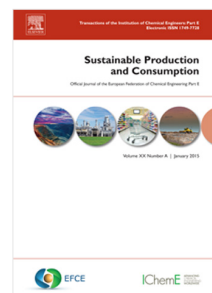


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Mapping diffusion of Environmental Product Declarations released by European program operators

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1 Mapping diffusion of Environmental Product Declarations released by European Program  
2 Operators

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8

9

10 Abstract:

11 In order to facilitate the adoption of green requirements in public procurement, European  
12 Commission has developed the Green Public Procurement (GPP) criteria for various typologies of  
13 products and services. Almost all GPP criteria require environmental labels as means of proof that  
14 the goods or supplies correspond to the required environmental characteristics. Among the labels  
15 required, there are type III labels, based on a life cycle assessment study.

16 The aim of this study is to (i) investigate to what extent a specific type III label, called Environmental  
17 Product Declaration (EPD), is spread in Europe and (ii) explore whether there is a correspondence  
18 between institutional initiatives toward GPP and the market.

19 This study explored the valid EPDs presented on the websites of the European program operators  
20 between September and December 2016. The identified EPDs were quantified and classified  
21 according to the program operator, title of the reference Product Category Rule (PCR), country,  
22 language and the product based on a classification system developed by the United Nations.

23 In total, 4,888 EPDs were collected mainly released by the Institut Baum und Umwelt e.V. (IBU) and  
24 PEP ecopassport (PEP). The obtained results showed that countries with the greater number of EPDs  
25 are France and Germany and that construction products are the types of products labelled most. The  
26 analysis of the languages used in the EPDs showed that 45% of the identified EPDs are written in

27 local languages. The obtained results have been cross-referenced with the national situations in terms  
28 of presence of National Action Plans (NAPs) and mandatory rules regarding GPP.

29 Our analysis revealed that there is correspondence between the presence of a NAP with principles  
30 towards GPP and the spread in the market of environmental labelling and that the product sectors  
31 covered by EPDs correspond to the sectors covered by GPP criteria.

32

33 **Keywords:** Environmental Product Declarations, EPD, Product Category Rules, Type III labels,  
34 Program Operators

35

36 **Highlights:**

- 37 - The diffusion of EPDs, which are type III labels, was analysed
- 38 - The EPDs emitted by Europe-based program operators were studied
- 39 - The EPDs were cross-referenced with GPP actions plans and criteria
- 40 - Construction products and electronics are the most labelled products
- 41 - The countries with greater number of EPDs are France and Germany

42

43 **1 Introduction**

44 In Europe the procedure of public procurement is regulated by Directive 2014/24/EU of the European  
45 Parliament and of the Council published in 2014 (EU, 2014). Among the numerous principles and  
46 requirements reported in this Directive, it is stated that when contracting authorities intend to  
47 purchase goods or services with specific environmental characteristics they may require a specific  
48 label, based on objectively verifiable and non-discriminatory criteria, as mean of proof that the goods  
49 or supplies correspond to the required characteristics. The labels that can be used have to be  
50 established in an open and transparent procedure in which all relevant stakeholders may participate;  
51 have to be accessible to interested parties and the related requirements have to be set by a third party  
52 (article 43) (EU, 2014). Consequently, contracting authorities have to require environmental labels

53 meeting the requirements of Directive 2014/24/EU, but at the same time companies that aim at taking  
54 part in a public tender have to extricate themselves among several labels.

55 At international level, labelling schemes can be classified into three typologies, namely type I, II, and  
56 III, based on the methodology used. Specific standards exist for each typology: the International  
57 Standards Organization (ISO) has published ISO 14024 for type I labelling scheme (ISO, 1999), ISO  
58 14021 for type II labels (ISO, 2016), and ISO 14025 for type III labels (ISO, 2006). Type I  
59 environmental labelling is a scheme which awards a mark or a logo based on the fulfilment of a set of  
60 environmental criteria and type II environmental declaration is a self-declared claim made by  
61 manufacturers (ISO, 2012). Type III environmental declarations present environmental information  
62 on the life cycle of a product to allow comparisons between goods with the same function and to help  
63 purchasers and users to make informed comparisons between products. They are aimed to be used in  
64 business-to-business communication, but they can also be used in business-to-consumer  
65 communication (ISO, 2010).

66 In order to facilitate the adoption of green requirements in line with Directive 2014/24/EU, European  
67 Commission has also developed the Green Public Procurement (GPP) criteria for various typologies  
68 of products and services (EC, 2018). With reference to the environmental characteristics of products  
69 or services, almost all GPP criteria refer to type I labels whereas some GPP refer to type III labels  
70 (Dodd et al., 2016). As reported in ISO 14025, in the practice of developing type III environmental  
71 declarations, programmes and declarations themselves are referred to using various names, among  
72 which Environmental Product Declarations (EPDs) (ISO, 2010).

73 The elaboration process of EPDs is managed by a specific body, called the program operator or EPD  
74 operator which in general conducts an environmental declaration programme (Ingwersen and  
75 Stevenson, 2012). The program operator can be a company, a public authority, a scientific body or  
76 another organisation. An EPD has to be created based on an appropriate set of specific rules, called  
77 Product Category Rule (PCR), which identifies and describes the process of preparing an EPD,

78 making it comparable and verifiable (Butt et al., 2015). Besides the programme operators, also the  
79 European Committee for Standardization (CEN) has developed some European Standards to be used  
80 as PCRs recently. For instance, EN 15804:2012+A1:2013 provides core product category rules for all  
81 construction products and services and allows that EPDs of construction sector are derived, verified  
82 and presented in harmonised way (CEN, 2013). Other European Standards complementary to EN  
83 15804 are EN 16810 (CEN, 2017a), EN 16783 (CEN, 2017b), EN 16757, (CEN, 2017c), EN 16485  
84 (CEN, 2014) and EN 16908 (CEN, 2017d).

85 In this context, the debate on the relationship between environmental issues and business  
86 performance at the company level is still ongoing (Boons and Wagner, 2009; Mazzi et al, 2016) and  
87 as highlighted by Yenipazarli (2015), companies should identify more suitable ways to label their  
88 products, but they should also understand the implications, market needs, and production constraints.  
89 Besides the introduction section, this article is organised as follows: a literature review about the  
90 evolution of the studies about EPDs and the usefulness of GPP as environmental friendly policy is  
91 presented in section 2; the research goals are presented in section 3; the methodology used to develop  
92 this study is described in section 4; the results obtained are presented in section 5 and discussed in  
93 section 6. The study is concluded in section 7.

94

## 95 2 Literature Review

### 96 2.1 Development of the EPDs for environmental performance measurement

97 Fet and Skaar (2006) presented one of the first papers about PCRs and certification procedures of  
98 labels based on ISO 14025 requirements. They aimed at demonstrating how EPDs were developed  
99 based on PCRs and in line with ISO 14025 taking into considerations examples from the furniture  
100 industry in Norway. They established an environmental database for Norwegian furniture and then  
101 prepared PCRs and EPDs for a selected product group, obtaining a consensus document for seating  
102 accommodation. The opportunities for companies in the development of EPDs were investigated by

103 Manzini et al. (2006). They conducted an empirical analysis on 17 companies explaining that the  
104 attractiveness of EPDs is a result of the synergic action of firm specific factors, such as Life Cycle  
105 Assessment (LCA) competence, financial resources and strategy, and industry level factors, such as  
106 product complexity supply chain fragmentation and stakeholders.

107 Del Borghi et al. (2007) performed four LCA studies of four waste disposal sanitary landfills in the  
108 framework of the International EPD® System (IES), a programme operator based in Sweden. In  
109 particular they analysed the comparability of EPDs results for different products in the same product  
110 category and obtained that it was possible to compare different EPDs for the same product category  
111 under specific conditions. Zackrisson et al. (2008) investigated EPDs as a mean to overcome the  
112 communication barriers, discussing the experience of 10 European companies; whereas Steen et al.,  
113 (2008) developed three interpretation keys to improve understanding of data and results of EPDs.

114 Two papers contributing to the development of two specific PCRs were published for food products  
115 (Shau and Fet, 2008) and for waste water treatment (Del Borghi et al., 2008).

116 Some studies were elaborated focusing on alignment between PCRs and comparison between EPDs  
117 and so providing a worldwide overview and a list of the existing program operators. These studies  
118 were developed by Subramanian et al. (2012) which elaborated a template to compare different PCRs  
119 towards a global alignment for five different product categories, such as milk, dairy products,  
120 horticultural products, wood and laundry detergents and by Ingwersen and Stevenson (2012) which  
121 analysed the development process of PCRs highlighting the critical aspects hindering their alignment.

122 Among the recommendations suggested by Ingwersen and Stevenson (2012) there were the use of a  
123 classification system to develop a clear structure for mapping products to categories, the elaboration  
124 of national and international data for key processes and the creation of global PCRs in order to limit  
125 geographical, restricted PCRs.

126 In 2013 Modhal et al. studied the importance of precise definitions regarding data quality in EPDs  
127 based on the fact that differences in the utilisation of data when performing an LCA may lead to  
128 incomparable EPDs.

129 Successively, in order to identify harmonisation potential, Hunsager et al. (2014) compared PCR  
130 development quantifying existing PCRs and EPDs in the world and studying rules and requirements  
131 among different programme operators. They identified, through their analysis conducted in May  
132 2013, 27 programme operators, 556 PCR documents and 3614 EPDs.

133 In parallel, Minkov et al. (2015) analysed how many Type III programme operators existed, how they  
134 developed and if there was harmonization among them. They reviewed the active programme  
135 operators, their reference documents and existing approaches for harmonization and showed that  
136 there were differences among the rules of different programme operators even if ISO 14025 was  
137 considered a common reference, however they also highlighted that supplementary documents  
138 specific for countries, or sectors, provided more explicit guidance. In the same year, Butt et al. (2015)  
139 focused on the appropriateness of LCA and also of PCRs for green procurement, limiting however  
140 the analysis to the case of road construction.

141 Besides this, Ibáñez-Forés et al. (2016) analysed the evolution of PCRs and the demand of EPDs  
142 through the Swedish program operator FES and conducted a survey to identify the factors that had led  
143 companies, mainly based in Sweden, Spain, and Italy, to adopt EPDs as communication tool. They  
144 observed that the categories “Food & agricultural products” and “services”, followed by “construction  
145 products” presented the greatest number of EPDs and that the countries with the highest number of  
146 products with EPDs were Italy, Sweden and Switzerland. They also revealed that the main factors for  
147 adopting EPDs by companies were communicating objective information and improving corporate  
148 identity, whereas the main weakness was lack of knowledge of consumers about EPDs. Strazza et al.  
149 (2016) explored the utilisations of EPDs not only as a communication tool but also as a source of  
150 data for LCA. They analysed the effects of using data reported in EPDs for a specific case study of

151 water bottles distributed on board of a cruise ship. They obtained that this practice generated  
152 consistent results under specific conditions.

153 More recently, several papers have been published with reference to the construction sector. For  
154 instance, some authors deepened the issue of harmonization: Schlanbusch et al. (2016) explored the  
155 experiences with LCA in the Nordic building industry and highlighted the need to harmonize the  
156 existing building LCA tools and Gelowitz and McArthur (2016) investigated the effects of EPDs in  
157 Leadership in Energy and Environmental Design (LEED) rating system. They highlighted that EPDs  
158 were useful to justify specific material selections however the number of EPDs in North American  
159 market was limited and the lack of EPDs harmonization could lead to the exclusion of a well-  
160 performing product. In sight of this they conducted an analysis of 50 EPDs of three types of  
161 construction products and showed that 82.5% of analysed EPDs were not completely in line with ISO  
162 14025 and 8% contained contradictory information (Gelowitz and McArthur 2017). In parallel, other  
163 authors presented new program operators, for instance Sariola and Ilomäki (2016) discussed the  
164 importance of reliable sources of environmental information regarding the building products in  
165 Finland with reference to the Finnish national EPD program launched in 2016 and Mukherjee and  
166 Dylla (2017) discussed the challenges encountered during the creation of an EPD programme for  
167 asphalt mixture. Other authors focused on specific aspects, such as Cordella and Hidalgo (2016)  
168 which analysed the key environmental areas in the design and labelling of furniture products using  
169 several EPDs and Achenbach et al. (2016) which analysed the EPDs in accordance with EN 15804  
170 and EN 16485.

171

## 172 2.2 GPP as a tool to support green products

173 Public procurement represents 14 % of the European Gross Domestic Product (EC, 2017). The  
174 Commission is developing and updating voluntary green public procurement criteria for goods,  
175 services and works in areas with high environmental impact in order to help public authorities using



176 GPP in a more strategic manner and contributing to a more innovative and sustainable economy. In  
177 addition, according to Directive 2010/31/EU on the energy performance of buildings, from 1 January  
178 2019, all new public buildings must be “nearly zero-energy buildings” (EC, 2016). Specific criteria  
179 will need to be applied systematically, leading to the need of practical support, for instance  
180 dissemination of standards and regular updates of labels (EC, 2017).

181 One of the first documents where the European Commission encourage Member States to develop  
182 publicly available plans, called National Actions Plans (NAPs), to make greener their public  
183 purchases, was the Communication on Integrated Product Policy (EC, 2003). Years later, 23  
184 countries have a NAP in force, even if still 5 countries have no NAP, namely Estonia, Greece,  
185 Hungary, Luxembourg, Romania (EC, 2018b).

186 NAPs have the task to improve knowledge and raising awareness about GPP and set general  
187 principles, even if they are not legally-binding. Despite of this, some countries have developed  
188 mandatory rules to increase the application of green criteria in GPP for some sectors. For instance,  
189 Austria and Bulgaria have mandatory rules for vehicles and energy efficiency; Croatia for energy  
190 efficiency; Czech Republic for furniture and IT equipment; Denmark for timber, vehicles and energy  
191 efficiency; France for vehicles, dematerialized communication technology, sustainably managed  
192 wood, organic and sustainably-made food, the development of car-sharing transportation, and the  
193 making of a carbon footprint on the State buildings; Germany for wood; Italy for several product  
194 sectors such as construction, clean services, waste management, street and office furniture (EC,  
195 2018c).

196 The fact that public procurement can act a key role towards environmentally friendly procurement is  
197 also highlighted in the scientific literature. An environmental oriented public procurement means to  
198 give greater consideration to products and services with better environmental characteristics and with  
199 eco-labels (Tarantini et al., 2011; Bakir et al., 2018). Brusselaers et al. (2017) quantified the leverage  
200 effect of GPP in Europe on the consumption and production of green wood. They showed that the

201 GPP for wood in Europe stimulates the consumption and production of certified wood. However, this  
202 leverage effect is not transposed into each region's consumption. Testa et al. (2012) assessed the  
203 determinants and drawbacks of green procurement adoption. Based on survey data and by applying a  
204 regression they found that effectiveness of GPP is strongly related with the investments in  
205 technological innovations and reputation. They showed that environmental policies, such as GPP, are  
206 able to influence the innovation abilities of the firms (Testa et al., 2012), and that relevant limitations  
207 linked to the small size of public authorities can be faced with national and local supporting  
208 initiatives (Testa et al., 2016).

209 Fuentes-Bargues et al., (2017) conducted a study of the use of environmental tendering criteria in the  
210 Spanish public construction. The results showed that the use of environmental criteria in Spanish  
211 public sector construction procurement is low in comparison to a certain group of countries, known  
212 as “Green 7” (Austria, Denmark, Finland, Germany, Great Britain, The Netherlands, and Sweden).

213 Ghisetti (2017) investigated the role of governmental demand in stimulating ‘greener’ production  
214 choices and confirmed the importance of green procurement to achieve a decarbonised and  
215 sustainable growth.

216 As exposed by Cheng et al. (2018), in their extensive literature review about adoption and  
217 development of GPP, the public sector can influence green procurement with suitable policies and  
218 encouraging “green” markets through public purchases, even if with different paces in different  
219 countries. Cheng et al., (2018), showed that there is an overall lack of studies about GPP, that the  
220 adoption of LCA-based award criteria in real life is limited and that there is a lack of analyses in  
221 environmental performance tracking and measurement. They also highlighted a limited reference to  
222 life cycle analyses and eco-labels.

223

224 3 Research goals

225 In recent years, different studies have explored the development and the utilisation of environmental  
226 labels such as EPDs, however, as highlighted by Cheng et al. (2018), there is an overall lack of  
227 studies about GPP. There are still some weak points in the analysis of the adoption of environmental  
228 labels with reference to GPP, namely (i) the lack of studies focusing on the diffusion of the EPDs  
229 released by Europe-based programme operators after the publication of Directive 2014/24/EU and  
230 (ii) the lack of studies exploring whether the market is ready to fulfil the environmental requirements  
231 of Directive 2014/24/EU, specifically whether their products present environmental labels with the  
232 requested features of EU (2014) – article 43.

233 Thus, in order to solve the above-mentioned gaps, this study aims at (i) investigating to what extent  
234 EPDs are spread years later the publication of Directive 2014/24/EU, identifying which are the  
235 countries with the greater number of EPDs and (ii) exploring whether there is a correspondence  
236 between national institutional initiatives and the initiatives of firms in terms of environmental  
237 labelling. This study aims at knowing how many EPDs are spread in Europe, in which market sector,  
238 for each European country analysed, also considering the presence of national NAPs and mandatory  
239 rules.

240 Thus the novelty of this paper is the following: this is the first analysis about the diffusion of EPDs  
241 after the publication of Directive 2014/24/EU with the highest number of EPDs analysed, this is the  
242 first comparison over time and the first identification of countries, sectors and languages together. It  
243 is also the first analysis which cross-references the activities of the European firms in terms of  
244 products' labelling and the institutional activities in terms of GPP.

245

#### 246 4 Methodology

247 This study analyses the diffusion of EPDs after the publication of the European Directive  
248 2014/24/EU and thus it is focused on EPDs released by European program operators, which represent  
249 56% of program operators in the world (Minkov et al., 2015).

250 The methodology used for this study follows the steps implemented by Ibáñez-Forés et al. (2016) for  
251 their analysis of the implementation of EPDs. Ibáñez-Forés et al. (2016) developed a twofold  
252 analysis: firstly they analysed the evolution of the implementation of EPDs and PCRs counting and  
253 classifying the documents released by IES and then elaborated and distributed a questionnaire to  
254 companies to understand the factors affecting the demand of EPDs. Our study makes reference only  
255 to the first part of the study developed by Ibáñez-Forés et al. (2016).

256 The most updated list of program operators, namely that elaborated by Minkov et al. (2015), was  
257 analysed and 18 European program operators were selected. Out of 39 worldwide programs they  
258 listed. To update this list, further program operators were investigated through a repeated internet  
259 search and only considering the programs stating their conformity to ISO 14025. Through this step,  
260 two new program operators were added: Building Information Foundation RTS (RTED/RTS) based  
261 in Finland and EPD Italy (EPDI) based in Italy. In total, 20 program operators were selected. The  
262 first, second, and third columns of Table 1 shows the names of the program operators, their  
263 abbreviations, and origin, respectively. PCRs and EPDs were searched in published documents  
264 available on the websites of the considered program operators. The consulted websites are reported in  
265 the last column of Table 1. In some cases, operators were contacted via email for more detailed  
266 information, for instance about PCRs in use and about compliance with ISO 14025.

267 In order to select the EPDs to be analysed, the following selection criteria were defined: the EPDs  
268 must be valid, namely not expired, and verified by third parties. Thus, pre-documents and expired  
269 documents were not considered. For the EPDs presented in two or more databases, only one of them  
270 was considered to avoid double counting.

271 To assure uniformity among different program operators EPDs were downloaded in a limited period  
272 of time. Thus, the definitive download of EPDs was conducted from September 2016 to December  
273 2016.

274 All the available EPDs were analysed by cataloguing the following information: the program  
275 operator, title of the reference PCR, name of the product, and the United National Central Product  
276 Classification (UN CPC) code. They were also analysed for the language of the PCR, language of the  
277 EPD, company. It is important to highlight that 107 EPDs released by PEP and 94 released by MRPI,  
278 representing 4% of the total number of identified EPDs, were not fully available and only some  
279 details were available for further classification presented in Sections 3.2-3.5. The reference PCRs  
280 were missing, and this led to a higher difficulty in the classification of the products.

281 To analyse the implementation of EPDs by economic sector the information on the program  
282 operators and the title of reference PCRs were collected to allow a proper classification of EPDs. The  
283 UN CPC code version 2.1 (United Nations, 2015) was used to classify the EPDs because it is  
284 internationally accepted, easily accessible, and already used by some program operators as also  
285 suggested by Subramanian et al. (2012). However, only two program operators (IES and EPD Italy)  
286 reported the CPC codes in their PCRs or EPDs; hence, it was necessary to hypothesize an appropriate  
287 CPC code for most the EPDs. In many cases, the definition of the CPC code was based on Hunsager  
288 et al. (2014), which assigned this code to a large number of EPDs. The first digit of the code  
289 corresponding to a specific section was reported to make the grouping of all the analysed products  
290 more feasible. Each section is subdivided into a certain number of divisions, for instance the  
291 divisions of section 3 are: 31 Products of wood, cork, straw and plaiting materials; 32 Pulp, paper and  
292 paper products; printed matter and related articles; 33 Coke oven products; refined petroleum  
293 products; nuclear fuel; 34 Basic chemicals; 35 Other chemical products; man-made fibres; 36 Rubber  
294 and plastics products; 37 Glass and glass products and other non-metallic products; 38 Furniture;  
295 other transportable goods and 39 Wastes or scraps. Each division is divided in a certain number of  
296 group and each group is divided into a certain number of classes (United Nations, 2015).

297 Minkov et al. (2015), who commented on the language used by program operators, highlighted that  
298 some program operators presented insufficient information in English, thus EPDs were catalogued

299 based on language used to evaluate the diffusion of the information and the usability of these  
300 documents.

301 To analyse the implementation of EPDs by country and map the diffusion of EPDs, the name of the  
302 company and the country where it is based were classified. The country of the company was found in  
303 the address contained in EPDs, where the national headquarter is indicated.  
304 Successively, the situation of the countries, in terms of presence of EPDs, was cross-referenced with  
305 the presence of a NAP and of mandatory rules.

306

307 Table 1 List of the program operators included in this study

Name of the program operators	Abbreviation	Origin	Website
Building Information Foundation	RTED/RTS	FI	<a href="http://www.rakennustiето.fi">www.rakennustiето.fi</a>
BAU EPD	BMT	AT	<a href="http://www.bau-epd.at">www.bau-epd.at</a>
BRE Global Limited	BRE	UK	<a href="http://www.bre.co.uk/breglobal">www.bre.co.uk/breglobal</a>
Centrum environmentalnich prohlášení	CENDEC	CZ	<a href="http://www.cendec.cz/cs/cendec">www.cendec.cz/cs/cendec</a>
Danish Environmental Protection Agency	EPD-DK	DK	<a href="http://www.eng.mst.dk">www.eng.mst.dk</a>
EPD Italy	EPDI	IT	<a href="http://www.epditaly.it">www.epditaly.it</a>
European Aluminium Association	EAA	EU	<a href="http://www.european-aluminium.eu">www.european-aluminium.eu</a>
FDES INIES	FDES	FR	<a href="http://www.inies.fr">www.inies.fr</a>
Ift Rosenheim	IFT	DE	<a href="http://www.ift-rosenheim.de">www.ift-rosenheim.de</a>
Institut Baun und Umwelt e.v.	IBU	DE	<a href="http://ibu-epd.com">ibu-epd.com</a>
Instytut Techniki Budowlanej	ITB	PL	<a href="http://www.itb.pl">www.itb.pl</a>
PEP ecopassport	PEP	FR	<a href="http://www.pep-ecopassport.org">www.pep-ecopassport.org</a>
PlasticsEurope	PE	EU	<a href="http://www.plasticseurope.org">www.plasticseurope.org</a>
Sistema Declaraciones Ambientales de Productos for la construcción	DAPc	ES	<a href="http://www.csostenible.net/index.php/es/sistema_dapc">www.csostenible.net/index.php/es/sistema_dapc</a>
Slovenian National Building and Civil Engineering Institute	ZAG EPD	SI	<a href="http://www.zag.si">www.zag.si</a>
The Association for Environmental Relevant Product Information	MRPI	NL	<a href="http://www.mrpi.nl">www.mrpi.nl</a>

The DAPHabitat System	DAPH	PT	<a href="http://www.daphabitat.pt">www.daphabitat.pt</a>
The International EPD System	IES	SE	<a href="http://www.environdec.com">www.environdec.com</a>
The Norwegian EPD Foundation	NEF	NO	<a href="http://www.epd-norge.no">www.epd-norge.no</a>
The Spanish Association for Standardisation and Certification	AENOR	ES	<a href="http://www.en.aenor.es/aenor/inicio/home/home.asp">www.en.aenor.es/aenor/inicio/home/home.asp</a>

308

309

310 **5 Results**

311 The results section is structured as follows. Section 5.1 presents the total number of EPDs identified  
 312 in this study released by the program operators listed in Table 1 and the number of PCRs published;  
 313 section 5.2 shows the mapping of the identified EPDs per country, with a focus on the languages used  
 314 in order to evaluate the diffusion of the information and their usability; Section 5.3 shows the EPDs  
 315 by sector.

316

317 **5.1 Quantification of the extension of EPDs diffusion**

318 In 2016, the total number of identified EPDs emitted by program operators based in Europe was  
 319 4,888 (Table 2).

320 Four main program operators, namely PEP, IBU, IES, and FDES INIES released together 80% of  
 321 the EPDs emitted: PEP released 52%, IBU 28%, IES and FDES INIES 10% of the EPDs emitted.

322 These four operators were the first ones established in Europe and in particular IBU and IES were the  
 323 two program operators which published the highest number of PCRs in 2016. 56% of the identified  
 324 PCRs were published by IES and 25% by IBU. The total number of identified PCRs was 318.

325 Based on the fact that the operators are partnering organizations with contractual agreements to use  
 326 each other's PCRs, the PCRs provided by IBU and IES are often utilized also by other operators; for  
 327 instance, CENDEC uses the PCRs published by IES and ZAG EPD uses the PCRs published by IBU.

328 The number of PCRs published by other operators is low because those operators often make use of a  
 329 general PCR accompanied by other specific documents; for instance, PEP uses one PCR but presents

330 11 Product Specific Rules (PSR), reference documents which complement and explain the PCR for  
 331 Product Environmental Profile defined by PEP program, and EPD-DK uses EN 15804 as the  
 332 general PCR and then makes use of the PCRs published by CEN, such as CEN (2014).

333 Analysing the evolution over time, in 2013, the total number of EPDs released by Europe-based  
 334 program operators was 1,954 (Hunsager et al., 2014), namely in just three years the number of EPDs  
 335 grew of about 2,934 items. The results presented in this Section are discussed in Section 6.1.

336

337

338 Table 2 Quantification of the EPDs released and PCRs published by Europe-based program operators  
 339 (PO)

Name of the program operators	Abbreviation	N. of EPDs emitted	N. of own PCRs
Building Information Foundation	RTED/RTS	0	1
BAU EPD	BMT	14	8
BRE Global Limited	BRE	40	1
Centrum environmentalnich problemu <sup>a</sup>	CENDEC	17	0
Danish Environmental Protection Agency	EPD-DK	12	0
EPD Italy	EPDI	10	1
European Aluminium Association	EAA	15	1
FDES FIDES	FDES	491	2
Ift Rosenheim	IFT	227	13
Institut für Raum und Umwelt e.V.	IBU	1347	81
Instytut Techniki Budowlanej	ITB	28	1
PEP eCOPassport <sup>c</sup>	PEP	1582	1
PlasticsEurope	PE	23	1
Sistema Declaraciones Ambientales de Productos por la construcción	DAPc	17	3
Slovenian National Building and Civil Engineering Institute <sup>d</sup>	ZAG EPD	2	0
The Association for Environmental Relevant Product Information	MRPI	94	1



The DAPHabitat System	DAPH	4	1
The International EPD System	IES	500	179
The Norwegian EPD Foundation	NEF	194	19
The Spanish Association for Standardisation and Certification	AENOR	71	4
Total		1888	318

340

341

## 342 5.2 Quantification of the EPDs per country

343 Table 3 shows the results obtained by mapping the diffusion of the EPDs released by Europe-based  
344 program operators. Even if our study is focused on European programs, some EPDs they have  
345 released are spread outside Europe; for instance, in Argentina, Australia, Brazil, Canada, India,  
346 Japan, Malaysia, Mexico, New Zealand, Qatar, Russia, Singapore, Thailand, United Arab Emirates,  
347 and the United States. In total, the EPDs that belong to companies outside Europe are 222 and  
348 represent 5% of the total collected EPDs.

349 Most EPDs belong to French (1,794) and German companies (1,134) – they cover 60% of the total  
350 EPDs identified – followed by Norwegian companies (320). These EPDs belong to companies  
351 located in countries with national program operators, namely PEP and FDES in France, IBU and IFT  
352 in Germany, and NEF in Norway. Italian companies follow with 267 EPDs; however, even if Italy  
353 has a national program operator, it has been recently developed and contributes only to 10 EPDs. On  
354 the contrary, Spanish companies present 185 EPDs even if two Spanish program operators are  
355 identified (AENOR and DAPH). The results presented in this Section are discussed in Section 6.2.

356

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360

361 Table 3 Mapping of the EPDs released by Europe-based program operators

Country	N. of EPDs	%
Argentina	12	0%
Australia	35	1%
Austria	64	1%
Belgium	121	2%
Brazil	16	0%
Bulgaria	1	0%
Canada	7	0%
Croatia	1	0%
Czech Republic	24	0%
Denmark	81	2%
Finland	27	1%
France	1794	37%
Germany	1134	23%
Greece	8	0%
Hungary	1	0%
India	2	0%
Ireland	4	0%
Israel	4	0%
Italy	267	5%
Japan	1	0%
Latvia	13	0%
Liechtenstein	2	0%
Lithuania	5	0%
Luxemburg	14	0%
Malaysia	3	0%
Mexico	4	0%
Netherlands	162	3%
New Zealand	2	0%
Norway	320	7%
Poland	36	1%
Portugal	19	0%
Qatar	1	0%
Romania	8	0%
Russia	5	0%
Singapore	1	0%
Slovenia	8	0%
Spain	185	4%
Switzerland	44	1%
Sweden	130	3%
Thailand	2	0%
Turkey	90	2%
United Arab Emirates	2	0%
United Kingdom	103	2%
United States	124	3%

362

363

364 Figure 1 shows the results regarding the languages used in identified EPDs. A total of 2,117 EPDs  
365 were written in English and 566 were in two languages including English. Few EPDs were written in  
366 more than two languages. Overall, the EPDs written in English cover 55% of all EPDs identified.  
367 This means that 45% were written in a local language.

368 Table 4 shows the results regarding the languages used in PCRs. Most operators elaborate PCRs in  
369 English or two languages (German/English or French/English), covering 287 documents,  
370 approximately 90% of the total PCRs published. However, some operators, even recently founded  
371 ones, only use the local languages such as German, French, Spanish, or Italian (Table 4), limiting the  
372 diffusion of the rules included in PCRs and thus hindering harmonization, as highlighted by Minkov  
373 et al. (2015).

374 It is important to highlight, that even if some operators make use of PCRs only in English, some  
375 related EPDs are written in local language. This is the case for instance of 8 EPDs released by EPD-  
376 DK, 5 EPDs by MRPI, 1 EPD by CENDEC, 1 EPD by IES, 5 by ITB and 3 by NEF. There are also  
377 several EPDs written in local languages which are released by program operators which make use of  
378 PCRs in local languages, for instance 12 EPDs by BMT, 71 by AENOR, 9 by DAPc, 220 by IFT and  
379 1 by EPDI.

380

381 Figure 1 EPDs identified by the main language

382

383

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386

387

388 Table 4 Languages used in PCRs

Program Operators	Language used in PCRs
AENOR	Spanish
BMT	German
BRE	English
CENDEC	English
DAPc	Spanish
IES	English
EPDI	Italian
EPD-DK	English
EAA	English
FDES	French and French/English
IBU	German/English
IFT	German
ITB	English
MRPI	English
NEF	English
PEP	French/English
PE	English
ZAG EPD	English
DAPH	English and Portuguese

389

390

## 391 5.3 Quantification of the EPDs released by sectors

392 The number of EPDs per program operator associated with different UN CPC codes is reported in  
393 Table 5. A total of 43 EPDs belong to section 1 - ores and minerals, electricity, gas, and water; 310  
394 EPDs to section 2 - food products, beverages, tobacco, textiles, apparel, and leather products; 1,995  
395 EPDs to section 3 - other transportable goods except metal products, machinery, and equipment;  
396 2,399 EPDs belong to section 4 - metal products, machinery, and equipment; 132 EPDs to section 5 -  
397 constructions and construction services; one EPD belongs to section 6 - distributive trade services;  
398 accommodation, food, and beverage services, and to section 9 - community, social, and personal  
399 services; and seven EPDs belong to section 8 - business and production services.

400 Some program operators are active only for one UN CPC sector. For instance, Bau EPD, CENDEC,

401 DAPc, ITB, PE, ZAG EPD, and DAPH are active only for section 3, and EAA for section 4. The

402 section for which almost all the program operators released at least one EPD is section 3, followed by  
 403 section 4 because of the large number of construction products, mainly covered by these sections.  
 404 Sections 6, 8, and 9 are presented only in EPDs released by IES, which is the program operator that  
 405 embraces all the sections identified.

406 These results are in line with those presented by Hunsager et al. (2014), where section 4 is the section  
 407 with most EPDs, followed by section 3.

408

409 Table 5 EPDs released by program operators and UN CPC section

Program Operators	UN CPC sections									Total	%
	1	2	3	4	5	6	8	9			
AENOR			44	27						71	1%
BMT			14							14	0%
BRE	1		14	25						40	1%
CENDEC			7							17	0%
DAPc			17							17	0%
IES	23	90	125	64	129	1	7	1		500	10%
EPDI			2	7	1					10	0%
EPD-DK			10	2						12	0%
EAA				15						15	0%
FDES	7	13	433	38						491	10%
IBU	3	207	619	518						1347	28%
IFT			150	77						227	5%
ITB			28							28	1%
MRPI	7		81	5	1					94	2%
NEF	2		346	45	1					394	8%
PEP			6	1576						1582	32%
PE			23							23	0%
ZAG EPD			2							2	0%
DAPH			4							4	0%
Total	43	310	1995	2399	132	1	7	1		4888	
%	1%	6%	41%	49%	3%	0%	0%	0%			

410

411

412 Products of Section 1 are labelled quite uniformly by French, Finnish, Spanish, Swiss, Swedish,  
 413 Italian, Norwegian, UK, and German companies and products of Section 2 are mainly labelled by

414 Italian companies (90 EPDs), followed by German companies (68 EPDs). Products of section 3 and 4  
415 are labelled mainly by French and German companies. In particular, the products of section 4 mostly  
416 belong to French companies, due to the PEP operator which is significantly active in the electronic  
417 sector (total of 1,317 EPDs). Products of section 5 and 9 are largely labelled by Italian companies,  
418 which are also prevalent relative to the products of Section 8 and 9.

419 Regarding the type of products for which the EPDs are published the most, for Argentina, Australia,  
420 Brazil, Canada, Czech Republic, Greece, Israel Latvia, Lithuania, Luxemburg, Poland, Russia,  
421 Slovenia, Spain, Turkey, UK, and Ireland, the most labelled products belong to the construction  
422 sector. The products of this sector are also the most labelled in other countries. For instance,  
423 insulation products are the products labelled the most in Belgium; wood-based panels in Austria;  
424 floor covering and building boards in Denmark; doors and windows in Finland, Sweden, Switzerland,  
425 and the United States; adhesives and coatings in Germany; concrete in Norway; and floor coverings  
426 in the Netherlands and Portugal. The construction products are the most labelled ones for all  
427 countries analysed except for Italy, which presents the majority of EPDs for food and agriculture  
428 products and France, which has the majority of labels for the electronic products. The results  
429 presented in this Section are discussed in Section 6.3.

430

## 431 6 Discussion

432 The discussion section is structured as follows. Section 6.1 is about the total number of EPDs  
433 identified in this study; section 6.2 deals with the mapping of the identified EPDs per country and the  
434 presence of a NAP and mandatory rules; Section 6.3 concerns the EPDs by sector and GPP sectors  
435 covered by NAJs.

436

### 437 6.1 Discussion on the extension of EPDs diffusion

438 The obtained results showed that the total number of valid EPDs released by European program  
439 operators was 4,888 in 2016, namely 150% higher than 2013 and higher than the total number of  
440 valid EPDs in the world in 2013 (3,614) quantified by Hunsager et al. (2014).

441 This significant spread was mainly due to the growth of two program operators: i) PEP, which  
442 presented 407 declarations in 2013 and 1,582 declarations in 2016 and ii) IBU, which presented 408  
443 declarations in 2013 and 1,347 declarations in 2016.

444 The official registration process within PEP started in the end of 2011 (Vital et al., 2012) and year  
445 after year PEP has published a set of PSRs - there was only one PSRs in use in 2013 and 11 PSRs in  
446 2016. In parallel, IBU has grown and become the main program operator for construction products in  
447 Europe. This great development mirrors the development of the interest of companies of the  
448 construction sector, as discussed in paragraph 6.3.

449 On the other hand, within the 4,888 EPDs identified in this study, just a very small number was  
450 released by the two more recently established programme operators: EPDI, founded in 2015, has  
451 released 10 EPDs and RTED/RTS, launched in 2016, none. This shows that a higher number of  
452 program operators does not lead to a significant increase of EPDs, necessarily.

453

## 454 6.2 Discussion on the EPDs per country

455 The obtained results show that most EPDs belong to companies located in France (1,794) and  
456 Germany (1,134), namely two countries with two national program operators, PEP and FDES in  
457 France, IBU and IFT in Germany. This shows that a high interest of the companies in EPDs leads to a  
458 market development of program operators.

459 There is a discrepancy between the results obtained in this study and the results obtained by Ibáñez-  
460 Forés et al. (2016) which reported that the Countries with the highest number of EPDs was Italy  
461 followed by Sweden and Switzerland. This is due to the fact that Ibáñez-Forés et al. (2016) focused  
462 on IES and neglected the other European programs.

463 The obtained results also show that 45% of analysed EPDs are written in local languages highlighting  
464 the fact that a great number of EPDs are developed for national market or national tenders.

465 Thus this study allowed highlighting these two main points: 1) there is a higher diffusion of EPDs in  
466 countries hosting one or more program operators and so the need for more EPDs in a country can  
467 lead to the presence of more than one program operator and 2) several EPDs are written in local  
468 languages highlighting their utilisation for national or local market, and national tenders. This shows  
469 that several company are not ready or not interested in international tenders.

470 Table 6 cross-references the national situation in terms of presence of NAPs, year of release,  
471 presence of mandatory rules (EC, 2018c) and the number of EPDs found thorough our study. It is  
472 possible to distinguish two main groups of countries: countries without EPDs and countries with  
473 EPDs. The countries without EPDs present the following situations: they have not a NAP in force  
474 (Estonia); they have a recent NAP in comparison with the situation mirrored in our study (Malta and  
475 Slovakia); or they have a NAP but no EPDs (Cyprus). This reveals that companies in these countries  
476 are in line with the institutional situation and that they are not ready for GPP in terms of EPDs, but  
477 also their countries have not embraced yet the principles and recommendation of European  
478 Commission. Thus, this study reveals correspondence between market situation and institutional  
479 situation towards GPP policies.

480 On the other hand, the countries with EPDs present the following situations: they have a NAP in  
481 force but no mandatory rules; they have both a NAP and mandatory rules; they have no NAP.

482 The countries which have a NAP in force but no mandatory rules are Ireland, Latvia, Lithuania,  
483 Poland, Portugal, Sweden and the UK. The number of EPDs in these countries show that there are  
484 several companies ready for GPP and which are ahead future possible legal requirements; except for  
485 Ireland and Lithuania for which the number of EPDs is very limited. The countries which have a  
486 NAP and also mandatory rules are Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark,  
487 Finland, France, Germany, Italy, the Netherlands and Norway, representing 79% of the total EPDs



488 collected in our studies. The number of EPDs in these countries shows that there are a great number  
 489 of companies ready for GPP and which are in line or ahead legal requirements; except for Bulgaria  
 490 and Croatia where the number of EPDs cannot be considered related to GPP (just 1 EPD) and Czech  
 491 Republic, which presented a NAP in 2017, one year later the collection of the EPDs for this study.  
 492 Thus, this study reveals correspondence between the presence of a NAP with principles towards GPP  
 493 and the spread in the market of environmental labelling.

494 The countries without NAP are Greece, Hungary, Luxemburg and Romania, which demonstrate that  
 495 even without a national policy on GPP some companies have the interest to develop EPDs to meet  
 496 market needs.

497

498 Table 6 National situation about GPP by country (EC 2018c) and number of EPDs by country

Country	NAP in force (Yes/No)	Year of NAP	Manufactury rules	EPDs
Austria	Yes	2010	Yes	64
Belgium	Yes	2009	Yes	121
Bulgaria	Yes	2014	Yes	1
Croatia	Yes	2015	Yes	1
Cyprus	Yes	2007	No	0
Czech Republic	Yes	2017	Yes	24
Denmark	Yes	2010	Yes	81
Estonia	No	-	No	0
Finland	Yes	2013	Yes	27
France	Yes	2007	Yes	1794
Germany	Yes	2008	Yes	1134
Greece	No	-	No	8
Hungary	No	-	No	1
Ireland	Yes	2010	No	4
Italy	Yes	2008	Yes	267
Latvia	Yes	2015	No	13
Liechtenstein	No	-	na	2
Lithuania	Yes	2015	No	5
Luxemburg	No	-	No	14
Malta	Yes	2015	No	0
Netherlands	Yes	2003	Yes	162
Norway	Yes	2007	Yes	320
Poland	Yes	2007	No	36
Portugal	Yes	2016	No	19

Romania	No	-	No	8
Slovakia	Yes	2016	No	0
Slovenia	Yes**	2009	Yes	8
Spain	Yes	2008	Yes*	185
Switzerland	na	-	na	44
Sweden	Yes	2017	No	130
United Kingdom	Yes	2011	No	103

499

500

501

### 502 6.3 Discussion on the EPDs released by sectors

503 The obtained results show that the construction products and the electronic products are the most  
504 labelled products in Europe. This study also shows that the UN CPC sections with most EPDs are  
505 section 4 and 3 which cover the largest number of construction products. Several obstacles were  
506 encountered in the definition of the UN CPC sections and this fact emphasizes the need of a shared  
507 classification system to develop a clear structure for mapping products, as already highlighted by  
508 Ingwersen and Stevenson (2012).

509 Based on the results discussed in Table 6 and Section 6.2, it is possible to cross-reference the criteria  
510 covered by GPP and the sectors which the EPDs belong to, focusing on the countries for which it has  
511 been revealed a correspondence between the presence of a NAP and the EPDs in order to understand  
512 whether the sectors covered by the EPDs correspond to the sector covered by GPP criteria. Table 7  
513 shows the product sectors covered by the EPDs analysed through our study (second column) and the  
514 answer to the question ‘Are the product sectors of EPDs covered by national GPP?’ (third column).  
515 The answer is given cross referencing the EPDs sectors with the sectors reported in EC (2018c).  
516 Table 7 shows that for the majority of the analysed countries, the product sectors covered by EPDs  
517 correspond to the sectors covered by GPP criteria. In some cases, the correspondence is complete, in  
518 other cases the correspondence is partial, in the sense that GPP criteria cover more product sectors  
519 than EPDs.

520 With reference to the construction sector, which is the sector covered the most by EPDs and GPP  
 521 criteria, the significant diffusion of EPDs is associated with the following reasons: a) the GPP criteria  
 522 for the categories “office building design, construction and management” and “road design,  
 523 construction and maintenance” consider EPDs as a proof that the goods or supplies correspond to the  
 524 required environmental characteristics and thus companies are encouraged to develop EPDs; b) there  
 525 are national regulations for public tenders which require labels as a proof of environmental  
 526 features of products; c) EPDs contribute points under some rating system of the building sector, as  
 527 highlighted by Gelowitz and McArthur (2016).

528 With reference to the electronic sector, the great diffusion of EPDs, mainly released by PEP, is due to  
 529 the fact that PEP program operator was developed by electrical industry stakeholders, on a voluntary  
 530 basis and its role is to elaborate suitable reference documents concerning electrical and electronic  
 531 products (Hassanzadeh et al., 2013).

532

533

534 Table 7 Analysis of the product sectors covered by EPDs and correspondence with sectors covered  
 535 by GPP criteria

Country	Product sectors covered by EPDs	Are the product sectors of EPDs covered by national GPP? (Yes/No)
Austria	Construction products	Yes
Belgium	Construction products and plastics product (non-construction)	Yes (construction); No (Plastic product)
Denmark	Construction products	No
Finland	Construction products Wood and paper product (non-construction)	Yes (construction); No (Wood)
France	Construction products Electronic products	Yes
Germany	Construction products Electronic products	Yes

Italy	Construction products	Yes (except for some products)
	Electronic products	
	Food and agricultural products	
	Fuel and chemical products	
	Glass and plastic (non-construction)	
	Laboratory facilities	
	Machinery	
Latvia	Construction products	Yes
	Fuels and chemical products	Yes (construction); No (fuels, chemicals)
Netherlands	Construction products	Yes (construction); No (fuels, chemicals)
	Fuels and chemical products	
Norway	Construction products	Yes
	Furniture	
Poland	Construction products	Yes
Portugal	Construction products	Yes
	Metal products	
Slovenia	Construction products	Yes
	Metal products	
Spain	Construction products	Yes (construction, transport, furniture)
	Food and agricultural products	
	Furniture	
	Fuels and chemical products	
	Transport	
Sweden	Construction products	Yes (construction)
	Electricity	
	Machinery	
	Services	
	Fuels and chemical products	
United Kingdom	Construction products	Yes (construction)
	Electric products	
	Wood	

536

537

538 **7 Conclusion**

539 This study explored the valid type III labels presented on the websites of the European program  
540 operators between September and December 2016 with the aim of investigating to what extent EPDs  
541 were spread, identifying which were the Countries with the greater number of EPDs years later the  
542 publication of Directive 2014/24/EU and exploring whether the market is ready to fulfil the  
543 environmental requirements of Directive 2014/24/EU.

544 The identified EPDs were quantified and classified by the program operator and the UN CPC section,  
545 by country cross-referencing with the UN CPC section, and by the language used in EPDs and PCRs.

546 In total, 4,888 EPDs were collected, showing that the total number of valid EPDs released by  
547 European program operators was 150% higher than 2013, and mirroring the growth of interest of the  
548 companies toward the EPDs.

549 The obtained results also show that:

- 550 - It is possible to distinguish two main groups of countries in Europe: countries without EPDs  
551 and countries with EPDs. With reference to countries without EPDs, this study reveals that  
552 companies in these countries are in line with the institutional situation and that they are not  
553 ready for GPP in terms of EPDs, but also their countries have not embraced yet the principles  
554 and recommendation of European Commission. With reference to countries with EPDs, this  
555 study reveals that there are several companies ready for GPP and which are in line or ahead  
556 legal requirements and that there is correspondence between the presence of a NAP with  
557 principles towards GPP and the spread in the market of environmental labelling.
- 558 - The product sectors covered by EPDs correspond to the sectors covered by GPP criteria. In  
559 some cases, the correspondence is complete, in other cases the correspondence is partial, in  
560 the sense that GPP criteria cover more product sectors than EPDs.

561 The main limitation of this study was the assignment of the UN CPC code to the products because  
562 only some of them included the code in the content of the declaration. The codes were hypothesized  
563 based on the descriptions reported in the declarations and on the related PCRs, limiting the  
564 appropriateness of our classification. This limitation can be overcome by making the identification of  
565 the UN CPC sections, which the labelled products belong to, mandatory in PCRs and EPDs.

566 Another limitation is due to the fact that 4% of the EPDs included in this study were not  
567 downloadable (107 of PEP and 94 of MRPI) and preventing the collection of some details, namely  
568 the language used and the reference PCR used to develop the EPD. This information was useful to  
569 classify the product in the UN CPC section.

570 A difficult step in the development of this study was to understand the content of the EPDs because  
571 they were often written only in local languages.

572 A further development of this study will be the investigation of each national law which regulates the  
573 green public procurement in order to verify whether they make reference to EPDs also for other  
574 products sectors besides the construction sector and whether the number of EPDs per sector can  
575 mirror the national requirements of public tenders.

576

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581

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Figure 1 EPDs identified by the main language



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730 Highlights:

- 731 - The diffusion of EPDs, which are type III labels, was analysed
- 732 - The EPDs emitted by Europe-based program operators were studied
- 733 - The EPDs were cross-referenced with GPP actions plans and criteria
- 734 - Construction products and electronics are the most labelled products
- 735 - The countries with greater number of EPDs are France and Germany

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