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In search of standards to support circularity in product policies: A systematic approach

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ABSTRACT

The aspiration of a circular economy is to shift material flows toward a zero waste and pollution production system. The process of shifting to a circular economy has been initiated by the European Commission in their action plan for the circular economy. The EU Ecodesign Directive is a key policy in this transition. However, to date the focus of access to market requirements on products has primarily been upon energy efficiency. The absence of adequate metrics and standards has been a key barrier to the inclusion of resource efficiency requirements.

This paper proposes a framework to boost sustainable engineering and resource use by systematically identifying standardization needs and features. Standards can then support the setting of appropriate material efficiency requirements in EU product policy.

Three high-level policy goals concerning material efficiency of products were identified: embodied impact reduction, lifetime extension and residual waste reduction. Through a lifecycle perspective, a matrix of interactions among material efficiency topics (recycled content, re-used content, relevant material content, durability, upgradability, reparability, re-manufacturability, reusability, recyclability, recoverability, relevant material separability) and policy goals was created. The framework was tested on case studies for electronic displays and washing machines. For potential material efficiency requirements, specific standardization needs were identified, such as adequate metrics for performance measurements, reliable and repeatable tests, and calculation procedures.

The proposed novel framework aims to provide a method by which to identify key material efficiency considerations within the policy context, and to map out the generic and product-specific standardisation needs to support ecodesign.

Via such an approach, many different stakeholders (industry, academics, policy makers, non-governmental organizations etc.) can be involved in material efficiency standards and regulations. Requirements and standards concerning material efficiency would compel product manufacturers, but also help designers and interested parties in addressing the sustainable resource use issue.

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1. Introduction

The aspiration of a circular economy is to shift material flows toward a zero waste and pollution production system. Sustainable resource use is considered a keystone of the European roadmap to 2050 (European Commission, 2011), and to target this transition, the European Commission proposed an EU action plan for the circular economy in 2015.

There are various ways in which the transition to a circular economy can be achieved – these could be revolutionary or evolutionary. In terms of the evolution of established policy, since 2009 the Ecodesign Directive has aimed to increase security of supply and contribute to sustainable development by establishing a framework for setting ecodesign¹ requirements (European Union, 2009a) for energy-related products (ErPs i.e. products that use or

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¹ Within this work, *Ecodesign* refers to the Directive 2009/125/EC, while *ecodesign* refers to the approach to designing products with special consideration for the environmental impacts of the product during its whole lifecycle.

have an indirect impact on energy consumption). ErPs addressed by the policy account for a large proportion of current natural resource consumption (European Union, 2009a), and have to comply with ecodesign requirements in order to obtain the 'CE' marking, and therefore to be placed on the European market and move freely (European Union, 2009a).

The majority of implementing measures defined under the Ecodesign Directive to date regulate energy efficiency during the use phase. However, as energy efficiency of ErPs has improved with the implementation of this policy, the environmental impacts associated with other environmental life cycle phases have become relatively more significant (Dalhammar et al., 2014). As a result, the scope for tightening energy requirements has been reduced and attention has shifted to material efficiency. However, the absence of adequate metrics and standards has been a key barrier to the inclusion of material efficiency requirements.

International standards play a crucial cross-industry role, addressing areas such as rational production, international terminologies, safety and health protection, measurement, analysis, quality control and environmental protection (Grob, 2003). The need for standards related to material efficiency is clearly identified by Bundgaard et al. (2017) in their analysis of the processes and stakeholder interactions to better address material efficiency under Ecodesign Directive. Thus, the inclusion of requirements on material efficiency aspects in Ecodesign implementing measures could be greatly facilitated by availability of standards on: upgradeability; ability to extract key components for reuse; repair, recycling and treatment; calculation of recycled and re-used content in products; methods to identify components by their environmental impact; reusability, recyclability and recoverability indices (European Commission, 2015a).

The aim of this paper is to propose a novel framework to address material efficiency and therefore to support European policies in the transition to a circular economy. The framework can be used to map, plan and monitor the upcoming standardization activities. Our research was contextualized on the standardisation activities related to the Ecodesign Directive. Case studies are presented in order to demonstrate how a possible framework approach could involve different stakeholders (for instance industry, academics, policy makers, non-governmental organizations, etc.) to work systematically on material efficiency standards and support policies needed to promote sustainable engineering.

Starting from a literature review focused on standardisation, material efficiency and circularity in EU policies (section 2), the proposed framework is introduced in chapter 3 and tested in section 4, with two case studies represented by electronic displays and a household electric appliance. Finally, sections 5 and 6 are devoted to the discussion of the proposed systematic approach, with final remarks, opportunities and drawbacks.

2. Literature review: standards, products policies and circularity of products

We present an overview of standardization processes, including a review of existing material efficiency topics relevant to product policy, in order to 1) understand the role played by standardization in the scientific community and in technological progress, and to 2) contextualize material efficiency topics in product policy and the circular economy, and describe the standardization process.

2.1. Standards

Standardization is the result of scientific and technological activities, whose main objective is the collaborative production and dissemination of technical knowledge (Russell, 2005).

Standardization includes terminology and definitions, requirements and guidelines for testing and for result assessment, measurements, verification and validation (Goluchowicz and Blind, 2011). According to ISO, standards refer to documents established by consensus and approved by a recognized body that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context. Moreover, standards should be based on the consolidated results of science, technology and experience, and aimed at the promotion of optimum community benefits (Ping, 2011). Standards are generally used by technicians, architects, designers and engineers as guidelines for conducting a test, checking minimum requirements or conformity, but also to support design development and innovation. Therefore, they are often jointly developed by standard organizations and groups of stakeholders, to maximize safety, health, quality, environmental protection and many relevant properties related to a specific product or service (Grob, 2003).

2.1.1. A brief history of standards

The process of developing and implementing technical standards began during the industrial revolution, with firm-level standardization; manufacturing devices, raw materials, workplace operating actions were standardized in order to allow new workers to be competent to their job immediately after simple training (Ping, 2011). However, the first systematic attempt at standardization took place in France during the Revolution and focused mainly on weights and measures: comparable weights and measures were a precondition for a functioning national and international system of commerce and trade which depended on a reliable common basis for exchange (Wenzlhuemer, 2010). As a result of industrialization, nations began to create institutions for standards research and development in the late nineteenth and early twentieth century and private standardization organizations began to be established to develop voluntary standards (Russell, 2005).

As standardization became the basis for technological and industrial innovation, these organizations appeared to be a mechanism for economic regulation, providing guidelines useful to coordinate industrial supply chains. The history of standardization and standards organizations was studied by Ping (2011), who also examined the driving forces behind the need to adopt a technical standard and the role of technical standards in the context of market economies. In another work, Russell (2005) discussed the central importance of standards for business and economics: standards can create intra-firm and inter-firm efficiencies, facilitating economies of scale in manufacturing and promoting interoperability between complementary products.

Nowadays the standardization portfolio is composed of private, national, regional and international standards. There are three principal international standards bodies: the International Electrotechnical Commission (IEC), the International Telecommunication Union (ITU) and the International Standard Organization (ISO). The European Union endorses the work of the three European standards organisations (ESOs): The Comité Européen de Normalisation (CEN, founded in 1961), the Comité Européen de Normalisation Électrotechnique (CENELEC, founded in 1973), and the European Telecommunications Standards Institute (ETSI, founded in 1988) (Wenzlhuemer, 2010). Table 1 shows how these organisations divide up the work of standardisation at a geographical and product scope level.

Within the EU there are agreements to recognise international standards and vice versa. Many CEN and CENELEC standards are identical to ISO and IEC standards – around 31% of CEN standards are identical to ISO due to the Vienna Agreement (ISO CEN, 2001), and around 60% of the CENELEC standards are substantially

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