability and willingness to collaborate with the procuring authority and/or the entire value chain for identifying and implementing low-carbon solutions.
4.3.1.2 Tender specifications

Tender specifications that focus on the desired infrastructure project can either be technical or functional. Both can be used to prioritize low-carbon solutions in infrastructure projects.

Technical Specifications

Low-carbon materials are characterized by their low embodied carbon content (based on manufacturing stages and material composition) compared to alternative materials and/or they can have positive carbon impacts during later life-cycle phases of an infrastructure project (e.g., less energy consumption due to: insulation properties of materials; carbon sequestration properties of materials; reuse and remanufacturing opportunities).

Technical specifications can include references to low-carbon materials or specific material compositions, and require using these in infrastructure projects. In the case of construction materials, specifications can build on established material standards. For example, EN 197 is a common standard for cement products and describes different cement types based on raw materials that they contain (CEM I – CEM V). Box 5 provides some examples of tenders that contain technical material specifications, partly by referring to EN 197.

Material standards (such as EN 197 for cement, EN 206 for concrete) define characteristics and requirements for the concerned material category. These standards are created and regularly adjusted by different actors with relevant industry expertise to ensure that standard-compliant materials available on the market fulfil important quality attributes (e.g., setting time for cement, durability requirements for concrete for different exposure classes). Certain material standards are set based on their composition, others are focusing on the quality performance of a material. It must be noted that a balance needs to be struck within public tenders between the use of standards and the room for innovation. The former provides material performance certainty for the procurer and planning certainty for the market on which materials public agencies will prioritize in their infrastructure projects. At the same time, technically prescriptive standards serve as a market entry barrier for innovative materials. The EN 197 standard for cement is sometimes criticized because it would be a standard too rigid to allow for sufficient material innovations. Room for innovation is easier pursued when performance standards are being used. Procuring authorities need to be aware of the kind of standard they are referring to in their tenders when aiming for the procurement of low-carbon innovation.
Box 5. Examples of technical specifications

Guidelines of Rijkswaterstaat, the Dutch Ministry of Infrastructure and the Environment (RWS, 2015):

“Only the following two cement types are allowed for respective infrastructure projects because they guarantee (a) Sustainability: 70% less CO2 emissions than Portland cement, and (b) Resistance against Alkali-Silicia Reaction (ASR):

1. CEM III cement with a percentage of slag higher than 50%; or
2. Portland-fly-ash cement CEM II with a percentage of fly-ash higher than 25%.”

According to the guidelines, other alternatives/innovative forms of cement are not allowed because they often cause problems in terms of quality.

National Health Services in Ireland, Sustainable Healthcare Building Guidelines (Feidhmeannacht na Seirbhíse Sláinte, Health Service Executive, September 2015):

These are centralized guidelines for sustainable construction and procurement. They include technical specifications for the use of cement types with lower carbon footprints for different applications:

“The Irish Government’s Green Public Procurement Action Plan recommends use of low carbon construction materials as a means of reducing a building’s environmental impact. Specify low carbon cement mixed with regular Portland cement (CEM I or CEM II/A). The Irish Concrete Standard I.S. EN 206, makes provision for the use of several alternative low carbon cements, as partial replacement of regular Portland cement (CEM I or CEM II/A) in concrete. Specification of low carbon cement (i.e. GGBS = Ground Granulated Blast-furnace Slag) in ready mix concrete and precast concrete typically includes:

(a) A cement combination comprising a minimum of 50% low carbon cement and CEM I or CEM II/A (cement type) to be used in all substructure (below ground level) concrete throughout the project, unless otherwise specified by the project Engineer.

(b) A cement combination comprising a minimum of 40% low carbon cement and CEM I or CEM II/A to be used in all superstructure (above ground level) concrete throughout the project, unless otherwise specified by the project Engineer.

(c) A cement combination comprising a minimum of 35% low carbon cement and CEM I or CEM II/A to be used in power-floated floors at or above ground level throughout the project, unless otherwise specified by the project Engineer.

(d) A cement combination comprising a minimum of 25% low carbon cement and CEM I or CEM II/A to be used in all precast concrete throughout the project, unless otherwise specified by the project Engineer.”
Functional Specifications

Specifications can also be formulated as functional, outcome-based or performance-based (concepts are being used interchangeably) specifications. By using these types of specifications, desired construction materials are not technically determined. Instead, their desired function or outcome is indicated. A function can be defined on different levels of an infrastructure project. Either on the intermediate material level (e.g., use of concrete with low embodied carbon content. Optional, a maximum carbon content can be defined: XX g CO2/m3 or at the project level (e.g., low life-cycle carbon footprint of the entire project). The use of performance-based specifications does not automatically result in more sustainable or low-carbon solutions. They have to be specifically designed to pursue that outcome (IISD, 2014).

From the perspective of minimizing the carbon footprint of the entire project throughout its life cycle, it is recommended to define functional requirements at a project level. Setting the performance barriers high enough is important to encourage sufficient innovation along the supply chain, all the way to material composition towards low-carbon design. Certain projects may not warrant an assessment on the project level, but rather at the level of materials being used. In either case, it will be necessary to apply carbon calculation tools and/or provide verified life-cycle impact assessments (environmental product declarations) of suggested materials to ensure comparability of different offers during the award stage.

According to interviewed construction contractors, functional specifications are more frequently used in public tenders for buildings compared to civil infrastructure projects. Contractors for building projects hence have the responsibility to design solutions and choose materials that fulfill the functional requirements. Box 6 provides an example of functional specifications used in public tenders.

Box 6. Examples of functional specifications

Dutch tender for Noord Brabant, concrete bicycle lane. The tender incentivizes the use of recycled materials and low-carbon solutions via:

a) Re-use of secondary products (concrete granulate and secondary sand) in concrete material (by percentage)

b) Calculated carbon dioxide footprint of concrete production (per m3)—this includes emissions from the extraction stage and production of all materials, storage and transport to production site until the concrete mix is ready for transportation.

Mechanism for integrating performance on a and b into the award methodology: A table that is included in the tender explains how much monetary value can be deducted from bidding price depending on the percentage of secondary materials used in the concrete mix. Another deduction can be done based on the achieved level of carbon dioxide emissions.

Source: Provincie Noord Brabant, 2017
Procuring authorities can also choose to refer to and draw from international building standards and certifications. Popular international certification schemes for buildings are LEED run by the U.S. Green Building Council and BREEAM owned by the BRE Group. The latter scheme is currently being extended by a new version for civil infrastructure projects (BREEAM New Construction Infrastructure, pilot phase). Likewise, the Civil Engineering Environmental Quality Assessment and Award Scheme (CEEQUAL, recently acquired by BRE Group) is applied for civil infrastructure projects. These schemes offer certification options during different phases of a construction process, for in-use buildings that are meant to be renovated as well as certification options beyond a single construction object (neighbourhoods, districts, etc.).

Beyond these internationally used schemes, there is a range of national sustainability assessment certification schemes for construction projects (e.g., DGNB in Germany). Each scheme promotes various areas of sustainability actions such as energy, water, waste, transportation, materials, etc. For each area, a certain number of maximum available points are allocated and thus a final score can be calculated for an assessed construction project. Depending on the overall score (percentage of maximal score), the project will receive a rating (e.g., BREEAM: pass, good, very good, excellent, outstanding; LEED: certified, silver, gold, platinum).

A procuring authority can pre-define which rating level is required for the infrastructure project. The higher the required rating level, the more ambitious a contractor will be while increasingly having to deal with all areas of the assessment scheme. Consequently, a contractor will also need to identify and use low-carbon construction materials. Figure 9 presents how LEED and BREEAM set an emphasis on low-carbon materials and innovation within their schemes.

Figure 9. Material and innovation sections of LEED and BREEAM certification schemes

<table>
<thead>
<tr>
<th>Material Section</th>
<th>LEED: 11.8%</th>
<th>BREEAM (buildings: new construction): 13.5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material aspects considered in both schemes:</td>
<td>• Design phase relevance to optimize materials to be used (resource efficiency) • Reuse and recycling of materials • Consideration of embodied carbon/ energy of materials • Lifecycle assessments/ environmental product declarations based on recognized standards (ISO, EN)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Innovation Section</th>
<th>Additional points allocated for Innovation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• LEED: max. 6 additional points (5% of max. score): Use of new materials that replace env. harmful/ toxic materials; diversity of other measures that promote reduction of energy consumption, sustainable mobility etc. • BREEAM: additional 1% to a building’s overall score if: a) Exemplary performance beyond requirements in one of the scoring categories; or b) Integration of a building technology or feature, design or construction method or process recognised as ‘innovative’ by BRE Global</td>
<td></td>
</tr>
</tbody>
</table>

LEED and BREEAM (and potentially other schemes) incentivise contractors to include low carbon materials into their projects for achieving high scores in the following categories:
Figure 10 compares the different tender design criteria concerning their level of specifications and installed incentives for contractors to comply with defined specifications. In tenders, technical and functional specifications can also be combined (i.e., defining technical specifications for intermediate products while leaving subsequent processing and engineering steps by only requiring a certain final function/property of a solution).

Box 7. Use of building standards in infrastructure procurement for the London Olympic Games

In the infrastructure procurement for the London Olympic games, the Olympic Delivery Authority (ODA) used recognized international building standards in addition to bespoke project requirements:

ODA’s Sustainable Development Strategy set out a range of bespoke standards relating to energy efficiency, water use, construction waste and materials. It also recognized the value of existing tools. It specified:

- A new version of BREEAM: A BREEAM rating of Excellent was required for the permanent venues.
- CEEQUAL to assess 18 permanent infrastructure projects on the Olympic Park, plus the Olympic and Paralympic Village car park. A CEEQUAL Whole Project rating of Very Good was sought for each project being assessed, with an amalgamated rating for the entire Olympic Park being awarded upon completion of all of the assessments. Both tools offered the ODA a reputable methodology that was independent and externally audited.

Source: Paterson (2011)
Irrespective of whether to put forward technical or functional specifications in tenders, it is crucial that procuring authorities prepare their tenders well and include all sustainability requirements that are of importance to them. Only then do they become part of the competitive bidding process try to find the most cost-effective solutions. If procuring authorities define new sustainability requirements after the contractor has been selected, they run the risk of not ensuring VfM. At the stage of contract award, a bilateral monopoly condition arises while the contractor likely possesses more information regarding material suitability and prices. It is a widespread observation that contractors take advantage to increase margins during renegotiation after the contract award.
Box 8. Case Study Oslo Municipality, Veitvet School (new construction)

1. Background

Several buildings and a school yard where newly built for Veitvet School in Oslo Municipality. The project was procured and funded as a public-private partnership (PPP). The contractor was selected through a competitive dialogue procedure. Sustainable construction was one of the core objectives during the project preparation phase and the municipality decided to use the new Norwegian Sustainability Standard “FutureBuilt.”

Supportive Policy Environment and Internal Sustainability Commitment:

- A passive house standard has been required for all newly constructed municipal buildings in Oslo since 2015 (bystyrevevtak 06/10 Grønne bygg).
- The Agency for Education was responsible for the procurement and is the building’s tenant at the same time: supportive conditions that incentivize the procurer to focus on quality, durability, building operation and maintenance, value for end-user, etc.
- High-level hierarchy support: Head of the agency is a member of the board of FutureBuilt → early ambition to make Veitvet school an official pilot project.

The FutureBuilt Standard:

FutureBuilt is a 10-year, Norway-wide and publicly financed program (2010–2020) with a vision of developing carbon-neutral urban areas and high-quality architecture through completing 50 pilot projects. These projects (urban areas and individual buildings) are meant to inspire and change practices in both the private and the public sectors. The projects need to fulfil a range of core criteria:

- Reduction of greenhouse gas emissions from transport, energy and materials. The carbon footprint must be reduced by at least 50 per cent compared to existing regulations and common practices. This is measured by a climate gas accounting tool for buildings.
- Delivery of high urban and architectural quality to add social, cultural and environmental values (especially with respect to outdoor spaces and the project’s relationship to the city environment).
- Demonstration of innovative solutions and showcase qualities (e.g., applying ambitious environmental standards such as energy-plus buildings, integrating new products and construction processes).

The criteria have to be applied when the project is 1) planned, 2) built and 3) evaluated afterwards. The contractor is obliged to document what they do and how they fulfill the requirements of FutureBuilt.

2. Procurement Approach

Pre-procurement phase: Different meetings were organized by the Agency for Education. These were attended by different municipal agencies as well as external consultants. The goal was to define which criteria should be used to facilitate environmental friendliness (reduction of carbon emissions and air pollution) and neighbourhood/architectural quality, how to emphasize these criteria in the procurement process and how to evaluate the
offers later. A report was written and laid the foundation for choosing the FutureBuilt criteria system. During the pre-procurement dialogue with the market, interested bidders suggested that BREEAM be applied, as it also suits the procurer’s objectives. The procuring authority followed this suggestion. Hence, the market was informed early in the process about the procurer’s sustainability ambitions.

**Tendering:** The tender was mostly based on functional criteria, integrated the FutureBuilt Standard and required BREEAM certification. A PPP funding model was applied that requests pre-financing from the contractor while staying in project ownership for 25 years (plus potentially 15 additional years) and refinancing all expenditures through rent.

Pre-qualification and a competitive dialogue procedure were applied.

**Pre-qualification criteria:**

- Price (50 per cent weight), sub-criteria: total rent per year, energy expenditures/energy consumption (kWh per m² in accordance with NS 3031)
- Project quality (40 per cent weight), sub-criteria based on FutureBuilt system
- Skills for and understanding of tasks (10 per cent weight): profile and know-how of key personnel, including competencies for environment

**Competitive Dialogue Phase:**

After pre-qualification, two dialogue phases took place. Five companies (construction companies/project developers) were participating in this stage of the competition, which is a good number for a comparatively small Norwegian market. The procuring authority set up a negotiation and evaluation committee consisting of technical as well as environment and carbon footprint experts.

**Phase 1:** Formal, individual meetings with all bidders were conducted where they had to present their building solutions and how they achieve these.

**Phase 2:** During this phase, concepts and functional criteria were improved thanks to the exchange with different bidders. For example, requirements concerning the building plan and the facade were changed while not prescribing materials to be used but leaving the responsibility with the contractor.

**Submission of Bids:** Documentation of criteria required by FutureBuilt as well as by BREEAM. As required by FutureBuilt, bidders had to submit a carbon footprint calculation for their construction project as part of their offer. They were able to use the free carbon calculation tool provided by the Norwegian construction agency (www.klimagassregnskap.no) or an equivalent. Accuracy of submitted carbon calculations was assessed by an expert company called Civitas.

3. Procured Building Solutions

The contract for Veitvet school was awarded to Skanska, mainly because their offer achieved the lowest construction costs and the lowest management, operation and
maintenance costs of all bidders, and because they offered a good and flexible finance model. Even though they had the second highest energy consumption, their bid scored second best on the carbon life-cycle calculation tool (59 per cent carbon reduction of materials compared to reference project). The low-carbon footprint was mainly achieved by using fly-ash concrete (they had to ensure beforehand with sub-contractors that fly-ash concrete could be supplied sufficiently), lime-tree pillars in upper levels of the building, wooden facade outside of the building, solar panels, tilted windows to improve daylight utilization and thermal heating as an energy source (which ensured 35 per cent of the carbon reduction). None of these solutions was prescribed by the procuring authority, but functional specifications and applied standards triggered the creativity and ambition of the winning bid. Also, Skanska decided early to document all deviations of their project solution compared to the reference project, even though this was not mandatory.

For more details, see FutureBuilt, 2017.

4. Awarded Contracts:

Four contracts were signed with the contractor: 1) Overlaying PPP contract, 2) Rental Contract for the Building, 3) Rental Contract for the Property, 4) Facility Management Contract.

The issued contracts did not only include the building construction but also building ownership and operation (PPP) for 25 years, and a potential extension for another 15 years. The school pays a monthly rental fee for this period, which consists of a fixed amount that covers the initial investment costs for construction and a variable amount that covers all operational costs. Thus, there is also an incentive for the tenant to keep electricity consumption low.

Incentive system: For the contractor, it was a significant risk to suggest building solutions during tendering and stay responsible for these solutions during a long contract period. At the same time, operational responsibility is a valuable incentive system for high-quality building solutions and performance delivery. If the Agency for Education is not happy with the quality of the building, they can hold back money—both from the facility management contract and the investment contract. Consequently, for the procuring authority there are fewer risks associated with building quality, operational performance and opportunistic behaviour of contractors.

Skanska sold the building ownership (overlaying PPP) shortly after they finished the building to Oslo Pension Insurance AS (a pension fund for citizens of Oslo Municipality). If the insurance agency wants to sell their ownership again, Oslo Municipality has the option to buy first (contractual clause). Skanska had to keep the Facility Management Contract and hired a sub-contractor that is responsible for providing maintenance services.

Source: FutureBuilt, 2017; interview, Oslo Kommune
Box 9. Case Study London Olympic Games 2012, procurement of concrete for the Olympic Park

1. Background and Supportive Policy Environment

The ODA was constituted as a public body with the responsibility to deliver venues, facilities, infrastructure and transport systems for the London 2012 Olympic Games while achieving sustainability objectives and on-time delivery within the available budget. Based on ambitious sustainability targets set out in the Sustainable Development Strategy for the Olympic Games, it was also the objective to identify and procure environmentally friendly materials according to four priorities: responsible sourcing, minimizing embodied impacts, and use of secondary materials and healthy materials.

With an expected volume of 500,000 m³ of ready-mixed concrete, it was anticipated as a major construction material to be procured with far-reaching sustainability implications. The concrete procurement was managed by the logistics team of ODA’s Delivery Partner. This was a consortium consisting of representatives from CH2M Hill, Laing O’Rourke and Mace. Forecasting methods applied for construction projects served during early design stages to understand consumption needs of concrete and aggregates. This allowed the consortium to determine tender specifications for concrete to meet overall sustainability targets.

2. Procurement Approach

The Delivery Partner identified early that a centralized procurement approach across the various infrastructure projects, early communication with supply chains as well as trials and testing of various sustainable concrete mixes were crucial for minimizing the overall environmental impacts of used concrete for the Olympic Games. Therefore, a public tender was issued for a framework supplier agreement requesting the delivery of concrete for all sites of the Olympic Games.

**Tender Specifications**: Since technical and functional requirements for concrete differ a lot depending on the area of application (type of building/project, structural element, exposure, etc.), not one single type of concrete was meant to be procured, but a range of different types (according to the different project developer needs). The public tender did not intend to technically determine the concrete type to be supplied but rather ensure the supplier’s capacity and flexibility to supply a wide range of sustainable concrete mixes. The tender included functional specifications in combination with minimum targets on material and construction site levels:

- Construction materials must contain at least 20 per cent recycled content (by value)
- 25 per cent (by weight) and 20 per cent (by value) of used aggregates must be recyclable
- 50 per cent of supplied materials (by weight) must be transported to the construction sites by sustainable modes (water or rail)
- Use of energy-efficient, low-emissions vehicles for site-wide concrete delivery
- Set-up of concrete batching plant(s) on-site (to secure in-time construction and facilitate the use of sustainable materials for ready-mix concrete).
Pre-Qualification: A pre-qualification questionnaire had to be answered by all interested suppliers. The questionnaire encouraged concrete manufacturers to work with their supply chains to identify and develop new material compositions to address the sustainability ambitions of ODA.

Request for Proposals and Evaluation: Suppliers invited to submit a proposal for concrete delivery were supposed to address the above-listed tender specifications. These sustainability-focused criteria (having a large impact on carbon performance) made up 20 per cent of the technical evaluation of offers (a comparatively high percentage compared to similar tenders at that time). The Most Economically Advantageous Tender methodology was applied to evaluate offers by using a Balanced Scorecard that covered a set of award criteria next to the commercial evaluation.

Figure 11. Balanced Scorecard for Tender evaluation (PQQ = Pre-Qualification Questionnaire; ITT = Invitation to Tender). Source: Department for Environment, Food & Rural Affairs, 2013.
3. Contract Award

The contract for concrete delivery was awarded to Aggregate Industries, which was part of Holcim Group (now LafargeHolcim). They won the contract based on price competitiveness, and the capacity and commitment to supply sustainable concrete mixes to the various project developers by sustainable transport modes. They selected a range of secondary and recycled aggregates and single-sized materials (such as a by-product from China Clay = stent; recycled rail ballast, recycled demolition waste, glass sand), proposed several concrete mixes that addressed the sustainability requirements and tested these mixes by applying regulations of the Quality Scheme for Ready Mix Concrete.

Subsequently, supply contracts were set up directly between Aggregate Industries and the various tier one contractors (project developers) who were responsible for specifying concrete requirements more precisely for their respective projects. They were contractually required to source concrete through Aggregate Industries (making use of the on-site concrete batching plant for ready-mix concrete) and not through other supply networks. ODA’s Delivery Partner encouraged project developers to identify and request cost-effective, locally sourced recycled aggregates for the concrete mixes, and utilize Portland Cement substitutes as much as technically feasible (giving preference to fly-ash but also considering ground granulated blast-furnace slag [GGBS]).

4. Solutions and Achievements

The mandatory sourcing from the selected concrete supplier triggered the need for early supply chain interaction, induced collaboration between project developers in terms of sharing best practices (e.g., include longer setting time for sustainable concrete mixes when calculating construction time frames) and triggered demand bundling. As a result, sustainable concrete mixes were developed (in line with specific quality requirements, time and budget constraints) and sourcing of precast concrete was reduced significantly. Due to requiring specific raw materials characteristics (setting time) for efficient processing in precast concrete manufacturing, the use of Portland Cement substitutes was hardly possible. Hence, a significant reduction of the embodied carbon footprint of concrete would not have been feasible. To develop viable sustainable alternatives, the ODA provided funding for testing site-wide ready-mixed concrete solutions with several project developers. Resulting environmental benefits likely would not have been feasible if contractors were required to source concrete independently.

Smart design of infrastructure projects decreased the estimated use of concrete by more than 13 per cent, which equals a savings of more than 20,000 tonnes of carbon dioxide (based on UK average carbon dioxide figures for ready-mix concrete with 18 per cent ground granulated blast-furnace slag [GGBS] content, and pre-cast concrete with 0 per cent Portland Cement substitution) and 120,000 tonnes of primary aggregates. An above-average use of fly ash and GGBS for Portland Cement substitution was achieved for sub-elements of many projects (32 per cent substitution on average). Cement substitution achieved 11.6 per cent carbon dioxide savings compared to the U.K. industry average, which equals 14,200 tonnes carbon dioxide savings. Moreover, a high share of recycled aggregates was used in concrete mixes (on average 21.9 per
cent), which avoided the use of 169,000 tonnes of primary aggregates. Due to sustainable transport modes used by the concrete supplier, 6,200 tonnes of carbon were saved and more than 70,000 heavy vehicle movements on local roads and highways were avoided. From a project-level perspective (from raw materials sourcing until finalized construction projects), approximately 24 per cent carbon dioxide savings, equivalent to 29,000 tonnes of carbon, can be associated with the sourcing of low-carbon concrete solutions for the London Olympic Games. The study by Hensen (2011) provides various project-specific case studies with details about used ready-mix concrete and achieved carbon dioxide savings.


4.3.1.3 Award criteria

Award criteria are used in the final tender evaluation. To ensure the selection of low-carbon infrastructure solutions, it is decisive to move beyond considering the lowest bid price and rather use further criteria to identify the most economically advantageous tender. Methodologies for how to arrive there are explained in Section 4.3.2. Generally, criteria used for pre-selection as well as tender design criteria (technical and functional) can be used during the award stage. It is important to operationalize these criteria to assess the bidders’ performance and distinguish between them. This can be done by defining more concise sub-criteria and key performance indicators on the (sub- or final) product or project level (e.g., embodied carbon content of cement measured in tonnes of carbon dioxide emitted per tonne of cement produced; embodied carbon content of concrete measured in tonnes of carbon dioxide emitted per tonne of concrete produced; life-cycle carbon footprint of bridge element during a lifetime of 40 years).

4.3.1.4 Contract performance criteria

Contract performance criteria or clauses serve to make submitted (environmental) performance levels of the winning bidder formally binding (e.g., carbon footprint of materials that have been proposed by the bidder in response to functional tender specifications) and incentivize compliance with issued technical tender specifications during contract execution. Moreover, contract performance clauses can explicitly include environmental considerations concerning contract execution if these clauses are published in the call for proposals or procurement documents and are linked to the subject matter of the contract (Directive 2014/24/EU Article 70; Directive 2014/25/EU Article 87). Performance clauses for supply contracts can include the provision of specific low-carbon construction materials with specified carbon footprints as promised by the winning bidder (and verified by a third party). Supply contracts can also include service and works elements (e.g., ensure low-carbon transport modes, resource-efficient construction work and proper waste management, etc.).

Monitoring the performance of contractors is important for enforcing compliance. Monitoring can be accomplished through requested reporting and provision of evidence (may be confirmed by third parties), third party auditing and/or performance monitoring by staff of the contracting authority itself (EC, 2016). Associated penalty and bonus payment systems provide valuable incentives for
performance compliance and performance improvements. Key performance indicators (related to performance criteria) help to monitor and apply the penalty and bonus system. Through indicators, operational performance levels such as durability of supplied materials, insulation characteristics or even carbon absorption capabilities of materials within indicated timespans can be monitored.

### 4.3.2 Tools for tender evaluation

Award methodologies and evaluation tools serve to compare received offers in response to a call for proposals. Implementing MEAT means that VfM goes beyond evaluating tenders based on lowest price. Other criteria, in this case low-carbon criteria, can and must be taken into account to make sure that public procurement supports innovation and low-carbon policies. For integrating carbon emissions into the tender evaluation and hence incentivizing interested contractors to develop low-carbon infrastructure solutions, several options for operationalization are available. Figure 12 shows three different, but not mutually exclusive, options of how to integrate carbon performance into the evaluation of tenders.

**Figure 12. Evaluation of carbon performance**
Profile and Capacities of Bidding Consortium: An assessment of the organizational capacities and experience of a bidding consortium to implement low-carbon infrastructure solutions. Criteria that can be used for evaluation have already been described with respect to the pre-selection of suppliers (carbon management system, sustainability expertise of executive team, project references, etc.).

Project- or Material-Focused Criteria and Targets: This option is strongly related to the evaluation of the specifications (technical or functional) that were promoted in the call for proposals. Evaluation criteria can be defined on project or material levels.

Technical as well as functional specifications can be linked to specific minimum target levels that must be fulfilled by all bidders. For example: cement must contain at least 35 per cent GGBS (area-specific, technical specification), the embodied carbon footprint of one tonne concrete must not exceed a certain amount of tonnes of carbon dioxide (area-specific, functional specification that does not prescribe by which means to achieve a low-carbon footprint for concrete), the life-cycle carbon footprint of the constructed building must be 20 per cent lower than the reference/average building design (open-ended, functional specification that does not prescribe either the area of action or the means by which to achieve a low-carbon footprint). If the bidder achieves defined targets, points will be awarded. Additional points can be awarded if the proposed performance level exceeds the target level. The case study of the London Olympic Games provides an example of how targets can be set and used for tender evaluation (Box 9).

Alternatively, functional criteria can be defined without setting a target level while only assessing the performance (e.g., embodied carbon footprint of used concrete). A certain scoring scale must be predefined to rate and distinguish the submitted performances of different bids.

Environmental Cost Indicator/Shadow Price: This approach suggests that all prioritized quality criteria of a public tender, such as the environmental impacts of an infrastructure project, have to be quantified within the proposal of each bidding consortium. Subsequently, a monetary value can be assigned to environmental impacts to integrate these into the bid price. LCAs of an entire project or used materials serve to determine the environmental profile of an infrastructure project. The evaluation can be supported by requiring third party verification (e.g., environmental product declarations) and certification schemes. For an example of this approach, see Box 10 on DuboCalc.
Box 10. DuboCalc: Operationalizing MEAT in the Netherlands

1. Background

Rijkswaterstaat (RWS), the Dutch Ministry of Infrastructure and the Environment, is responsible for the procurement of many infrastructure assets in the Netherlands. In line with ambitions of the Dutch House of Commons to establish sustainable procurement by 2015 in Dutch public authorities, RWS promoted the development and use of different tools for integrating sustainability considerations into the design and procurement stages of infrastructure projects. At the same time, the elaborate application of these tools throughout the procurement cycle supports performance-based tendering (rather than prescribing technical specifications) and innovation for sustainability.

2. DuboCalc: Purpose and Functionality

DuboCalc is a software tool that calculates and quantifies the environmental impacts of used construction materials in infrastructure projects. Third-party verified LCAs (based on ISO 14040 series, N EN 8006 and CML2) of a huge variety of materials available on the market provide data for the underlying database of DuboCalc. The entire life cycle of materials—from material extraction, manufacturing and construction up to maintenance, demolition and recycling—is covered by the assessments and impacts are calculated for 11 environmental impact parameter categories (climate change, ozone layer depletion, human toxicity, etc.). Additionally, DuboCalc assesses energy consumption during the use-phase of infrastructure projects. DuboCalc converts all assessed environmental effects into a single aggregated figure, the Environmental Cost Indicator (ECI) value. This is done by applying the shadow price method, which is based on costs required for the prevention of negative environmental impacts. The lower the calculated ECI value, the lower the environmental impacts of the assessed infrastructure design.

3. Application of DuboCalc during Procurement

Role within award methodology: RWS (or any other procuring authority) predefines a maximum monetary value assigned to “environmental performance” as a criterion during tender evaluation. This monetary value is the baseline for calculating a (fictional) bid price reduction that is granted to each submitted bid. Depending on the environmental performance, the (fictional) deduction will be higher or lower. A formula (see below) serves to calculate the precise amount. The deducted monetary and the ECI value (result of DuboCalc) are inversely related—the higher the ECI, the lower the monetary value. The lower the submitted ECI of a proposal (= the lower the environmental impacts), the higher the deducted amount. Hence, proposed projects with low environmental impacts will have a competitive advantage during the bidding stage.

The following formula serves to calculate the precise monetary value to be deduced:

\[ \text{Bid Price Deduction} = \frac{(\text{ECI}_{v_{\text{max}}} - \text{ECI}_{v_{\text{ins}}})}{(\text{ECI}_{v_{\text{max}}} - \text{ECI}_{v_{\text{min}}})} \times C_{\text{max}} \]
Key:

ECIvins = ECI of assessed tender
ECIvmax = ECI of tender with highest ECI
ECIvmin = ECI of tender with lowest ECI
Csmax = Maximum monetary value assigned to the criterion “environmental performance”

Prior to a call for proposals, RWS defines the scope of the infrastructure project, uses DuboCalc to calculate the ECI value of a reference project and defines a percentage of envisioned ECI reduction. By doing this, RWS determines the general elements to be included for calculating ECI and also sets a benchmark for bidders.

Use of DuboCalc during tendering: DuboCalc is made available to all contractors that have shown interest in submitting a bid. For the calculation of environmental impacts of a specific infrastructure design, the software requires input of the amounts of all (bulk) materials used, transport distances and construction lifetime. Each interested contractor must provide these inputs while having the opportunity to use DuboCalc to estimate the environmental impacts of different design options.

Main point analysis: Analyzing the impact of single items (construction materials, processes) on the level of the ECI value.

Variant analysis: Analyzing different project design and implementation options on the ECI value.

LCA: Analyzing the impact of single life-cycle phases on the ECI value.

Since bidders are aware that a respective monetary amount will be deducted from their bid price, they need to make rational decisions concerning their level of environmental performance. For example, an environmentally friendly design could potentially require higher upfront costs; this increases the bid price while decreasing the ECI value, and hence achieves a high bid price deduction.

Tender evaluation and enforcement: The ECI values of all submitted tenders are assessed and the respective (fictional) monetary deduction for each bid is calculated based on the above Bid Price Deduction formula. Finally, the adjusted award-relevant bid price of each proposal is calculated as follows:

\[
\text{Bid Price} = \text{Submitted Bid Price (project costs)} - \text{Monetary Deduction (based on ECI value)}
\]

To avoid a situation in which bidders submit environmentally friendly design options to win a tender while being practically unable to implement them, contract clauses and a sanction mechanism are in place. The contract will determine when and how the selected contractor must demonstrate that the promised ECI value is achieved. When failing to realize the promised performance, a financial penalty equivalent to 1.5 times the fictionally deducted amount is applied.
4. Material Innovation

New materials that do not yet have the required LCA verification and hence are not yet part of DuboCalc’s database can still be included in the bids. If bidders with such materials are awarded the contract, they are required to submit an externally certified LCA prior to project implementation. In this way, the use of DuboCalc tries to minimize market access barriers for innovative building materials.

5. Long-Term Benefits of DuboCalc

Using DuboCalc and applying the MEAT methodology in infrastructure procurement does not only promote better environmental performance for the respective tender at hand but facilitates long-term sustainability and innovation benefits. In the Dutch market for infrastructure projects, it was observed that companies have started competing on environmental performance. However, it takes a significant amount of time. If the industry can rely on a continuous application of DuboCalc and the recognition of good environmental (and carbon) performance for infrastructure projects, there are long-term incentives and fewer market risks for investing in material innovations. Moreover, contractors will feel encouraged to collaborate with other value chain actors to develop low-carbon solutions and ensure the availability of sufficient volumes of such materials. Through this procurement methodology, the public sector stimulates and at the same time utilizes the market’s innovation capacities.

From 2018 onwards, DuboCalc will also help to define minimum performance requirements. For example, a maximum ECI value for asphalt will be determined and used as an exclusion criterion if bidders do not comply. By doing this, procuring authorities incentivize the market to go beyond addressing the “low hanging fruits” and increasingly invest in (low-carbon) innovation, deep into the supply chain.

Figure 13 summarizes the different elements and incentive mechanisms of applying DuboCalc and ECI within the procurement of a specific infrastructure project to stimulate sustainable design and ambitious environmental performance.
Figure 13. How Dubocalc and the ECI incentivize low-carbon performance

- Great degree of freedom in design & implementation
- Variation in degree of env. impacts among bidders likely

Reference Design
1st level of ambition
- Scope for Dubocalc calculation defined
- Benchmark ECI calculated and percentage of envisioned reduction

Percentage of min. ECI reduction
2nd level of ambition
- ECI and % of envisioned reduction included in RfP
- Max. monetary deduction defined

MEAT & Enforcement
- Formula applied to calculate adjusted (fictional) bid prices
- Sanction mechanism: 1.5 * deduction amount

Competition among bidders
3rd level of ambition
- Bidders identify design options & calculate ECI values with Dubocalc
- Submission of ECI value & bid price

Sources: EC, 2013; OECD, 2014; RWS, 2013; interviews with RWS
4.4 Innovation brokers

There is clear a role for “innovation brokers” in the implementation of strategic public procurement. These brokers can exist under different modalities and have a role at different points of the procurement cycle. In the Netherlands, the dedicated agency PIANOo was set up under the Ministry of Economic Affairs to provide technical knowledge and accompany the procurement processes of any procurement authority (at the national or subnational level) in the Netherlands. This also ensures that knowledge on the processes is being internalized within public agencies.

In Germany, the region of Nordrhein-Westfalen uses a different modality of an innovation broker (Zenit), a more semi-private actor that undertakes a role in bringing SMEs and procuring authorities together in a transparent manner.

At the EU level, the Horizon 2020 program provides financing for Pre-Commercial-Procurement and the Public Procurement of innovation. Under various calls for proposals, the funds cover the time and resources needed to set up the PCP and PPI processes, as well as subsidize a percentage of the cost of buying an innovative solution. The funds have to be deployed in various EU member states to encourage cross-border procurement and shared lessons from public procurement processes in different EU member states.

Figure 14 gives an overview of the different roles that innovation brokers can play in positioning public procurement as a driver of innovation.

**Figure 14. Roles of innovation brokers in public procurement of innovation**

<table>
<thead>
<tr>
<th>Resolving Risk Aversion in Public Sector</th>
<th>Capacity Building/ Support for Public Sector</th>
<th>Capacity Building for Private Sector (SMEs &amp; Start-Ups)</th>
<th>Improving Policy Coherence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trust building between stakeholders &amp; enabling mutual understanding</td>
<td>Facilitate internal communication between municipal departments</td>
<td>Awareness raising about public sector needs and current call for proposals</td>
<td>Mediate between different levels of policy making/ governance for PPI &amp; PCP (EU, national, regional)</td>
</tr>
<tr>
<td>Knowledge diffusion about:</td>
<td>Support for Tendering:</td>
<td>Information provision on:</td>
<td>Promotion of (crossborder) collaboration opportunities among municipalities and knowledge exchange</td>
</tr>
<tr>
<td>- Strategic role of innovation procurement</td>
<td>- Information about sector specific innovation</td>
<td>- Funding options</td>
<td></td>
</tr>
<tr>
<td>- Best practices in other regions</td>
<td>- Market engagement</td>
<td>- Tender formalities &amp; proposal design</td>
<td></td>
</tr>
<tr>
<td>- Contract design/ risk management</td>
<td>- Tender design (e.g., functional specs, tender lots for SME involvement)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- National &amp; EU funding schemes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Facilitation of consortium building</td>
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</tbody>
</table>
CONCLUSION AND
RECOMMENDATIONS
To use the public procurement process to its full potential and introduce low-carbon and innovation performance throughout the public procurement cycle, a number of actions can be implemented at both the European and national/regional levels. Optimizing the public procurement process will provide EU citizens optimal VfM for its tax contributions and will secure the EU’s long-term competitiveness of its construction and infrastructure industries in a low-carbon economy.

In the area of construction materials, in particular cement, the research demonstrates that a big hurdle for innovations to be scaled-up and deployed on a wider scale in infrastructure projects relates to risks in various areas: raw material availability, uncertainty related to performance of a new material, standards and market/investment risks. In each of these areas, public procurement authorities can play a role in mitigating the risks and removing the barriers for the deployment of innovative, sustainable construction materials. These are outlined in Figure 15.

Figure 15. Risk areas and the role for public procurement as mitigation option

<table>
<thead>
<tr>
<th>Risk Area &amp; Mitigation Options</th>
<th>Role for Public Procurement</th>
</tr>
</thead>
</table>
| **Raw material availability** | • Acquire knowledge about regional availability of raw materials  
                               | • Informed procurement strategy to put forward demand for low-carbon materials |
| • Long-term supply contracts with material suppliers. Issue: company specific but not a sector-wide solution  
  • Switch to widely available clinker substitutes?  
  • Reduction of virgin raw materials in concrete = recycling |
| **Performance uncertainty** | • PCP, launch customer + integration of pilots into large infrastructure projects  
                              | • Risk sharing and performance evidence  
                              | • Innovation Deals: temporary exemption from standards/regulation |
| • Cement standard ensures performance of cement with clinker substitutes (CEM II – CEM V)  
  • Incremental instead of radical product portfolio shifts |
| **Standards: Barrier for novel cement/binders** | • Allow performance verification schemes aside EN standards  
                                             | • Use innovative materials in less demanding applications |
| • Little prospects for EN cement & concrete standards to become both entirely performance-based  
  • Alternative pathways to verify material performance? |
| **Market & investment risks** | • Long-term infra plans and coherent policies with low-carbon priorities  
                               | • Low-carbon (functional) tender criteria and award methodology  
                               | • Shift of mind-set: Innovation facilitator |
| • Value chain collaboration to increase use of novel low-carbon materials + standardisation & streamlining carbon management along value chain |
5.1 Recommendations for the European Commission

The implementation of the new industry strategy for Europe, launched in September 2017, will be a key process for the EC to support member states and cities in their procurement of infrastructure to ensure the sector’s future competitiveness. The relevant EC Directorate-Generals, DG GROW, DG Environment and DG Connect, could foster the implementation of the following recommendations as a means to encourage, support and reduce the risks for procuring authorities in EU member states when procuring low-carbon infrastructure solutions.

5.1.1 Promote best practices

Engaging and negotiating with market parties is key when determining low-carbon priorities for infrastructure projects and for encouraging potential contractors to identify and integrate respective solutions in their offers. Any engagement is always subject to the principles of transparency and fair competition. This is essential for strategic, sustainable public procurement. To facilitate market engagement and negotiation effectively, public procurers need EU-level support in becoming negotiators and decision makers to secure VfM for low-carbon infrastructure solutions. In short: the procurement profession needs support for capacity building and professionalization. We recommend promoting best practices and lessons learned from awarded tenders and executed projects (originating in member states) that focus on low-carbon infrastructure procurement and low-carbon innovation. This can be done at various forums available for capacity building: international forums, conferences, workshops, online platforms, news alerts as well as case studies and reports.

5.1.2 Provide dedicated funding schemes

The EC can play an important role as convener of these forums and encourage knowledge sharing. The EU Horizon 2020 program is an instrumental funding scheme to promote the potential for public procurement on enhancing innovation. Moreover, we recommend the provision of EU funding to national and local procuring authorities for innovation procurement, as it is an effective approach for risk-sharing between different governance levels and can encourage procuring authorities to engage with new approaches on innovation procurement, including low-carbon innovation. These recommendations are in line with the 2017 EU Procurement Package that supports the professionalization (business skills, technical knowledge and procedural understanding) of public buyers in member states and advancing public procurement of innovation through facilitating exchange of good practices and innovative approaches.
5.1.3 Support the development and dissemination of tools that operationalize VfM and low-carbon performance across the life cycle of assets

The perception that demand for low-carbon (and other environmental) requirements entails comparatively higher expenses for infrastructure projects is caused by a continued focus on upfront costs of the project (design and build), little transparency about negative and positive externalities resulting in aggravated risk management, as well as limited knowledge about the applicability of life-cycle costing instruments for infrastructure projects. To operationalize the public sector responsibility of ensuring VfM across an asset’s life cycle, we strongly recommend the development of suitable life-cycle costing instruments for infrastructure projects, modelling tools to quantify (long-term) external costs and benefits of low-carbon solutions and methodologies to make environmental product declarations comparable. We recommend the building of regional and national LCA databases and data sharing at the EU level supported by the EC, as this will have the most widespread impact across EU member states and allow knowledge sharing across jurisdictions.

5.1.4 Facilitate priority setting and decision making on low-carbon solutions

Overcoming the institutionalized tradition of interpreting VfM as lowest price necessitates concerted efforts. Public procurers need relevant and timely assurance for implementing MEAT (such as including low-carbon performance into tender award criteria), so that public budget holders and auditors do not question (the basis of) their award decisions. Auditors also need to understand the beneficial implications of these procurement priorities and the value of an increased degree of risk taking in procurement. Auditors’ primary task must be to check procedural compliance rather than investigating whether tenders were awarded to the lowest bid price. We recommend that the EC engages in and promotes the training of auditors in member states, in parallel to public procurement officials.
5.1.5 Provide technical assistance for low-carbon tenders

Low-carbon priorities can be operationalized in public tenders through defining performance-based requirements (e.g., carbon dioxide life-cycle footprint; degree of material reuse, etc.), technical specifications that ask for low-carbon materials, and employing assessment and award methodologies that are based on full LCAs and take into account carbon performance. We recommend knowledge sharing and assistance to national and local procuring authorities in preparing, writing and evaluating public tenders for low-carbon infrastructure projects. Offering such professionalized services is meant to be temporary until sufficient capacities are established internally and/or until collaboration/joint procurement among local authorities is mainstreamed or innovation brokers are established as a measure to overcome time and capacity constraints of procuring authorities.

5.1.6 Promote the proliferation of innovation brokers

The Executive Agency for Small and Medium-sized Enterprises of the EC launched a call for proposals to promote the concept of using and establishing an innovation procurement broker. This is a welcome development. An innovation broker can also support and facilitate the procurement of low-carbon innovation for infrastructure projects. We recommend that the EC launch more similar calls, and likewise help to determine, mainstream and institutionalize innovation brokers in EU member states, especially in regions where (small) procuring authorities have limited internal capacities. Innovation brokers can be established in different organizational structures: a dedicated department or employees within municipalities (e.g., dedicated staff for the City of Amsterdam’s Startup in Residence Programme), in national- or regional-level support agencies (PIANOo in the Netherlands, Zenit in the state North-Rhine Westphalia in Germany), research institutes with specific expertise or as private consultancies. EU bodies and appointed research projects could support identifying the national-level status-quo of available innovation brokers in each member state and propose context-specific solutions for mainstreaming such innovation support infrastructure.

5.1.7 Facilitate policy coherence

A low-carbon economy is an important ambition of the EU. Likewise, the EU has placed strategic public procurement as one of the core pillars for delivering their industrial innovation and sustainable development goals. This suggests the need to more strongly promote low-carbon objectives and low-carbon innovation through public procurement. In this regard, we recommend that the EU demonstrate a leadership role throughout their activities (directives, communications, funding schemes, calls for proposals, conferences, etc.) to shift public procurement from an administrative function to a more strategic function within public authorities in EU member states. This will help to strengthen the confidence of procurement officers in member states in prioritizing low-carbon performance of procured solutions.
5.2 Recommendations for national and regional procuring authorities in EU member states

Procuring authorities are challenged to use procurement as a strategic instrument in better prioritizing low-carbon objectives, which presupposes empowerment, a change in their mind-set and adjustment of procurement practices. To this end we recommend the following.

5.2.1 Make optimal use of capacity building and EU funding opportunities

Support measures provided by the EU as well as nationally and regionally established service providers (e.g., innovation brokers) naturally have to be utilized by procuring authorities in order to make an impact. Therefore, we recommend to procuring authorities that they better inform themselves about support opportunities and that higher hierarchy levels in authorities encourage (and provide a budget for) interested procurement and/or legal staff to take part in capacity-building workshops and in identifying, becoming familiar with and utilizing value-adding resources.

5.2.2 Centralize/bundle demand to create scale and incentives for low-carbon investment

We recommend procuring authorities to pursue exchange with other authorities prior to designing and launching a tender. Collaboration among public bodies and among municipalities can promote standardized procedures for similar infrastructure projects and scale demand for low-carbon solutions. This increases the volume and value of public tenders, and provides more certainty/predictability and economies of scale for market actors. At the same time, it can reduce transaction costs for procuring authorities prior to and during tendering.
5.2.3 Facilitate cooperative business models

When public tenders are large enough in volume and/or provide long-term contractual arrangements, this can also incentivize cooperation and consortium building throughout the value chain. This can in turn lead to cooperative business models (facilitated through legal entities and/or contractual arrangements concerning responsibilities and profit sharing) that unite the expertise of different value chain actors to share risks among them, making it more appealing to integrate innovative solutions and also invest in determining standardized solutions where appropriate. Research findings show that not all details can be covered by contractual clauses, but trust and collaborative mind sets are crucial elements for these business models (e.g. @One Alliance integrates different value chain actors and disciplines, and therefore seeks to standardize and streamline new solutions that ensure efficiency while improving public services). To foster the emergence of such elements, we recommend that procuring authorities introduce and facilitate consortium building during pre-procurement dialogues and reward the integration of various value chain actors. Moreover, to allow sufficient lead time for value chain actors to advance low-carbon solutions, we recommend publishing respective infrastructure plans on national or even EU-wide information platforms significantly prior to a request for proposals.

5.2.4 Encourage dialogue throughout the procurement cycle

To plan tenders efficiently and quickly, and to determine suitable low-carbon materials for complex and innovation-oriented infrastructure projects, transparent market engagement and dialogues are decisive. We recommend that procuring authorities engage with the market continuously for having access to market intelligence, to use third-party facilitated project-specific market consultations prior to tendering and to make use of dialogue-enabling procurement procedures (i.e., the competitive procedure with negotiation or the competitive dialogue). These third parties can take the role of innovation broker.

5.2.5 Encourage performance-based procurement procedures that enable functional-based procurement

We also recommend the use of functional- or performance-based specifications with a low-carbon focus where feasible. This enables procuring authorities to promote design thinking for low-carbon objectives (among others) while not having to have expertise about available solutions for complex infrastructure projects. At the same time, performance-based specifications will allow market actors that were not involved in early planning stages to apply their expertise in suggesting technical solutions and innovations. Finally, the performance focus facilitates the identification of best available technologies in the market. A pre-condition for all these efforts is the professionalization of the procurement process, as recommended above.
5.2.6 Apply publicly available tools for carbon and environmental footprint calculations

It is important to mainstream the application of tools that calculate the carbon or environmental footprint of materials proposed for infrastructure designs and/or apply LCAs on a project level. We recommend that procuring authorities utilize such available tools by requiring bidders to use them and, if necessary, by providing information sources and supplier trainings. Through widespread and continuous application, there will be increasing data on the environmental (and carbon) footprints of products, which will gradually improve the underlying databases of such tools. This increases the credibility and encourages the use of such tools as they become more informative for all parties. For example, in the Netherlands, after introducing DuboCalc (calculation of the environmental cost indicator of proposed construction materials) almost 10 years ago, the market can now confidently use it for designing ambitious low-carbon projects. Contractors of infrastructure projects are incentivized to start innovating and collaborating with their supply chains, and use the available databases to identify low-carbon material alternatives. LCA databases must contain country/region-specific information, and submitted data need to be verified by third parties (certified environmental product declarations). Databases need to be managed by independent organizations that are recognized as trustworthy by the private and public sectors.
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