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A life cycle approach to Green Public Procurement of building materials and elements: A case study on windows

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ABSTRACT

Green Public Procurement (GPP) is a significant policy tool for reducing the environmental impacts of services and products throughout their whole life cycle. Scientific and easily verifiable environmental criteria, based on a life cycle approach, should be developed and used within procurement procedures. In this paper, Life Cycle Assessment (LCA) is applied to wood windows showing how it can support the criteria definition. After a foreword on GPP development in Italy, the evaluation features of the environmental performances of building materials and components are outlined. The LCA case study is then presented, describing the use of the analysis results to define the environmental criteria. LCA allowed to identify the main impacts and the critical processes of the window life cycle, giving a scientific framework to discuss GPP criteria with manufacturers associations and stakeholders. Nevertheless, it couldn't help neither in identifying detailed criteria for GPP nor to define numerical thresholds to be used as reference in procurement procedures. The appropriate strategies should be selected taking into account the technical status of the market, the standard development and the voluntary industry commitments, involving manufacturers associations. Finally, some elements to develop a structured approach for GPP of construction materials are presented.

1. Introduction

Sustainable Consumption and Production policies of European Union (EU) has considered Green Public Procurement (GPP) a fundamental policy instrument to reduce the environmental impacts of products throughout their life cycle, increasing innovation and efficiency in the use of energy and materials. Recently, the European Commission has set up a GPP strategy, developing guidelines and training tools and renewing the relevant regulations to encourage public authorities to reduce the environmental impact of their purchases, thanks to the introduction of environmental criteria into tendering procedures. As part of this strategy, the Commission adopted in 2008 a Communication on green procurement to give guidance on environmental criteria and propose ways of approaching voluntary or mandatory target setting [1].

Public authorities spend approximately two trillion Euros every year, equivalent to some 17% of the EU's Gross Domestic Product (GDP), for buying goods and services [2] and many are spent in sectors responsible for high environmental impacts, such as transport, buildings and furnishings. Consequently, by using their market leverage to opt for products that also respect the environment, public authorities can influence suppliers and manufacturers to produce more eco-friendly goods and services. The market created by GPP has also the potential to influence private companies and the consumers to change their consumption habits, making a significant contribution toward sustainable consumption and production [3]. As a result, the growth of GPP is seen as a means of creating a more sustainable market, allowing also to foster innovative environmental technologies, both at EU and national level.

The development of scientifically sounded, shared and easily verifiable environmental criteria, based on consistent and reliable data and methods, is a key element of this policy. Over recent years, the European Commission has encouraged Member States to develop and adopt National Action Plans (NAPs) for greening their public procurement, outlining the priority objectives at national level and setting out the environmental criteria for some priority product categories.

In Italy, the NAP for GPP was approved in April 2008 [4]. Its strategic environmental aims are fostering efficiency and savings in the use of natural resources, with a particular focus on energy and its impacts (for instance greenhouse effect), reducing both the use of dangerous substances and the waste production. According to the European guidelines, this plan identifies some priority sectors

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Nomenclature

Al	aluminum
BAT	Best available techniques
CFC-11	chlorofluorocarbon-11
CH_4	methane
CML	Centrum voor Milieukunde Leiden
CO_2	carbon dioxide
ENEA	Italian National Agency for new technologies, energy and sustainable economic development
EU	European Union
g	solar factor
GDP	Gross domestic product
GPP	Green public procurement
IPPC	Intergovernmental panel on climate change
LCA	Life cycle assessment
NAP	National action plan
NO_x	nitrogen oxides
LEED	Leadership in energy and environmental design
ITACA	Istituto per l'Innovazione e Trasparenza degli Appalti e la Compatibilità Ambientale
PO_4^{3-}	phosphate ion
PVC	Polyvinyl chloride
SO_x	sulfur oxides
SO_2	sulfur dioxide
U_w	thermal transmittance of the window
VOCs	Volatile organic compounds
WMO	World Meteorological Organization

of intervention selected among others on the basis of their environmental improvement potential, public expenditure, potential impact on the supply side, political sensitivity, market availability and economic efficiency. The construction sector, which accounts for more than 10% of the EU's GDP [5], is one of Europe's most considerable industries with significant and complex relationships with the economic, social and environmental spheres of sustainable development. Italian NAP identifies this sector and all related activities, services and products (which include construction materials, such as wood, aluminum, steel, concrete, glass; construction products, such as windows, wall and floor coverings; heating and cooling equipment; operational and end-of-life aspects of buildings; maintenance services; on-site performance of works contracts) as a priority one for which to develop detailed GPP criteria.

Despite the diffusion of some green building rating and certification schemes and the availability of some Type III eco-labels (Environmental Product Declarations) of construction materials, in Italy, since now, only limited activities have been undertaken on GPP of building products. Consequently, a technical working group has been set up by the Italian Ministry of Environment with the aim of defining minimum environmental requirements that qualify a product as environmental preferable along its whole life cycle, while ensuring an appropriate response of the market. Therefore, a case study founded on Life Cycle Assessment (LCA) methodology has been developed on windows by the Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA), with the aim of evaluating the environmental impacts of this building element along its entire life cycle in order to define the environmental criteria for public tender processes.

The aim of this paper is to present this case study showing as LCA methodology can support the definition of scientifically sounded GPP criteria for construction products, based on consistent and reliable data and methods.

2. The environmental performance of building materials and products

The assessment of the environmental performances of construction materials and products is a complex issue which requires the use of a set of comprehensive criteria [6]. The environmental impacts of these materials can be observed, in fact, at several levels: locally, if we look at the effects of activities such as quarrying or at specific impact of the manufacturing processes (e.g. dust emissions, noise); globally, as a result of the greenhouse emissions linked to the energy consumption or released during the manufacturing process; also internally, considering the effects on the health of the occupants of the building [6,7]. Therefore, a correct evaluation should adopt a life cycle perspective [8,9], considering not only the impact of materials production stage (raw material supply, transport, manufacturing of products and all upstream processes from cradle to gate), but also their contribution in the building construction process (transport to the building site and building installation/construction), use phase (energy losses, maintenance, repair and replacement, refurbishment) and, finally, end-of-life (recycling and disposal, including transport). In the existing buildings, the impacts of the use phase are usually the dominant ones and are mainly due to the building energy demand for heating and cooling [10–12]. The impacts due to the construction products manufacturing on the overall lifetime impact of a building are smaller, but nevertheless significant [11,13] and, as buildings become more energy efficient, are expected to significantly increase [14]. In order to reduce the total energy use in buildings, it's extremely important that the design of new buildings will focus not only on reducing the required operational energy (obtained by burning fossil fuels or consuming electricity in lighting, heating and cooling systems), but also on the choice of building materials [14].

In the EU a lot of work has been carried out in order to improve the energy efficiency at building level, even if the focus was often limited to the heating system, neglecting the energy demand for the cooling system. In the European Commission Directive on the Energy Performance of Buildings (2002/91/EC) [15], minimum standards on energy performance of new and existing buildings have been required. Moreover, several green building rating and certification systems have been developed (in Italy, among others: ITACA [16], CasaClima [17], LEED [18]). These systems, intended to foster more sustainable building design, construction and operations, often address the problems of building materials choice in a very general way, assigning additional credits or scores to materials that meet some requirements like, for instance, a minimum recycled content, or which are recyclable, local materials or made from renewable resources, without considering the material specific production's processes and their environmental impacts. These systems, besides, often specify a minimum thermal transmittance value for the major elements of the building envelope (e.g. vertical and horizontal walls, roofs and windows) in order to guarantee an acceptable energy performance of the building.

This approach, while seems rather successful in promoting the diffusion of better performing buildings, does not give an adequate impulse to the improvement of the environmental performance of the whole production chain of building materials and products. Therefore, it's necessary to deal with these issues by adopting a life cycle approach. For each significant product category, it's preferable